SUMMARY

OF

RESEARCH

1990-1991

COMPILED AND EDITED

BY

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ENGLISH DEPARTMENT

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Foreword

The role of research at the Naval Academy is to maintain an atmosphere of scholarly excellence in which midshipmen seek knowledge. Discipline and curiosity are both essential to a naval officer and the balance of these traits determines the character of our graduates.

In the two decades since the Research Office was created, progress can be measured by the growth in research budgets, papers, books, and presentations. Naval Academy faculty and midshipmen have seized the opportunities to do research provided by local and nearby facilities, research courses, sabbaticals, and travel support.

The information presented in this report describes the research projects and productivity of our faculty and midshipmen for the 1990-1991 academic year. Each of sixteen academic departments in five divisions presents the details of its efforts. The history of the budget and productivity is presented in Figures 1 and 2, showing the growth of research by our faculty.

This growth parallels the increase in civilian faculty Ph.D's to ninety-six percent. Five research chairs were sponsored by various Naval Systems Commands and Naval Operations; research funding was distributed over basic research, exploratory and advanced development, as well as O&M,N funds enabling support for newer faculty, and are administered by our Naval Academy Research Council. Additional operating funds were devoted to supporting twenty-two faculty members' efforts in instructional development largely using faculty and midshipmen computers. Our major reimbursable sponsor, after the Chief of Naval Research, is now the National Security Agency whose $217,088 support for interactive video language instruction, four visiting faculty and fifteen summer training billets for midshipmen have become a significant part of our mission. The naval laboratories funded thirty-four faculty members' research this year for a total of $547,128. On 20 September the Chief of Naval Research signed a Memorandum of Under-

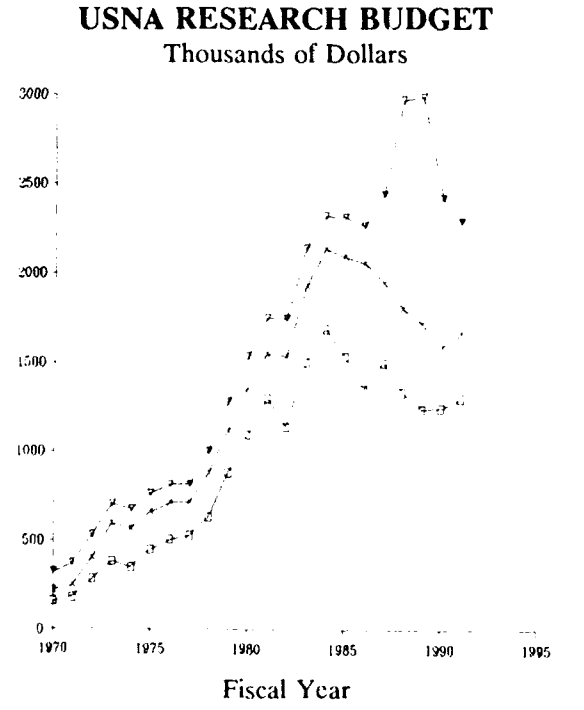

Figure 1. The growth of the research budget since 1970 reflects contributions from programs such as the (dark blue) sponsored projects of individual faculty, (blue) research chairs, and (light blue) Academy-wide programs.

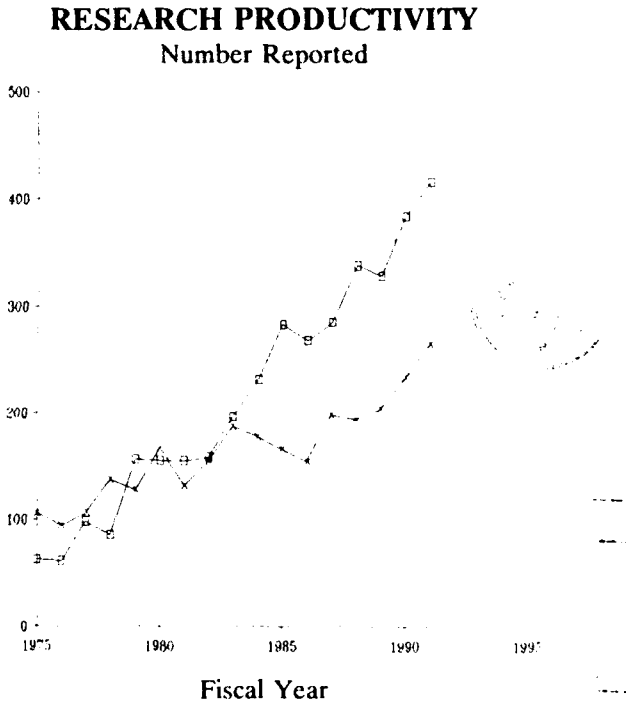

Figure 2. The productivity of faculty and midshipmen measured through publications (x) and presentations(□), has increased with the research budget.

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standing with the Superintendent of the Naval Academy, Rear Admiral Thomas C. Lynch, USN, to provide not only seed funds for technical faculty research, but also up to half salary matching that from Navy laboratories. This should stimulate increased scholarly participation in naval research.

Midshipmen participation in research at the Naval Academy continues with seventy-seven research courses and forty-eight design courses reported, eleven Trident Scholars (with thirteen selected for the coming year), 146 midshipmen using summer leave time to work with twenty Navy, DoD, and Federal Agencies, and roughly 116 travelling abroad under the Cox foreign language program.

In addition to the above agreement with the Chief of Naval Research, additional instruments of collaboration and support were added this year; the Defense Systems Management College has agreed to support faculty research, workshops, and curriculum development, and the Naval Surface Warfare Center will be funding faculty research on development of their close-in weapons system. Increasingly, departments are aligning themselves with Department of Defense sponsors in their research area. The visiting faculty program reached this year a new high of twenty-five participants, including research chairholders, Secretary of the Navy Fellows, Navy laboratory staff, two Office of Naval Technology Postdoctoral fellows, and individuals choosing to join our faculty for a period of research. Their active involvement with our faculty and midshipmen maintains a dialogue essential to our national participation.

Faculty research continues to be recognized nationally. Assistant Professor of Naval Systems Engineering David L. Kriebel was selected to receive the National Science Foundation's prestigious Presidential Young Investigator award for five years in support of his work on coastal engineering. Assistant Professor Joseph F. Lomax became the first Naval Academy faculty member in the Chemistry Department to receive a National Science Foundation research grant. His success completes our impressive four year record of eleven grants from twenty-five proposals to the National Science Foundation. Assistant Professor of History Mary A. DeCredico won the Jefferson Davis Prize given by the Confederate Memorial Library Society for her book *Patriotism for Profit* on the Confederate economy in Georgia. Research at the Naval Academy has achieved increasing recognition, and its benefits to our teaching mission are proportional.

ROBERT H. SHAPIRO
Academic Dean and Provost

CARL S. SCHNEIDER
Associate Dean for Research

Contents

Division of Engineering and Weapons

DEPARTMENT OF

Aerospace Engineering

Professor Maido Saarlas
Chair

Research conducted this year covered the full spectrum of aerospace engineering disciplines. The application of increasingly sophisticated computer methods and numerical techniques characterized most of the work performed. Sources of funding for research included the National Air and Space Administration, the Navy Research Laboratory, and the U.S. Coast Guard.

The satellite earth station was used extensively in support of both faculty research and midshipmen projects. Space shuttle missions and various satellites were used in radio communications, data link, and telemetry download experiments. Extensive work was done using numerical methods and sophisticated computer graphics techniques to solve acoustic and hull design problems of interest to the Navy and Coast Guard. Extensive work was done in analyzing flow characteristics and performance data of ultralight wing designs.

The research efforts of the aerospace engineering faculty have benefitted the Academy in three fundamental areas: Students have had opportunities to participate in research work at the leading edge of astronautical engineering technology. The Defense Department has been the beneficiary of the Academy's extensive computer resources, which have been invaluable in addressing problems currently confronting defense planners. Finally, faculty participation in developments in the field of aerospace engineering has enhanced the learning process in the classroom, from the most fundamental courses to sophisticated design projects.

Sponsored Research

Solution Techniques for the FEM Structural Dynamics Problem and FEM Structural Models using Conventional and SI Units

Researcher: Professor William J. Bagaria
Sponsor: National Aeronautics and Space Administration/Goddard Space Flight Center

The first part of this research was to investigate current and future FEM computer solution techniques. With the advent of faster, lower cost computers with larger real memories, many of the limitations of past techniques are being removed. However, each solution technique has consequences for the engineer who is creating the FEM computer model. As a result the modelers must change their strategies based on which solution technique they are using. This means that a solution technique can not be chosen based just on speed or accuracy of computation. This study primarily compared the Guyan/Givens, General Dynamic Reduction (GDR) and Lanczos eigenvalue solution methods. The Guyan/Givens method has been the most widely used method in the past. It resulted in the lowest run times with good accuracy. The problem with this method , however, is that it requires a very experienced engineer to create a model that will give good results. The GDR method is in fairly widespread use, because it does not require as experienced a modeler, although this method does require a knowledge of the expected answer in order to set properly the computational parameters. If these parameters are not properly chosen, the answers can end up being a set of random numbers. The Lanczos algorithm was developed in the 1950's, but was not practical. With the advent of faster computers with larger memories and new techniques to speed up solution convergence and accuracies, it is now the more attractive method. The study compared these three methods, on various models, using several modeling strategies. The researcher was able to suggest that the Lanczos solution method, with the appropriate modeling techniques, was the "best" analysis method to use.

The second part of this research was an investigation into the problems of converting from designing in customary units (inch, second, pound force) to SI units. There were two primary findings: First, converting the FEM model from customary to SI units by multiplying by the appropriate conversion factors resulted in answers in SI units which did not agree with the answers in customary units. The problem was caused by the required degree of accuracy of the numbers and conversion factors. Since there are spacecraft and launch vehicles in both sets of units, and they will be mated to each other, the solution is to model each component in the units it was designed and fabricated in. Then the modal model of each component can be generated. Since the mode shapes and natural frequencies are normalized, these modal models can then be combined, and the desired solution achieved. Second, the rationale for conversion to SI units was to have world-wide uniformity. It was discovered that there are more variant combinations of SI units than there are customary units. German companies are still using DIN metric rather than SI metric units; Japanese companies are using the bastard kilogram-force unit; the European Space Agency (ESA) uses $MPa \cdot mm^{1/2}$ for fracture toughness whereas the U.S. Military Design Handbook 5 and U.S. aerospace companies use the consistent SI unit of $MPa \cdot m^{1/2}$ (To convert the ESA unit to the SI unit requires a conversion factor of 31.622777660...); some companies are using gm/cc for mass densities rather than kg/m^3. The consequence of this proliferation of using units other than the fundamental SI units (meter, second, kilogram) is less consistency than when using customary units. In order to insure that different FEM models work together, it must be insisted that the fundamental SI units of meter, second, and kilogram be used. Notice however, that while the FEM model length unit needs to be the meter, the engineering and fabrication drawings use the millimeter as the length unit (The mm is the SI drawing length unit.).

Systems Engineering of the UHF Follow-On Communications Satellite

Researcher: Assistant Professor Walter K. Daniel
Sponsor: Space and Naval Warfare Systems Command

The UHF Follow-On is a communications satellite currently being designed and built for the Navy to replace the FLTSATCOM system. The researcher is investigating alternatives for the design of the attitude control and structural subsystems, as well as supporting the Space and Naval Warfare Systems Command (SPAWAR) directly. In addition to reviewing technical documentation and participating in the attitude control subsystem meeting of August 1991, the researcher delivered a series of lectures on spacecraft systems engineering to SPAWAR personnel.

Introductory Tutorials for CAD Systems in the Aerospace Engineering Department

Researchers: Assistant Professor Michael D.A. Mackney and
Mark Hurst (Science and Engineering Apprentice Program Student)
Sponsor: Naval Space Command

As part of the implementation of the Prime Computervision CADDS system and the Silicon Graphics personal workstations within the Aerospace Engineering curriculum, some introductory work was commenced during the summer of 1990. The need to produce models from which a variety of analyses may be undertaken is fundamental to modern Aerospace Engineering. Both the Prime Computervision system and the Silicon Graphics workstations represent significant resources, which with their advanced applications software, require users to have essential training. A tutorial was prepared for the CADDS system which provides simple sets of rules to help the new CADDS user learn the foundations of basic 2-D drafting.

Another tutorial was prepared for the PATRAN solid modeler running on the department's Silicon Graphics personal workstations. PATRAN can be used to prepare models for subsequent analysis by the finite element method. An advantage of the PATRAN processor is the retention of a session file from which any task can be recreated; this is particularly useful in the educational environment. The work highlighted the need for integrated facilities and a high level of qualified, trained support staff to ensure the availability of high-end engineering workstations, as well as indicating that much remains to be done to successfully implement advanced resources into the curriculum.

Asymptotic Theory of High Aspect Ratio, Nonuniform Composite Swept Wing Flutter

Researcher: Assistant Professor Gabriel N. Karpouzian
Sponsor: Naval Academy Research Council (ONR)

This research project was concerned with a development of an asymptotic theory for the flutter solution of a high aspect ratio, nonuniform composite swept wing for a prescribed spanwise distribution of geometric, structural, and inertia properties. The wing's motion consisted of two modes: (1) a bending mode representing the spanwise deflection of the elastic axis in the normal direction to the wind, and (2) a torsion mode describing the twist distribution about the elastic axis. The work aimed at specifically determining the sweep effects on the asymptotic solution for the eigenvalues and mode shapes of the flutter problem.

The purpose of this project was to find an asymptotic solution to the flutter speed and frequency and the flutter mode shapes for a nonuniform swept wing planform of high aspect ratio in the coupled bending-torsion mode. Of

special interest was the evaluation of the order of the magnitude of the asymptotic corrections due to sweep effects in comparison to previous investigations for the flutter problem of unswept wings.

The leading-order outer problem is found to be independent of sweep. The corresponding system of ordinary differential equations (ODE's) itself-adjoint, which means that the eigenvalues of this problem exist all the time regardless of sweep. Thus, in the leading-order approximation the flutter eigenvalues (speed and frequency) are the same as in the case of an unswept wing (NARC 1989). However, for the higher order outer problem, the corresponding governing ODE's for the coefficients of the expansions for the mode shapes are nonself-adjoint due to sweep effect represented by the first-order derivatives of the mode shapes, which are absent in the leading-order problem. Thus, the sweep effect enters as a higher order correction to the unswept case. The eigenvalues of these higher-order problems, if they exist, are of order of the inverse of aspect ratio, which are small corrections to the leading-order eignevalues for a high aspect wing. In the asymptotic sense, their determination is not warranted because of their relative small contribution. Therefore, the calculation of the mode shapes is based on the leading-order eigenvalues, which are obtained from matching the inner and outer solutions.

As a first cut in the design procedure, the sweep effect on the flutter speed and frequency (design limits) can then be neglected.

Computer-Aided Hull Design and Model System

Researcher: Professor David F. Rogers
Sponsor: U.S. Coast Guard

This is the continuation of a multi-year program to investigate computer-aided design for ship hulls and towing tank models. The prime area of study is improvement of ship hull fairing techniques and data manipulation techniques. The Coast Guard will ultimately intergrate the modifications into an overall ship design system.

Independent Research

Design, Fabrication, and Testing of Composite Shells for a Mars Balloon Payload

Researchers: Assistant Professor Walter K. Daniel
and Ensign Karl E. Jensen, USN

A Mars balloon is being built by the French space agency CNES, with the payload provided by a United States team. The payload is patterned after a guiderope used by hot-air balloonists for vehicle stability when flying near the surface. The Mars balloon payload will be dragged across the surface during the night and lifted off the surface when the balloon is heated by sunlight. The actual scientific payload is contained inside an articulated series of shells that is the guiderope. The researchers are investigating replacing the baseline titanium shells with composite ones in order to save weight. A finite element analysis used to determine the best ply orientation was the subject of one conference paper. A guiderope model has been built and tested. Composite shells have been manufactured at the University of Maryland and tested using the guiderope model. During this year, further analyses were performed, and the final results of the project were presented at the American Institute of Aeronautics and Astronautics Structures Conference.

Hull-Superstructure Interaction

Researcher: Assistant Professor Michael D. A. Mackney

The principal aim of this study is to investigate the fundamental behavior of the hull-superstructure interaction using numerical and experimental techniques.

The Numerical work uses the finite element technique and three purpose-written preprocessors to generate error-free data sets representing simplified hull-superstructure models. These interactive preprocessors written in True Basic permit the generation of parametric genus models, from which to study parameter sensitivity. The experimental program of work is based on six scaled acrylic models, which are extensively strain gauged and statically loaded to simulate simple bending action.

The work is ongoing, with extensive numerical case studies in-hand, and with the associated experimental program being carried out.

Research Course Project

Aerodynamics of Compound Rotor/Prop-fan Configurations

Researcher: Midshipman 1/C Troy A. Dinkel, USN
Adviser: Associate Professor Gerald F. Hall

This research effort provides for the delivery of a computer code capable of analyzing axial inflow performance and for the evaluation of the merits of the prop-fan/tilt rotor propulsion system. This code will analyze the system in hover and will also provide high speed, initially subcritical, prop-fan cruise information.

Concurrent with the numerical effort, an experimental investigation of the prop-fan/tilt rotor system will be carried out utilizing the rotor hover stand at the Naval Academy. The full scale hover stand will provide thrust and powe data as a function of vertical spacing between the rotor and prop-fan configurations, differential rotation of the two components, and power ratio.

Based on the results of the analytical and experimental methods, recommendations and a plan for the development of the prop-fan/tilt rotor propulsion system will be prepared.

Navy UHF Satellite Communications

Researcher: Midshipman 1/C Christina B. Glaser, USN
Advisers: Professor George F. Pieper and
Commander Robert Bruninga, USN (Retired)
Sponsor: Naval Space Command

This project was a study of the advantages and disadvantages of low power, weak signal voice communications. The researcher accessed Navy UHF satellites and demonstrated operations by installing terminal equipment on a Yard Patrol Craft (YP) and at the Naval Academy Satellite Earth Station Facility. Navy terminal equipment in the fleet typically uses 25 KHz channels and power levels between 10 to 80 watts. The normal modulation is wideband FM or PSK to permit secure communications. Single Sideband (SSB) is more efficient at weak signal levels and only occupies e Khz of band width. Combining the advantages of narrow bandwidth and weak signal performance, a link improvement on the order of 10 dB over FM may be possible. Also, the lower average power level of SSB improves channel sharing characteristics. Using SSB, 6 users can share a single channel.

Terminal equipment was assembled from off-the-shelf, non-development radio frequency equipment, modified to operate in the military UHF satcom spectrum. The basic SSB exciter operated at 28 MHz.

The researcher studied the concept of operations of the Navy UHF SATCOM system and spacecraft. She considered the advantages of FM, PSK and SSB modulations, and performed link calculations to determine system design requirements for the YP SATCOM System. She also participated in the design modifications to the RF hardware, allowing operations in the military UHF band, and assisted in the tuning and assembly of the system components. The project involved liaison with the Navy Space Command, Fleet Satellite Operations Center, and the Professional Development Division.

Flow Characteristics of a Lifting Body for Ultralight Design

Researcher: Midshipman 1/C Jeffrey G. Heiges, USN
Adviser: Professor Bernard H. Carson

Presented is a study of the flow characteristics of delta wing design -- the X-UL-1. The X-UL-1 is an experimental ultralight model, designed to improve the stall characteristics currently present with ultra-light aircraft. The results obtained indicate such an improvement: even at high angles-of-attack (around 32 degrees), the flow remains relatively stable and attached over the control surfaces on the trailing edge. Also, the best lift-to-drag ratio occurs at +10 degrees angle-of-attack and is approximately equal to 4.7. Finally, a preliminary design for a full-scale ultra-light aircraft was made. The actual 550-pound aircraft would require a 43-horsepower engine to establish a 200-fpm climb at the best lift-to-drag ratio. Data obtained compare favorably to expected values and should provide a good basis for future experimentation on similar designs.

Publications

BAGARIA, William J., Professor, "Speculation on the Avian Pecten as a Heat Exchanger," Letter-to-the-Editor-Section, *American Scientist*, **78**, 6 (1990), 488-489.

The structure in the eyes of birds, called the pecten, continues to mystify researchers. By looking at the features of the pecten, one can speculate on its function. The pecten is flat, heavily pigmented, and filled with blood vessels. These features would indicate that it is an efficient heat exchanger. The reasons a heat exchanger would be needed are: the bird feathers highly insulate the flight muscles, which are large producers of heat; this heat must be dissipated to prevent overheating of the bird; the cornea of the eye needs to be heated when flying in cold weather; and the temperature of the brain--which is between the eyes in birds--needs to be regulated.

BAGARIA, William J., Professor, "Undergraduate Astronautics at the United States Naval Academy," *Engineering Education*, **81**, 3 (April 1991), 386-388.

This paper describes the "astronautical engineering track" within the aerospace engineering curriculum, at the U.S. Naval Academy. This track, along with the preexisting "aeronautical track," allows a midshipman to emphasize either astronautical or aeronautical engineering. The objective of this program is to give the midshipmen the necessary astronautical engineering background so that a preliminary spacecraft design can be performed. The spacecraft design is done in the design course during the last semester of the degree program. The astronautical track was developed within the revised Accreditation Board for Engineering and Technology (ABET) guidelines. The revised curriculum was approved by the administration of the Academy in May 1986, and received ABET accreditation in July 1988.

CARSON, Bernard H., Professor, "Algorithms for Determining Planar Area Properties from Peripheral Points," Division of Engineering and Weapons Report EW 13-90, October 1990.

The determination of planar properties--cross sectional areas, centriods, moments of inertia, and so forth--plays a central role in the solution of many diverse engineering problems. Despite the increasing availability of computational power to engineers and students alike in recent years, with the advent of small desktop computers, the traditionally laborious and error-prone methods of making these determinations, involving area decomposition or strip integration, are still being taught to the present generation of engineering students, mostly due to a lack of a suitable alternative technique. These classical methods are found to be particularly difficult to adapt to general computational algorithms. This work presents a novel approach, requiring only the peripheral points of any planar area as inputs, and is ideally suited for numerical methods. It is shown that all planar properties of technical interest can be generated, once and for all, with straightforward algorithms that are readily programmed in any scientific computing language, or adapted to typical spreadsheet formats. These algorithms are fully general and require no decision-making on the part of the user. Various worked examples are presented.

KARPOUZIAN, Gabriel N., Assistant Professor, co-author, "Aeroelasticity of Anisotropic Composite Wing Structures Including the Transverse Shear Flexibility and Warping Restraint Effect," American Institute of Aeronautics and Astronuautics paper No. 91-0934, April 1991.

The equations governing the static and dynamic aeroelastic equilibrium of cantilevered wing structures laminated of advanced composite materials are derived. These equations, based upon the plate-beam model, incorporate a number of effects which are essential for the accurate prediction of their aeroelastic behavior; namely, (1) the anisotropy of the materials of constituent layers, (2) the warping restraint effect, (3) the transverse shear flexibility, and (4) the rotatory inertias.

A simple case emphasizing the effect played by transverse shear flexibility coupled with the warping restraint on the aeroelastic divergence of swept wing structures is considered, and pertinent conclusions are outlined.

KARPOUZIAN, Gabriel N., Assistant Professor, "Asymptotic Theory of Bending-Torsion Flutter of High Aspect Ratio Wing in the Torsion Controlled Domain," American Institute of Aeronautics and Astronautics Technical Note, Vol. 29, No. 5, May 1991, pp. 780-781.

An analytical study of bending-torsion flutter of high aspect ratio wing is presented in the framework of an asymptotic theory. Central to the development of the present theory are the identification of an important controlling parameter, namely, the bending-torsion stiffness ratio EI/GJ, and the

consequential identification of two distinct frequency domains, under a fixed EI/GJ, referred to as the torsion controlled domain and the bending dominated domain, respectively. The theory is developed in the torsion controlled domain, and, to substantiate its adequacy, a detailed analysis based on the method of matched asymptotic expansions is carried out in the case of a uniform unswept cantilever wing in an incompressible airflow. The results are tested against those obtained by a more exact treatment. Comparison of the asymptotic and exact calculations for the flutter eigenvalues and mode shapes lends support to the present theory.

MACKNEY, Michael D. A., Assistant Professor, and Mark HURST, Science and Engineering Apprentice Program Student, "HULGEN 3 - A Finite Element Preprocessor for Hull-Superstructure Interaction Studies-Descriptions and Listing," Division of Engineering and Weapons Report EW-14-90, November 1990.

This report gives a description and listing of the third finite element preprocessor required to generate numerous correctly formatted data sets for analysis by the GIFTS finite element system in hull-superstructure interaction studies. The earlier developed genus model for a two superstructure arrangement and its associated algorithms for topology and connectivity have been coded in True Basic to allow user selectivity for a number of preprocessor options. Editing of a process-generated file containing the essential unformatted parameters and dimensions allows rapid production of related data sets, where perhaps only a single parameter has been changed. This final preprocessor is constructed with some innovation, giving it significant usefulness in support of parametric studies.

Appendices include the full True Basic program listing, a listing of the intermediate File Maker file, and a correctly formatted full data file for subsequent analysis by the GIFTS finite element system.

MACKNEY, Michael D.A., Assistant Professor, "Hull-Superstructure Interaction Studies, Progress Report and Bibliography," Division of Engineering and Weapons Report EW-15-90, November 1990.

This report reflects part of a continuing research study of hull-superstructure interaction and covers an up-dated literature review, as well as a summary of the status of the work. The earlier literature search covered the period of 1899 to 1983, and cited sixty references of primary relevance to the study. The updated review extends the period to 1989 and includes a total of ninety-seven references. Thirty-four additional summaries are taken from the authors' papers, giving a total of sixty-two now referenced.

The second part of the report gives the status of a multifaceted study and includes a number of topics, including structural model formulation and algorithmic development, finite element preprocessor development and implementation, data generation, GIFTS finite element processing, experimental model fabrication, experimental testing rig design, development, and fabrication, experimental model strain gauging, experimental data acquisition, and structural behavior analysis. Ten of the project's phases have been initiated, some are essentially complete, and a few are yet to be initiated.

Major accomplishments include the literature search, the formulation and development of three different genus models of hull-superstructure configuration which permit-user controlled geometry changes, and the coding and implementation of three preprocessors for these genus models. These pre-processors generate correctly structured and formatted data sets for the GIFTS finite element system, are written in True Basic, and can be run on personal computers and some high-end engineering workstations.

The numerous data sets are being generated with some finite element processing. Six small scale Lucite case acrylic sheet models have been constructed and are being instrumented for an experimental validation of aspects of the numerical work. A simple loading rig has been developed which allows the models to be loaded in pure bending; and a computer-based data acquisition system is being commissioned to aid in the experimental program.

Presentations

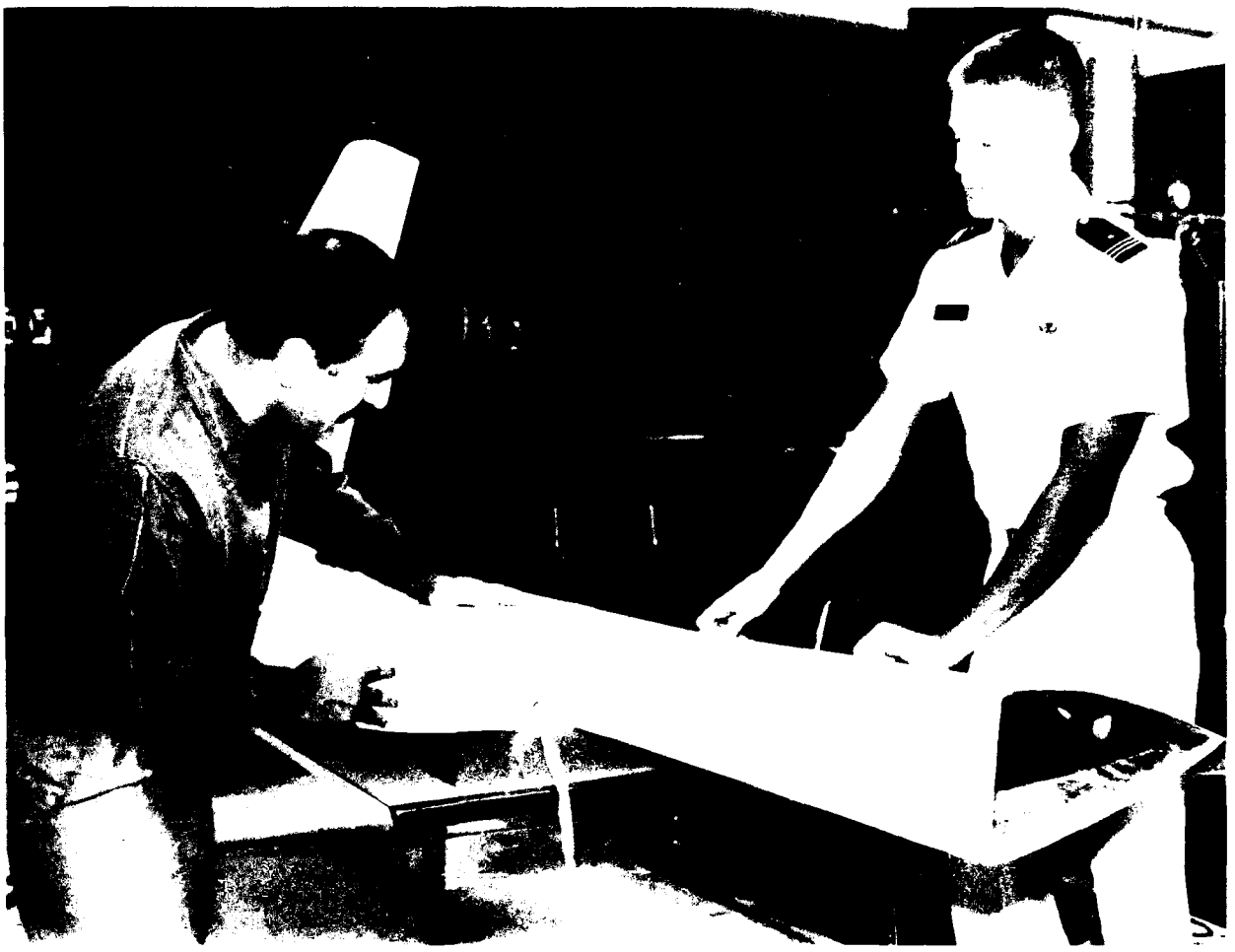
CARSON, Bernard H., Professor, "Origins of Scaling Laws for Low Reynolds Number Flight," Naval Research Laboratory Remotely-Piloted Vehicle Research Conference NUC, San Diego, California, 19-20 September 1990.

DANIEL, Walter K., Assistant Professor, "Launch Options for Small Mars Precursor Missions," AIAA/USU Fourth Annual Conference on Small Satellites, Logan, Utah, 29 August 1990.

DANIEL, Walter K., Assistant Professor, and Karl E. JENSEN, Ensign, USN, co-authors, "Design, Fabrication, and Testing of Composite Shells for a Mars Balloon Payload," AIAA/ASME/ASCE/ AHS/ASC Thirty-second Structures, Structural Dynamics, and Materials Conference, Baltimore, Maryland, 2 April 1991.

KARPOUZIAN, Gabriel N., co-author,"Modelling and Aeroelastic Formulation of Composite Anisotropic Wing Structures Including the Transverse Shear Flexibility and Warping Restraint Effects," the Society of Rheology and the Society of Engineering Science, Santa Fe, New Mexico, 21-25 October 1990.

KARPOUZIAN, Gabriel N., co-author, "Study of Divergence and Flutter of Composite Anisotropic Wing Structures Including the Transverse Shear Deformation and Warping Restraint Effects," Thirty-second Structures, Structural Dynamics, and Materials Conference, Baltimore, Maryland, 8-10 April 1991.



DEPARTMENT OF

Satellite Earth Station Facility

Robert E. Bruninga
Director

The Satellite Earth Station consists of a 40-foot parabolic dish antenna with computerized tracking capability for all orbiting satellites. It has feeds for reception of C and Ku band video signals from geostationary satellites and VHF/UHF feeds for the reception of telemetry and communications from a number of experimental spacecraft.

The research capabilities of the Satellite Earth Station were enhanced this year by the addition of a full-time engineer to the facility. Robert E. Bruninga, CDR, USN, Retired, came aboard on the maintenance contract with Bendix Field Engineering to operate the facility. He has a keen understanding of the Academy environment, having served in the Electrical Engineering Department at the Academy during 1983-1985 and has a strong background in naval communications. He provides operation and maintenance of the Earth Station Facility, as well as providing assistance to student and faculty projects.

During this year a number of experiments and special projects were performed using the facility:

OPERATION MOONBOUNCE: The dish was used by the Academy Radio Club to participate in the annual Earth-Moon-Earth communications experiments sponsored by the American Radio Relay League. During the weekend of 2 November, twenty-four stations from around the world were heard via reflections from the moon. Due to low transmit power available this year, the Academy only had one successful two-way contact with a station in New York.

SPACE SHUTTLE COMMUNICATIONS EXPERIMENTS: The Academy was one of five stations authorized by the National Aeronautics and Space Administration (NASA) and the Federal Communications Commission to attempt to transmit live video to the space shuttle *Atlantis* during mission STS-37 in April as part of the Shuttle Amateur Radio Experiment (SAREX). Using a 200-watt video transmitter and precise tracking data from NASA, the Academy successfully uplinked video during three orbits on 8 April 1991. The pictures from the Academy were the strongest of the attempts and the only ones received in color. Uplinking fast scan video to the shuttle was a first for the manned space program.

During December, the SAREX mission on Space Shuttle STS-35 was tracked for five days using the USNA dish antenna. Although two-way communications were not successful, several pages of radio communications and telemetry were received during at least a dozen orbits visible from Annapolis.

SOVIET SPACE STATION MIR: During February, the Soviet Cosmonaut Musa Manarov operated an amateur radio station on board the Soviet space station MIR. He connected his radio to his laptop computer, allowing data connections and the exchange of messages. For ten days the Academy tracked MIR and experimented with this data link, logging onto his computer on a number of occasions.

SATELLITE TELEMETRY AND TRACKING LAB: During the last week of April a satellitte telemetry and tracking lab was conducted with the students of ASTRO II, EA-462. The objective of the lab was to predict the orbit of the OSCAR-17 satellite, receive downlink telemetry, and calculate the orientation of the spacecraft based on the value of the six solar array currents. Two other spacecraft were actually used due to the limitations of lab hours and the fact that OSCAR-17 experienced a software crash the week before. OSCARS AO-16 and WO-18 were used.

NAVY UHF SATCOM EXPERIMENTS: Midshipman 1/C Christina Glaser conducted experiments through the Navy Fleet Satellite for her EA-496 independent research project. Her objective was to demonstrate weak signal narrowband modulation techniques to increase channel capacity through the existing 25 KHz FM transponders. She constructed a six-foot-long helix antenna and was able to obtain several hours of experimental time on FLTSAT-7.

TELEMETRY BALLOON: Midshipman 1/C David Stohs constructed a five-channel telemetry payload in his EE-313 Digital Design Class which measured altitude, inside and outside temperature, balloon status, and ground contact. The balloon was launched on 27 April at 10:00 a.m. and tracked for almost three hours across the DELMARVA Peninsula. The balloon reached 70,000 feet or about 12 miles and was received as far away as Connecticut. It landed in the bay water off Ocean City, Maryland, and was recovered two days later.

REMOTELY-PILOTED VEHICLE: Midshipman 1/C Gary Null constructed a

Remotely-Piloted Vehicle for his Weapons Systems Engineering project, ES-402. He received considerable assistance from the Satellite Facility on the video link from his vehicle. The video was transmitted from the vehicle back to the control station using a low power 900 MHz video transmitter, which is a prototype for future balloon launches at the facility.

YARD PATROL CRAFT SATELLITE COMMUNICATIONS: As a follow-on to Midshipman Christina Glaser's UHF satellite experiments, a project was initiated to install prototype Satellite Communications equipment on the YP's for the summer cruises. The design work is in progress for two satellite transceivers to be constructed and installed on the lead boats of each major deployment. The equipment will permit two-way message exchange between the boats and the Academy during one hour of satellite access time per day. The system will be integrated with other YP radios (HF, VHF, and UHF) to take advantage of other propagation systems.

DEPARTMENT OF

Electrical Engineering

Commander William E. Davidson, USN
Chair

Research and scholarly activity are fundamental to the vitality and viability of a discipline. This is particularly applicable to electrical engineering, which is broadly based and rapidly expanding. Research helps both faculty and midshipmen keep abreast of advancing technology and ultimately improves the effectiveness of the academic environment by encouraging a modern and relevant curriculum.

Funding for our research comes from the Naval Research Laboratory, the David Taylor Research Center, the National Institute of Standards and Technology, and from within the Naval Academy. Research topics supported by the Navy Laboratories during the past year included Interaction of Microwave Energy with Inorganic and Organic Materials, Target Characterization by Impulse Radar, Prediction of Low Rate Radiation Effects, Characterization of Ultrasonic Transducers, and Detection and Characterization of Wear Particles in Fluids. This faculty research contributes directly to our operating forces and provides relevant topics which benefit the professional as well as the academic development of our midshipmen.

Sponsored Research

Target Characterization by Impulse Radar

Researcher: Associate Professor David S. Harding
Sponsor: Naval Academy Research Council (ONR)

The researcher conducted an investigation of techniques for the processing of RADAR reflections from targets illuminated by pulse type electromagnetic fields of short duration and very wide bandwidth. The objective of such processing and discrimination includes targets such as hostile aircraft and missiles.

Prediction of Low Rate Radiation Effects

Researcher: Professor Richard L. Martin
Sponsor: Naval Research Laboratory

A method has been devised for prediction of the performance of radiation-hardened microelectronic devices when subjected to low dose rate nuclear radiation over extended times. The method uses a series of high dose rate radiation pulses separated by recovery (or annealing) times. Correlation of this method, which uses either room temperature annealing for long times or elevated temperatures annealing for short times, with actual low dose rate irradiations is presently being conducted. Analysis of the annealing results is also being performed to understand better the physical effects contributing to the annealing characteristics of the devices.

Characterization of Ultrasonic Transducers

Researchers: Professor Antal A. Sarkady and
Associate Professor (retired) Herbert Neustadt
Sponsor: Naval Research Laboratory

The aim of this research work is to develop electric circuit models and measurement systems required to characterize ultrasonic transducers. The precise characterization is required to improve inspection of welds in naval shipyards. During the last year, the circuit models of ultrasonic transducers have been improved to include coupled vibrational modes of piezoelectric crystals. During the last year, two journal papers have been published on this work.

Detection and Characterization of Wear Particles in Fluids

Researchers: Professor Antal A. Sarkady and
Associate Professor (retired) Herbert Neustadt
Sponsor: David Taylor Research Center, Annapolis Laboratory

Detection and characterization of wear particles in lubricants is an important naval problem, because an accurate knowledge of bearing wear rate is required to perform scheduled maintenance on naval ship machinery. In this research work, a focused, wideband (2.5MHz-12.5MHz) ultrasonic transducer operating in echo mode is used to detect wear debris (copper beads as small as 0.1mm in diameter) found in lubricant oil and to discriminate this debris from entrapped air bubbles of approximately equal size. In this past year, signal features of small copper beads and air bubbles of various sizes have been studied and defined; the discriminating features between air bubbles and copper beads have been identified.

Independent Research

Interaction of Microwave Energy with Inorganic and Organic Materials

Researcher: Assistant Professor Ralph W. Bruce

Research was conducted into the interaction of microwave energy with inorganic and organic materials. Design of microwave equipment as an energy source for acid dissolution of inorganic materials was also investigated. This project was sponsored by the National Institute of Standards and Technology.

Research Course Projects

Digital Modulation Delay

Researcher: Midshipman 1/C Robert A. Kovalchik, USN
Adviser: Professor Ralph P. Santoro

A programmable digital delay line that samples a 20-20KHz band-limited audio signal at 60 KHz and delays it from 1ms to 4 seconds has been designed and constructed. The design is centered on a 12-bit analog-to-digital converter and a 256-word dram memory. The application of the device is for high quality musical special effects.

Signal Acquisition Through Microprocessor Control

Researcher: Midshipman 1/C Robert A. Kovlachik, USN
Adviser: Professor Ralph P. Santoro

This work is an extension of the project entitled "Digital Modulation Delay" to include microprocessor control of the signal acquisition process and to provide general purpose digital signal processing for the acquired signal. This extended device can be operated in a stand-alone mode or through a personal computer by means of an RS232 communication port. A 68000 microprocessor with up to 512K bytes of ROM for firmware and up to 8 Mbytes of RAM provides for intelligent control of the device, which is based on the Nubus structure.

Publications

BRUCE, Ralph W., Assistant Professor, "Activation Energies for the Dielectric Loss Factor/AC Conductivity of Some Polycrystalline Ceramics," *Ceramic Transactions of the American Ceramics Society*, **21** (1991), 107-116.

By analyzing the temperature dependence of the dielectric loss factor/AC conductivity, the activation energy can be determined. Analyses will be presented based upon material type, percent of the major phase, density, and frequency. Trends in the material's behavior when placed in a microwave field can be determined from these analyses. Additionally, from the determination of the temperature at which a material's AC conductivity begins to change rapidly, the onset of a material's change in phase may be indicated, e.g., the onset of sintering. In particular, it has been determined that the dielectric loss constant of Al_2O_3 has two activation energies, one in the range of .16 to 1.15Kcal/mole for low temperatures (< 700 C) and one in the range of 9.22 to 69.2 Kcal/mole for high temperatures (> 700 C) at a frequency of 3.5 GHz and samples from 85% to 100% Al_2O_3.

LIM, Tian S., Associate Professor, "A Microcomputer-Based Laboratory Exercise: Analog-to-Digital Conversion Techniques," *CoED Journal* (Computers in Education Division of ASEE), **1**,1, (January-March 1991), 5-9.

This paper describes a microcomputer interfacing laboratory offered by the Department of Electrical Engineering at the U.S. Naval Academy. This undergraduate laboratory demonstrates two analog-to-digital conversion (ADC) techniques, the ramp method and the successive approximation method. The two techniques use the same hardware but different software algorithms. In both cases, the ADC is accomplished by using a Microcomputer (Apple IIe) to control a John Bell Engineering (JBE) digital-to-analog conversion (DAC). The analog input voltage and the output of the DAC are compared and processed. The output of the DAC is adjusted by the software until it matches the analog input voltage. When they match, the binary number at the DAC represents the digitial equivalent of the unknown analog signal.

RYNONE, William, Assistant Professor, and Antal A. SARKADY, Professor, "Non-Destructive Testing Via Standard Laboratory Test Equipment," *Canadian Acoustics*, **19**, 1 (January 1991), 25-32.

Non-destructive testing research involving ultrasonics is being pursued at the U.S. Naval Academy under the sponsorship of the David Taylor Research Center. Specifically, this paper addresses the efforts to improve various aspects of testing, including the equipment, software, and problems that were overcome in using a digitizing oscilloscope and computer made by different manufacturers.

SARKADY, Antal A., Professor, and Herbert M. NEUSTADT, Associate Professor (Retired), "Estimating Radiation Conductance of a Thickness-Drive Transducer from Electrical Driving-Point Admittance Measurements, Including Details on Removing Parameters," American Institute of Physics Document No. PAPS-JASMA-89-917-49, February 1991.

For many thickness-drive transducer applications, it is desirable to have a good estimate of the radiation conductance (or other property based on power output) of the transducer. Generally, however, it is difficult to measure directly transducer power output. It is therefore desirable to have a procedure for estimating radiation conductance from easily measured quantities. The measured quantities used in this paper are electrical admittances at the terminals of the transducer when it is in air, and when in water. The transducer model used to interpret the measured admittance is a lumped-constant equivalent circuit; it has been refined to represent an electrically excited thickness-drive transducer over the frequency range 0.5-40 MHz. Two methods are used to estimate radiation conductance $G_{rad}(f)$, and efficiency. One, the general-case method, gives values of G_{rad} over a wide range of frequencies; the other gives the general case where a novel procedure, similar to iterative optimization, is used to estimate that is frequency dependent. The validity of the two methods is tested by comparing resultant G_{rad} (f) values with those measured by the National Institute of Standards and Technology (formerly National Bureau of Standards). The maximum discrepancy at the lowest transducer resonance is approximately 15% for the small number of transducers on which measurements have at present been made. The transducers studied herein have active elements with characteristic impedance much higher than that of water. Polymer-film transducers are not considered.

SARKADY, Antal A., Professor, co-author, "On-Line Wear Particle Monitoring Based on Ultrasonic Detection and Discrimination," David Taylor Research Center Report, DTRC/PAS-89-7, May 1989, 1-12.

The David Taylor Research Center and the Naval Academy Electrical Engineering Department developed an ultrasonic technique for the nondestructive evaluation of shipboard machinery conditions. The ultrasonic wear particle sensor (UWPS) quantitatively measures the amount and size of wear-generated debris in the machinery lubricating oil by employing wide-band, ultrasonic pulse echo techniques. In addition to its present capability to detect, count, and size wear debris over a broad range of sizes, several methods of electronically discriminating contaminant particles from air bubbles have been demonstrated experimentally.

The UWPS presently exists as a microprocessor-controlled laboratory instrument. An earlier version of the UWPS successfully detected and counted wear particulate generated by oil-lubricated rolling element bearings in several bearing failure tests. The instrument used in these tests did not discriminate air bubbles from water debris but was successful in detecting abnormal bearing wear. Three methods have been investigated which may ultimately provide the instrument with the ability to identify scatterers as either air bubbles, water droplets, or debris particulate. One method uses the intensity vs. the angle of scatter of the ultrasonic pulse to discriminate air from debris. Another method is based upon phase measurements of the reflected pulse echo. The latest method investigated measures the spectra of the individual pulse echoes and correlates the spectral features with particle composition.

This report discusses the theory of operation of the UWPS, methods used for determining the size of individual clatters, and the various methods of discriminating wear debris from entrained air. Test data are presented, and possible applications are discussed. It is felt that this instrument will be a powerful tool for nondestructively determining the wear condition of hydraulic and lubricating oil machinery.

SARKADY, Antal A., Professor, "Wear-Particle Discrimination Progress Report", ULNA Report, 25 January 1991, 1-52.

The scattering of acoustic waves by solid cylinders and spheres is well documented with Faran, Hickling, and Neubauer, et al. being the early investigators. More recently, acoustical resonance theory was developed by Gaunaurd, Uberall and Flax and was applied to cylindrical and spherical targets. However, most of the early scattering experiments were performed on large targets at low frequency range (1KHz to 200KHz). More recently, the availability of wide band ultrasonic transducers prompted many investigations, including high frequency region (0.2MHz to 50MHz). Principle goals of the investigations are counting, sizing, and characterization of metal wear particles found in lubricant oil (2190TEP). Sizes range from 3 to 2000 microns. Detection and characterization of these small wear particles is a difficult problem because the oil is highly attenuating. Attenuation increases rapidly with increasing frequency. In addition, small entrapped air bubbles are often found with high concentrations in oil. These air bubbles must be rejected in a wear particle experiment.

Discriminating metal wear particles from air bubbles is a non-trivial problem. Recently, J. Feld and J. Cammarata of Monitek Technologies, Inc. reported that good discrimination has been achieved in the frequency domain, between particles and bubbles in water. Their instrument uses a focused, lightly damped, thickness mode ultrasonic transducer with fundamental frequency of 5MHz and a third harmonic of 15MHz, transmitting approximately equal power at both frequencies. The ratio of echo amplitudes (amplitude of the 15MHz spectral line over the amplitude of the 5MHz line) is used as discriminating parameter. Their finding indicated that particles tend to have an amplitude ratio of greater than 0.9 while air bubbles have less than 0.2 (when these targets are in the focal point).

The goals of this research study were twofold: verify Monitek's particle/air bubble discrimination technique in water and try to use this technique in lubricant oil (2190TEP). However, in order to overcome the oil attenuation problem, the fundamental frequency of transducer was chosen to be 2.5MHz. This choice increased the particle sizing threshold but offered the best chance for success in discrimination.

WOOTEN, Curran, Instructor, co-author, "Semistate Equivalency: The Lewis Realization," *Proceedings* of the Twenty-ninth IEEE Conference on Decision and Control, December 1990.

The concept of input-output equivalency of real linear lumped time-invariant systems is formulated in terms of semistate theory; this equivalency is then tied to the Lewis backward-forward semistate decomposition, which is reviewed and derived. Finally, a system synthesis based upon this Lewis decomposition is given, allowing physical realization of any linear lumped time-invariant semistate described regular system via its Lewis equivalent system.

Presentations

ALLEY, Reuben E., Professor, "Nova Reperta: Twenty Scientific Engravings of the Early Seventeenth Century," and "The Vacuum Rotor-A Novel Heat Engine," American Association of Physics Teachers, San Antonio, Texas, January 1991.

BRUCE, Ralph W., Assistant Professor, "Introduction to Electromagnetic Heating," Twenty-fifth Annual Meeting of the International Microwave Power, Denver, Colorado, 26 August 1990.

BRUCE, Ralph W., Assistant Professor, "Activation Energies for the Dielectric Loss Factor/AC Conductivity of Some Polycrystalline Ceramics," Symposium on Microwaves: Theory and Application in Materials Processing, Ninety-third Annual Meeting of the American Ceramics Society, Cincinnati, Ohio, 29 April - 2 May 1991.

BUTKA, Brian K., Assistant Professor, Computer Use/Application and Professional Engineers, Sixth Grade class in the local school district.

BUTKA, Brian K., Assistant Professor: "A Model of Narrow-Bandgap MISFET's," Twenty-second Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 3 May 1991.

COLLINS, Glen, Assistant Professor, "Artificial Intelligence and Belief Functions," Sigma Xi Research Society, Annapolis, Maryland, 17 October 1990.

LIM, Tian S., Associate Professor, "An Undergraduate Electrical Engineering Laboratory with Microcomputer," 1990 American Society for Engineering Education Annual Conference, Toronto, Canada, 25 June 1990.

WEIS, Stephen R., Assistant Professor, co-author, "Frequency-division Based Polarization Diversity Scheme for Overcoming Signal Fading in an Interferometric Sensor," IEEE Lasers and Electro-Optics Society Meeting in Boston, Massachusetts, 6 November 1990.

DEPARTMENT OF

Mechanical Engineering

Professor John O. Geremia
Chair

Research in the Mechanical Engineering Department encompassed several areas of specialization within the broad field of mechanical engineering. These areas included thermodynamics of internal combustion engines, fluid dynamics, mechanical and thermal design, and materials science. Specific objectives of the current research varied from computer modeling of thermodynamic cycles to advanced composites and ceramic materials research. Research was supported by a variety of sponsors, including the Office of Naval Research, the Nuclear Regulatory Commission, and the David Taylor Research Center. The Academic Dean funded several faculty members on instructional development projects. In addition, some faculty pursued independent research in areas of personal interest.

Research efforts at the Naval Academy are driven by the need for faculty to stay abreast of rapidly changing technology and to introduce subsequently that new technology into their courses. Some updating of course material is also facilitated by seminar speakers and visiting professors. Under an exchange program with the David Taylor Research Center, two visiting professors taught in the department, and one of our professors carried out research at the Center. The efforts of the mechanical engineering faculty to become more effective classroom teachers through their research activities are reflected by their numerous publications and presentations at national and international conferences.

Sponsored Research

An Evaluation of the Impact of Decentralized Cooling Systems on Future Submarines

Researcher: Associate Professor Elliott E. Dodson
Sponsor: David Taylor Research Center, Annapolis Laboratory

The future availability of CFC refrigerants for use in Naval chilled water plants is threatened by environmental concerns. Thermoelectric cooling as an alternative had been evaluated previously by the Electric Boat Division of General Dynamics Corporation, and, at that time, found heavier and less efficient than vapor compression cooling.

Technological advancements since the Electric Boat Study, both in design and thermoelectric material performance, are evaluated in this present report, by considering modifications to the Electric Boat Study and the impact of such modifications, as applied to SSN21. Modifications involved the entire HVAC system (with evaluations of several optional configurations) and also, the waste heat rejection system.

A decentralized HVAC system with an environmentally acceptable cooling system, combined with decentralized passive through-the-hull cooling panels, showed potential reductions of 200,000 lb and 2,500 ft^3 and no increase in power. Changing to a decentralized system would reduce the weight and volume associated with the large scale headers required for distribution in the current centralized systems. Decentralized cooling would reduce submarine cost due to modular construction and because a major portion of ventilation ducting would be eliminated. The decentralized cooling system would also provide increased survivability, arrangement flexibility, and reduction of the acoustic signature. Recommendations for future work required to overcome major obstacles and to demonstrate advantages of decentralized cooling are presented. Thomas W. Bein of the David Taylor Research Center also worked on this project.

Effect of Impact Loading on the Mechanism of Crack Propagation in Ceramic Matrix Composites, and Freeze/Thaw Cycles of Organic Composites to Simulate Deep Seawater Submergence

Researcher: Professor Dennis F. Hasson
Sponsor: Office of Naval Research

The research on impact testing of ceramic matrix composites (MC's) continues. The database has been expanded to include the comparison of different fibers on the same matrix and vice versa. Also, new matrices, such as M_oSi_2, will be obtained and tested.

The study of the effect of freeze/thaw cycles on the structured integrity of organic matrix composites which are subjected to high pressure seawater is currently in progress. Other specimens are subjected to seawater at ambient pressure for comparative purposes.

The results of the above studies will be submitted for publication.

Evaluation Effects of Cyclic Loading on the Fracture Behavior of a Cast Stainless Steel

Researcher: Professor James A. Joyce
Sponsor: David Taylor Research Center, Annapolis Laboratory

Tests conducted in Japan as part of the High Level Vibration Test (HLVT) program for reactor piping systems revealed greater than expected levels of fatigue crack growth in a cast stainless steel pipe elbow. The material tested was equivalent to ASME SA-351 CF8M. The project was tasked to develop the appropriate material property data to characterize cyclic deformation, cyclic elastic-plastic crack growth, and ductile tearing resistance. The computer-controlled servo-hydraulic test machines at the U.S. Naval Academy were used to develop the required data.

The tests conducted included monotonic and cyclic tensile tests, monotonic J-R curve tests, and cyclic elastic and elastic-plastic fatigue crack growth rate tests. The cyclic elastic-plastic fracture behavior of the stainless steel was the primary concern and was evaluated using a cyclic J-integral approach.

It was found that the cast stainless steel was very resistant to ductile crack extension. This research was also supported by the Brookhaven National Laboratory.

Optimizing Power for Cascaded Curzon-Ahlborn Cycles

Researcher: Professor Vincent J. Lopardo
Sponsor: Naval Academy Research Council (ONR)

The research was divided into two phases. In Phase I the researcher evaluated the conditions of optimum specific power (power divided by the heat exchanger areas) for the irreversible model of the Curzon and Ahlborn engine as a function of temperature ratios and heat exchanger area ratios. The C-A engine is the same as the Carnot engine, except that a finite temperature difference exists between the heat exchangers and the thermal reservoirs. The resulting optimum specific power is equal to $(1 + \theta_L)^2 U_H T_H/(1 + \alpha_L)^3$ where θ is the normalized temperature ratio, α_L is $(U_L/U_H)^{-1/3}$, and U is the overall heat transfer coefficient.

In Phase II, two C-A engines are used in series between two thermal reservoirs. The power was optimized with respect to the four unknown operating system temperatures. The two thermal reservoir temperatures are assumed known. Although the resulting equations could not be explicitly solved, the temperatures are easily determined by numerical solution.

Three-Dimensional Potential Flow Analysis of a Centrifugal Pump

Researcher: Assistant Professor Steven M. Miner
Sponsor: Naval Academy Research Council (ONR)

Potential flow analysis and the finite element method are proposed for calculating the flow field in a centrifugal pump. The impeller and volute will be modeled together to gain insight into the interaction that takes place between these components. In addition, the velocity and pressure fields can be used to calculate unbalanced forces acting on the impeller. These forces can cause premature bearing failure, elevated operating costs, or catastrophic failure with extended down time. Finally, the contribution that the flow field makes to the acoustic signature of the machine can be considered.

The results of this investigation include: (a) three-dimensional analysis of the impeller and volute together; (b) comparison of results to available measured data for the same impeller; and (c) calculation of the impeller unbalance force.

Crevice Corrosion of Alloy 625 in Seawater

Researcher: Associate Professor Patrick J. Moran
Sponsor: Naval Academy Research Council (ONR)

Alloy 625 is a NiCrMoFe alloy and is the main piping material in the new SSN21's. It has excellent mechanical and welding properties and, with the exception of crevice corrosion, excellent corrosion properties. It has been found to be susceptible to crevice corrosion in seawater service. The researcher worked on this problem during the summer of 1990 as an ASEE-ONR (American Society for Engineering Education - Office of Naval Research) Senior Faculty Fellow at the David Taylor Research Center. Work is continuing on this problem. The researcher is particularly interested in determining the alloying elements which are attacked by the crevice corrosion. Scanning electron microscopy and x-ray microanalysis are being utilized to detect the regions of crevice corrosion attack and to analyze the chemical composition for the material in these regions. This information is critical in determining alternative materials to alloy 625 and in designing mitigation strategies for alloy 625.

Improved Characterization of Crash Severity

Researcher: Professor Russell A. Smith
Sponsor: University of North Carolina

The purpose of this project is to determine whether it is possible to create an improved means of characterizing crash severity by utilizing additional data variables already present in the North Carolina statewide crash data files. Here crash severity refers to a variable that describes the "potential" for injury to a crash-involved occupant of a motor vehicle as a consequence of those factors that influence vehicle acceleration. Also, the term "improved characterization" designates a new scale that will account for more injury variance than the present deformation rating scale (TAD). The desirability of this goal lies in the use of crash severity as a control variable in research aimed at evaluating designs. One almost always wishes, in such analyses, to control for crash severity, and the better the control variable, the more discerning can be the analyses. At present, crash severity in the North Carolina data is best characterized through the use of a seven-point deformation rating scale. The improved characterization would include a single variable that is sensitive to damage, object struck, and mass.

Work was initiated in 1990, and an algorithm was developed. Test and evaluation of this algorithm will occur in 1991.

Independent Research

Control Hinge Moment Coefficients

Researchers: Professor Joseph D. Gillerlain, Jr.

This investigation involves an experimental measurement of the hinge moment coefficient for an NACA0012 airfoil in windtunnel tests. The results are compared with predictions of linear theory and corroborated with other available data. Also investigated were applications to canard control surfaces and swath stabilizer surfaces. Commander Vernon Gordon, USN, formerly with Aerospace Engineering, also collaborated on this project.

Experimental Constraint Effects Study: Elastic Plastic Fracture

Researcher: Professor James A. Joyce

The objective of this project is to develop test methodology for fracture testing tensile loaded single and double edge cracked specimens. These tests should allow evaluation of constraint effects when the measured J-R curves are compared to standard bend loaded specimens. Testing in progress at both the Naval Academy and the David Taylor Research Center, Annapolis Laboratory will be completed by May 1991. Analytic work is being conducted at the University of Illinois, Champaign, to utilize the experimental results and make adjustments based on constraint factors and metallurgical failure mechanisms. This project was supported by the U.S. Nuclear Regulatory Commission.

Nonlinear Structural Dynamics

Researcher: Assistant Professor Raouf A. Raouf

This is part of a continuous effort to understand the nonlinear dynamics of structures in general and composite structures in particular. The interest in this topic is two-fold:

(1) Interest in nonlinear dynamics: Nonlinear dynamics is far from being understood. There is mounting evidence in engineering application that nonlinearities can no longer be ignored. Engineering research is starting to address this problem, and research activities are being focused on it.

(2) Interest in composite structures: The increasing interest in the use of composites in engineering applications makes it important to understand their behavior, especially in their nonlinear regimes.

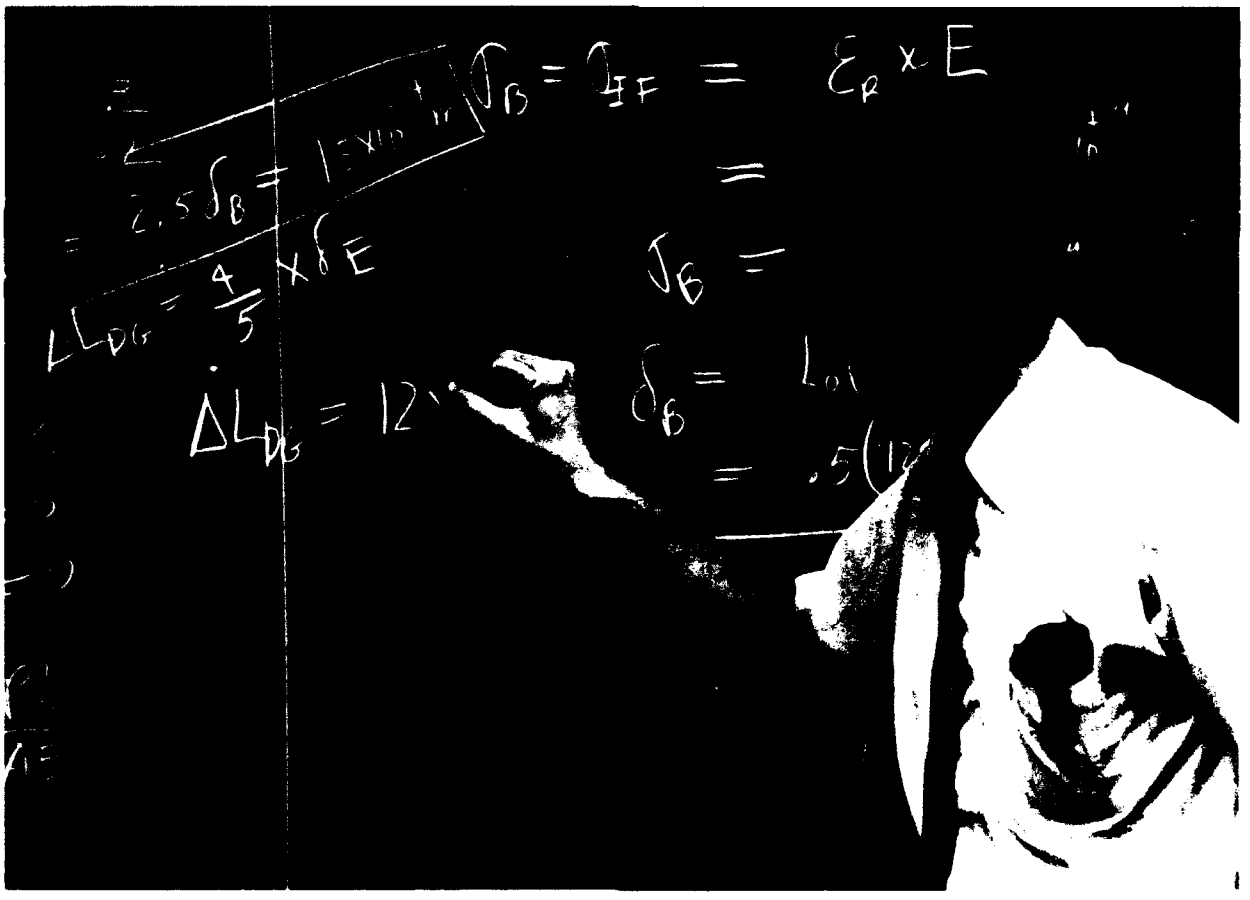
Research Course Projects

An Experimental Investigation of Flow-Induced Vibrations of Thin Leading Edges in Water

Researcher: Midshipman 1/C Preston W. Jones, USN
Adviser: Professor Robert A. Granger

A wedge with various adapted leading edges was inserted on a string and immersed in water in the Naval Academy recirculating water tunnel. Lift and drag were measured for a range of parameters. Velocity, angle-of-attack, leading edge chord, and material elasticity were varied over a predetermined set of values. The lift coefficient and drag coefficient were calculated from measured data and plotted for a class of leading edge geometries and materials over a small range of Reynolds numbers.

The results are new, in that no data on C_L and C_D exist in the literature for very thin leading edges on that vibrate in a liquid flow.



Publications

HAMM, Michael K., Lieutenant, USN, co-author, "Phenomenological and Experimental Study of the Thermal Response of Low Density Silica Ablators to High Enthalpy Plasma Flows," *Proceedings* of the American Institute of Aeronautics and Astronautics Thermophysics Conference, , Honolulu, Hawaii, 24-26 June 1991, AIAA No. 91-1324.

This paper presents a phenomenological analysis and the results of an experimental study of the competing physicochemical phenomena present during the process of melting and vaporization of silica fiber-based low density ceramic materials. Interest is focused on the thermal response of such materials to high enthalpy, stagnation arc-jet flow environments. Based on dimensional analysis and the methodology of Bethe and Adams, a simplified phenomenological model is developed to represent the thermal response of the liquid "melt" layer which develops on the surface of these glass-like systems. Modifications are made to approximate the behavior of low density porous glassy ablators (NASA Reusable Surface Insulation or RSI) in high enthalpy environments.

Arc-jet flow experiments were performed on a variety of RSI materials of different densities and over a range of stagnation pressures and heat fluxes. The data obtained indicate the correct trends predicted by the approximate theory. A dimensionless correlation is derived for melt run-off in terms of material and flow parameters; however, the accuracy of the current data is insufficient to conclude compliance with the model.

JOYCE, James A., Professor, co-author, "Effects of Cyclic Loading on the Deformation and Elastic-Plastic Fracture Behavior of a Cast Stainless Steel," David Taylor Research Center Report, DTRC/SME-91-11, February 1991.

Tests conducted in Japan as part of the High Level Vibration Test (HLVT) program for reactor piping systems revealed greater than expected levels of fatigue crack growth in a cast stainless steel pipe elbow. The test was equivalent to ASME SA-351CF8M.

The test conducted included monotonic and cyclic tensile tests, monotonic J-R curve tests, and cyclic elastic and elastic-plastic fatigue crack growth rate tests. The cyclic elastic-plastic fracture behavior of the stainless steel was of primary concern and was evaluated using a cyclic J-integral approach.

It was found that the cast stainless steel was very resistant to ductile crack extension.

JOYCE, James A., Professor, co-author, "Extension and Extrapolation of J-R Curves and Their Application to the Low Upper Shelf Toughness Issue," U.S. Nuclear Regulatory Commission Report, NUREG/CR-577, January 1991.

This document develops methods of measuring experimentally the limits of valid fracture mechanics data that can be obtained from small fracture mechanics specimens. The proposed technique generally shows that present ASTM limits are overly conservative, and the new technique would allow almost a three-fold increase in the amount of crack extension allowed in the testing of a surveillance specimen.

Analytic relationships are then developed to allow use of the new experimentally measured limit to J-controlled crack growth for design or failure analysis applications to correlate best with the omega criterion which defines limits on both the maximum J-level and the maximum crack extension allowable for a particular specimen size and material toughness combination.

The final section looks at the problem of extrapolation of J-R curve data when needed for a structure fracture analysis. Several forms of extrapolation relationships are compared from the point of view of accurate and conservative extrapolation, and particularly from the standpoint of tearing instability analysis of a growing, ductile crack on the material upper shelf.

JOYCE, James A., Professor, "Characterization of the Effects of Large Unloading Cycle on the Ductile Tearing Toughness of HSLA Steel," *Journal of Testing and Evaluation*, **18**, 6 (November 1990), 373-384.

This paper describes part of an ongoing project to study the effects of interaction between intense fatigue cycling and ductile tearing and the fatigue crack growth rate demonstrated by structural steels. Earlier work has utilized a cyclic J-integral approach to characterize the cyclic crack growth rate and a relatively standard J-resistance curve approach to characterize the material ductile tearing toughness. This work has shown that a relatively simple superposition can be used to predict specimen life when a combination of tensile fatigue cycling and ductile tearing is applied. The results are far from perfect but seem to offer a scheme which is conservative and hence much more desirable than an LEFM approach which invariably gives nonconservative life estimates.

This new work looks at the effect of complete unloadings and of complete crack opening displacement reversals on the subsequent ductile tearing toughness and fatigue crack growth resistance. Initial data show that the effect of a complete unloading cycle can be predicted using the baseline cycle J-crack growth rate data of the test material. A complete COD reversal, however, produces a much greater crack growth step than would be predicted using an extrapolation of the standard cyclic J-method. To account for this effect, a cyclic J-resistance curve is developed and compared with the measured data. Fractographic SEM work is also used to support the unloading compliance measurements and the use of a ductile tearing procedure to predict the crack growth during these intense compression cycles.

JOYCE, James A., Professor, co-author, "Application of J-Integral and Modified J-Integral to Cases of Large Crack Extension," *Proceedings* of the Twenty-first Fracture Mechanics Symposium, ed., J. P. Gudas, J. A. Joyce, and E. M. Hackett. Philadelphia: American Society for Testing and Materials, 1990, pp. 85-105.

The J-integral is widely accepted as a measure of elastic-plastic fracture toughness of engineering alloys. Specimen size and geometry dependence were first noted in fracture toughness measurements using the ASTM E813 calculation of the deformation J-integral (J_d) by McCabe and Landes in 1983. The modified J-integral (J_m) was introduced by Ernst to attempt to minimize or eliminate size and geometry dependence. Since J_m was introduced, questions have arisen regarding the proper parameter to describe the response of a flawed body to loading. The objective of this research task is to investigate the crack growth and specimen J-capacity limitations of J_d and to verify the accuracy and specimen independence of the current J_m formulation. This research is expected to affect decisions concerning the use of small laboratory specimens to predict elastic-plastic crack growth resistance in engineering structures.

The J-R curve tests have been conducted on 1/2T, 1T, and 2T compact specimens of materials having critical fracture toughness values ranging from J_{Ic} = 140 to 455 kJ/m^2. These materials include HSLA-80 steel, A106 steel, 3-Ni steel, and two A533B steels. These tests were conducted in accordance with ASTM E1152, except that specimen loading was continued until large crack extensions were present, in many cases exceeding 50% of the initial uncrack ligament (b). All specimen data were then analyzed using the equations of ASTM E1152 for the standard deformation J-integral (J_d) resistance curve. Additional analysis was conducted as well in terms of the modified J-integral (J_m) using equations proposed by Ernst and Landes. This latter quantity was possibly useful for larger crack extensions. The test procedure was directed towards finding the useful limits of the two J-quantities for the materials listed above or for materials of equivalent strength and toughness.

JOYCE, James A., Professor, co-author, "Adhesive Fracture Testing," *Proceedings* of the Twenty-First Fracture Mechanics Symposium, ed., J. P. Gudas, J. A. Joyce, and E. M. Hackett. Philadelphia: American Society for Testing and Materials, 1990, pp. 307-321.

The need for lightweight materials for a variety of applications has resulted in the use of structural adhesives to bond prototype structures. Adhesives developed to accommodate the stringent requirements of these high-technology applications are usually deficient in one or two of three very crucial properties: strength, moisture resistance, and toughness. So far, advances in adhesive formulation that have ameliorated one of these deficiencies have generally adversely affected the others. Hence a considerable amount of effort is being expended in the search for strong, moisture resistant, and tough adhesives.

As adhesives become tougher and less brittle, evaluating their performance in terms of fracture parameters becomes more complicated. Linear elastic fracture mechanics (LEFM), which is widely used to characterize these materials, does not fully describe adhesive performance as more and more ductility or plastic deformation is introduced. In this study the researchers introduce the energy separation method for characterizing the fracture resistance of adhesives and compare it with currently used elastic and plastic fracture and parameters such as G and the J-integral. Both neat and bonded 1/2 CT plan specimens were tested and compared in this work.

MINER, Steven M., Assistant Professor, co-author, "Turbulence Measurements in a Centrifugal Pump with a Synchronously Orbiting Impeller," *American Society for Mechanical Engineers Journal of Turbomachinery*, Paper No. 91-GT-70.

Turbulence profiles were measured in a centrifugal pump with an impeller with backswept blades using a two directional laser velocimeter. Data presented include radial, tangential, and cross product Reynolds stresses. Blade-to-blade profiles were measured at four circumferential positions and four radii within and one radius outside in a four-bladed impeller. The pump was tested in two configurations; with the impeller running centered within

the volute, and with the impeller orbiting with a synchronous motion (ϵ/r_2 = 0.016). Flow rates ranged from 40% to 106% of the design flow rate. Variation in profiles among the individual passages in the oribiting impeller were found. For several regions the turbulence was isotropic, so that the cross product Reynolds stress was low. At low flow rates the highest cross product Reynolds stress was near the exit. At near design conditions the lowest cross product stress was near the exit, where uniform flow was also observed. Also, near the exit of the impeller the highest turbulence levels were seen near the tongue. For the design flow rate, inlet turbulence intensities were typically 9%, and exit turbulence intensities were 6%. For 40% flow capacity the values increased to 18% and 19%, respectively. Large local turbulence intensities correlated with separated regions. The synchronous orbit did not increase the random turbulence, but did affect the turbulence in the individual channels in a systematic pattern.

MINER, Steven M., Assistant Professor, "Program POT2D: A Two-Dimensional Potential Flow Code for Turbomachinery," University of Virginia Report UVA/643092/MAE90/315, June 1990.

POT2D is a two-dimensional potential flow analysis code. It was developed for use in determining the velocity and pressure fields within the impeller and volute of the Plexiglas pump rig in the Rotating Machinery and Control Laboratory (ROMAC) However, the derivation of the governing equations and their implementation in the code was general enough that a wide range of potential type problems can be handled.

The discretization of the problem domain is carried out using the finite element technique. This method was selected because of its inherent flexibility in handling the irregular geometries that are encountered in turbomachines. Both the bald passages and the volute have highly curved surfaces, and the finite element mesh can easily conform to these surfaces.

MORAN, Patrick J., Associate Professor, co-author, "The Influence of P2VP Incorporation into LiI on the Rate Capabilities of Lithium Iodine (P2VP) Batteries," *Journal of Electrochemical Society*, **137**, 8 (1990), 2379-2385.

An electron microphobe has been utilized to examine the LiI electrolyte layer that forms in LiI_2 (P2VP) batteries with pelletized cathodes. Carbon x-ray maps were generated to determine the distribution of reacted P2VP that becomes incorporated into the LiI layer as it grows into the cathode. It was found that a carbon-containing derivative of P2VP was uniformly incorporated into the LiI formed during low rate discharges (cells discharged across constant 20 and 40 kΩ loads, approximately 20-40 $\mu A/cm^2$). The conductivity of these layers is similar to those reported for LiI containing dispersed particles Al_2O_3 and SiO_2. On the other hand, LiI layers formed at high rates (cells discharged across constant 1 and 2 kΩ loads, approximately 200-300 $\mu A/cm^2$) contained large chunks (greater than 10μm) of reacted P2VP. The resistivity of electrolyte layers formed at high rates is consequently nearly an order of magnitude greater than those formed at low rates. Evidence is presented suggesting that the cathode material is inhomogeneous, and that at high rates regions that are iodine rich discharge preferentially, leaving chunks of reacted P2VP trapped in the layer.

MORAN, Patrick J., Associate Professor, co-author, "Effects of Acid Deposition on Materials," State of Science and Technology Report Number 19, National Acid Percipitation Assessment Program, Washington, DC: Government Printing Office, 1990.

All materials that are exposed to the outdoor environment are subjected to degradation caused by natural weathering processes. Since the mid-nineteenth century, air pollution has been suspected of accelerating the degradation of natural and man-made materials. Wet and dry acidic deposition, alone or combined with other air pollutants, probably contributes to this increased rate of damage. The goal of research concerning the effects of acidic deposition on material surfaces is to quantify any incremental effects due to wet and dry deposition of hydrogen ion, sulfur dioxide, and nitrogen oxides on mass loss and other forms of alteration. This goal has been pursued by the National Acid Percipitation Assessment Program (NAPAP) both in the field and in laboratory test chamber experiments.

It is the purpose of this report to review the literature on the impact of acidic deposition on the materials selected by the NAPAP for study, and to report the results of the NAPAP experimental research program on the chemical and physical processes that relate to the impact of pollutants on material surfaces. The materials selected for the study under the NAPAP program included zinc/galvanized steel and other metals, carbonate stone (as monuments and building facings), and surface coatings (paints).

MORAN, Patrick J., Associate Professor, co-author, "Electrochemical Impedance Measurements for Evaluating and Predicting the Performance of Organic Coatings for Atmospheric Exposure," *ASTM 1000 Corrosion Testing and Evaluation: Silver Anniversary Volume*. Philadelphia: American Society for Testing and Materials, 1990, pp. 397-412.

This paper focuses on the use of electrochemical impedance spectroscopy (EIS) as a predictive tool in assessing organic coating deterioration. EIS has been used by a number of investigators in recent years to assess coating deterioration. Good correlations between EIS data in immersion environments and other deteriorating parameters exist (primarily evaluated visually). The potential use of EIS for sensing coating degradation in atmospheric exposure has not been fully evaluated. The authors have recently developed an atmospheric electrochemical monitor (ATMEIS) designed to assess degradation of painted metal substrates during atmospheric exposure using EIS. The monitor consists of a painted steel coupon which a gold electrode was electron-beam deposited to serve as a reference/counter electrode. EIS measurements are made between the underlying steel substrate and the gold reference/counter electrode residing on the coating surface. The ATMEIS has been tested both in immersion exposure and in an atmospheric exposure chamber and has been found to generate EIS data consistent with those predicted for a painted metal coupon in an agressive environment. This paper reports the details of recent studies by other investigators in immersion environments using EIS to sense coating deterioration and discusses the design and testing of the ATMEIS monitor for atmospheric EIS.

RAOUF, Raouf A., Assistant Professor, co-author, "One-To-One Autoparametric Resonances in Infinitely Long Cylindrical Shells," *Journal of Computers and Structures*, **35**, 2 (1990), 163-173.

The nonlinear response of infinitely long circular cylinders (rings) to a primary excitation of one of the flexural modes was analyzed, taking into account its interaction with its companion mode. Due to the complete circular symmetry of the cylindrical shell, each natural frequency corresponds to two orthogonal mode shapes. The mode with the same spatial variation as the external excitation is called the driven mode, while the other orthogonal mode is called the companion mode. A combination of symbolic manipulator and the method of multiple time scales is used to derive four first-order ordinary differential equations for the modulation of the amplitudes and phases of the interacting modes. The fixed points of the modulation equations provide the frequency-response curves. There are two possible fixed point solutions: a single-mode solution consisting of the driven mode only and a two-mode solution consisting of the driven and companion modes. The latter solution corresponds to travelling waves. As the excitation frequency varies, the fixed-points of the single-mode solution suffer saddle-mode collisions, resulting in jumps. On the other hand, the fixed-points of the two-mode solution can undergo Hopf bifuractions. Between the Hopf bifurcation frequencies, a numerical solution of the modulation equations shows that they possess limit-cycle or chaotic solutions. For a range of excitation frequencies, the periodic single-mode solution coexists with either a periodic or a periodically modulated two-mode solution.

WU, Chih, Professor, "Power and Efficiency Limits of Real Solar Pond Heat Engines," *International Journal of Energy Systems*, **11**, 1 (1990), 35-38.

Maximum power and efficiency at the maximum power of an irreversible solar pond heat engine are treated. When time is explicitly considered in the energy exchanges between the heat engine and its surroundings, it is found that there are limits on the efficiency of the real solar pond heat engine at maximum power condition. These limits can guide the evaluation of existing solar pond systems or influence design of future solar pond heat engines.

WU, Chih, Professor, "Power Performance of a Cascade Endoreversible Cycle," *Journal of Energy Conversion and Management*, **30**, 3 (1990), 261-266.

A cascade endoreversible cycle is defined as a cycle made by several endoreversible cycles. It utilizes different working fluids to obtain more nearly optimum conditions than could be attained by using a single working fluid endoreversible cycle in a large available temperature range. The performance of the cycle at its maximum output power condition is analyzed.

WU, Chih, Professor, "Specific Power Optimization of Closed-Cycle OTEC Plants," *Journal of Ocean Engineering*, **17**, 3 (1990), 307-314.

The specific power of a simple irreversible closed-cycle Ocean Thermal Energy Conversion (OTEC) power plant is analyzed and optimized. The plant uses a working fluid such as ammonia to produce power. Specific power is the net output per unit total heat exchanger surface area. Net output generated by working fluid is obtained in terms of the rate of heat added to the working fluid from the warm surface ocean water, less the rate of heat added to the working fluid from the deep ocean water. A time factor is added to simulate the heat exchanges between the OTEC plant and its surroundings. A mathematical expression is derived for the specific power output of the irreversible

OTEC heat engine. It is found that there is a bound on the specific power output. This bound provides the basis for a practical engineering effort towards maximizing the per unit time and per unit total heat exchanger area production of work in power plants whose heat transfer area is constrained by economic consideration.

WU, Chih, Professor, "Specific Power Bound of a Finite-Time Closed Brayton Cycle," *International Journal of Ambient Energy*, **11**, 2 (1990), 77-82.

The purpose of this paper is to define a finite-time closed Brayton cycle and apply it to an indirect gas-cooled nuclear reactor plant for its optimization. Practical engineering heat engine power optimization usually takes the form of determining minimum heat exchanger area per unit net power output or minimum cost per unit power output, rather than determining the maximum cycle efficiency. The objective function of the optimization described in this paper is specific power, power output per total heat exchanger surface area. The specific power output of a real indirect gas-cooled nuclear reactor plant, coupled with its heat source and sink, is analyzed. It is found that there is an upper bound on the specific power output of the nuclear power plant. This bound can guide the evaluation of existing real plants or influence design of future power plants.

WU, Chih, Professor, "Power Optimization of an Endoreversible Brayton Gas Heat Engine," *Journal of Energy Conversion and Management*, **31**, 6 (1991), 561-565.

The power output of a simple endoreversible Brayton gas heat engine is analyzed and optimized. The endoreversible engine is defined as a power cycle in which the two processes of heat transfer from and to the surrounding heat reservoirs are the only irreversible processes in the Brayton cycle. A mathematical expression is derived for the power output of the irreversible heat engine. The power optimization provides the basis for designing a real heat engine and for a performance comparison with existing Brayton power plants.

WU, Chih, Professor, "Work and Power Optimization of a Finite-Time Brayton Cycle," *International Journal of Ambient Energy*, **11**, 3 (1990), 129-136.

This paper extends the author's previous work on the formulation of criteria for comparing the performance of real and ideal processes through the use of finite-time processes. The efficiency for the finite-time Carnot cycle at maximum power is derived. This is followed by an expression for the power output of the finite-time Brayton cycle. However, this is considered to be too complex to yield simple analytical solutions, and a numerical solution is given. Finally, the efficiency of a Carnot Brayton cycle, a finite-time Carnot cycle, and a finite-time Brayton cycle are compared, showing that the latter cycle can provide a more suitable basis for real engine and design.

WU, Chih, Professor, "Specific Output Power of a Dry Geothermal Plant," *The Journal of Energy*, **16**, 4 (1991), 757-761.

The specific output of a simple, irreverislbe, dry geothermal field power plant is analyzed. The plant has a secondary vapor Rankine cycle, which is coupled to the dry geothermal field heating fluid (heat source) and a cooling fluid (heat sink) by heat transfer. An expression is derived for the specific power output of the irreversible geothermal heat engine. The maximum specific power output is found by using computer graphics.

Presentations

ADAMS, J. Alan, Professor, "Confronting Advanced Surfaces with Nurbs," American Society for Engineering Education, Design Graphics Division, Arizona State University, Tempe, Arizona, 18 November 1990.

ADAMS, J. Alan, Professor, "Computer Graphics in Mechanical Engineering," Computers In Engineering Conference of American Society for Mechanical Engineers, Boston, Massachusetts, 6 August 1990.

ADAMS, J. Alan, Professor, "Computer Literacy Using Equation Solvers," University Programs in Computer-Aided Engineering Design and Manufacturing Conference, Brigham Young University, Provo, Utah, 15-17 May 1991.

JOYCE, James A., Professor, "J-Resistance Curve Testing of Short Crack Bend Specimens Using an Unloading Compliance Technique," Twenty-Second National Symposium on Fracture, American Society for Testing and Materials, Atlanta, Georgia, 20-22 June 1990.

JOYCE, James A., Professor, "Shifting J-R Curve Data to Define i," American Society for Testing and Materials Committee Week, San Antonio, Texas, 12-14 November 1990.

JOYCE, James A., Professor, "Shifting CTOD-R Curve Data to Define δ i," American Society for Testing and Materials Committee Week, Indianapolis, Indiana, 7 May 1991.

JOYCE, James A., Professor, "Evaluation of Constraint Effects on Short Cracked Bend and Short Cracked Tensile Specimens," Constraint Symposium, American Society for Testing and Materials Committee E24, Indianapolis, Indiana, 8-9 May 1991.

MINER, Steven M., Assistant Professor, "Current Utilization of CFD in U.S. Industry," Fujitsu Computers Computer-Aided Engineering Seminar, Cincinnati, Ohio, 3 August 1990.

WU, Chih, Professor, "Update on the Development of Ocean Thermal Energy of Conversion and its Potential in the Republic of China," Chinese American Academic and Professional Convention, New York, New York, 4-6 July 1990.

WU, Chih, Professor, "Power Optimization of an Endoreversible Closed-Cycle OTEC Plant," World Renewable Energy Congress, Reading, United Kingdom, 23-28 September 1990.

WU, Chih, Professor, "Power & Economical Optimization of an OTEC Power Plant," World Renewable Energy Congress, Reading, United Kingdom, 23-28 September 1990.

WU, Chih, Professor, "Specific Power Bound of a Nuclear Power Plant," Power High Techology '91 Conference, Tainan, Taiwan, Republic of China, 4-7 March 1991.

WU, Chih, Professor, "Power Optimization of a Finite-Time Brayton Heat Engine," International Symposium on Computer Applications in Design, Simulation and Analysis, Las Vegas, Nevada, 19-21 March 1991.

WU, Chih, Professor, "Multi-Purpose OTEC," International Conference of Ocean Thermal Energy Conversion, Taipei, Taiwan, Republic of China, 30 April - 5 May 1991.

DEPARTMENT OF

Naval Systems Engineering

Associate Professor Marshall L. Nuckols
Chair

The Naval Systems Engineering Department conducted scholarly research and professional development vigorously in all three disciplines of naval architecture, marine engineering, and ocean engineering during the academic year 1990-1991. Faculty members and midshipmen took part in numerous sponsored research activities, including the Trident Scholar Program. A number of faculty members participated in non-funded research and directed senior midshipmen in their research activities, utilizing the excellent laboratory and computer facilities available to this department.

The department recognizes with pride the selection of Assistant Professor David L. Kriebel as a Presidential Young Investigator by the National Science Foundation. Dr. Kriebel is an Ocean Engineer whose primary research interests include coastal engineering, breakwaters, and deep water mooring. The award brings with it a large research grant which will be used under the direction of Dr. Kriebel to upgrade and increase utilization of the department research facilities.

The department continued to participate actively in professional society meetings and conferences, both nationally and internationally. Research results have been published in journals and other technical publications, or presented at national and international seminars. The outcome of the department's deep involvement in research by the civilian and military faculty members is reflected in the academic environment in the classroom for professional and major courses.

Research themes of the department faculty were varied. They include tests of the floatation system for the U.S. Army's Bradley fighting vehicle, breakwater model tests, wave group analysis, prediction of beach profile response, computer-aided design, dosimeter analysis, decision-making methodology, ice breaker design studies, reliability centered maintenance, thermodynamics of heat engines, the effects of corrosion on marine structures, and the effects of shallow water on ship mooring and sonar dome resistance.

Research funding was made available from many sources including department operating funds and contracts and grants from various research organizations such as the Naval Academy Research Council, Office of Naval Research, U.S. Army, U.S. Army Corps of Engineers, Naval Facilities Engineering Command, Naval Medical Center, United States Coast Guard, Naval Coastal Systems Center, Naval Sea Systems Command, the Trident Scholar Program, and IBM.

Sponsored Research

Comparative Testing of Pontoon-Based Flotation Systems for the U.S. Army's Bradley Fighting Vehicle

Researchers: Lieutenant John L. Braun, USN,
Midshipmen 1/C William C. Duerden,
Jonathan W. Lebaron, and Hyon S. Lim, USN
Sponsor: Bradley Fighting Vehicles, United States Army

The objective of this project was to test variations of the pontoon-based flotation devices for the U.S. Army's Bradley Fighting Vehicle. These particular pontoons were variations of those developed as a result of research done here at the Naval Academy in the fall of 1990. The tests made use of an existing 1/5 scale model of the Bradley Fighting Vehicle. Tests evaluated the performance of these pontoons in the following areas: freeboard in both the static and dynamic ballast conditions; water entry and exit on varying slopes at creep speed; calm water resistance; and a qualitative assessment of the dynamic water flow around the rear hatch. Particular emphasis was placed on the impact of these particular pontoon variations on the vehicle's ability to make a water entry, crossing, and exit with both the driver's hatch and the rear hatch fully open.

Comparative Testing of Pontoon-Based Flotation Systems for the U.S. Army's Bradley Fighting Vehicle

Researcher: Midshipman 1/C Anthony A. Case, USN
Advisers: Lieutenant Commander James W. Cowell and
Lieutenant D. Wayne Nobles, USN
Sponsor: Bradley Fighting Vehicle Systems,
U.S. Army Tank-Automotive Command

The Bradley Fighting Vehicle is an armored vehicle designed to provide protected cross-country mobility and vehicular mounted firepower to infantry/cavalry units. The Bradley was initially designed to float, which would allow it to traverse rivers. Design modifications added significant weight to the vehicle, however, and the Bradley currently in service requires an external flotation system.

In the spring of 1990, the U.S. Naval Academy completed a comparative evaluation of the presently deployed swim curtain and the new pontoon alternative. The results of that study and full scale testing during the summer of 1990 indicated that some design modifications were required. Inflation Systems, Inc. developed two new alternatives (Alternatives II and III), and the Naval Academy was asked to perform an evaluation of these systems, and to compare the results with the results previously obtained. Alternatives II and III were tested in the following areas: (1) static freeboard, (2) ingress/egress, (3) resistance, and (4) seakeeping. The test results show that both alternatives performed satisfactorily.

Pressure Loading of Planing Hull Bottoms

Researcher: Professor Roger H. Compton
Sponsor: U.S. Coast Guard

The major structural loading on planing hulls in calm water and seaways is due to extremely high--sometimes localized, ofter impulsively applied--pressures acting on the bottom of the boat. Structural design methods require knowledge of the magnitudes of the pressures to be encountered during the boat's life. Many diverse current estimation methods exist, mostly empirical, which are based on very little hard data--model or full scale. This project involves a review of the current prediction methods, an evaluation of experimental means of measuring impact pressures, and an extensive test program involving the side-by-side testing of a hard chine and a round bilge hull having identical length-to-beam ratios, displacement-to-length ratios, and pitch gyradius-to-length ratios. Testing at various speeds is being conducted in calm water, regular waves, and irregular waves. An attempt to correlate impact pressures to vertical acceleration magntitudes in waves is being made.

SWATH Ruddelizer Loading Due to Waves

Researcher: Professor Roger H. Compton
Sponsor: Naval Sea Systems Command

A novel aspect of a novel new ship type, the Small Waterplane Area Twin Hull (SWATH) ship, is the inclined after control surface used for both steering and veritical motion control called the "ruddelizer." Its novel configuration raises questions about the magnitudes of seaway-induced structural loadings which the ruddelizer is likely to experience. Conventional design practices for rudders and horizontal control surfaces (sail planes, bow planes, and stern planes) for submarines are related, but not similar enough to use with confidence for SWATH ruddelizer design. A large model of T-AGOS 19 was prepared cooperatively by the Naval Academy Hydromechanics Laboratory (NAHL) and the David Taylor Research Center, Carderock, for testing in irregular waves at NAHL. An extensive test series involving three seastates, eight ship-to-wave headings, and four ruddelizer deflection angles was undertaken. For all tests, the model was at zero speed and free in all six degrees of freedom.

Wave Groups and Breaking Waves in Random Seas

Researchers: Professor Thomas H. Dawson, Assistant Professor
David L. Kriebel, and Louise A. Wallendorf, Ocean Engineer
Sponsor: Office of Naval Research

Wave groups and wave breaking in deep-water random seas have been studied experimentally using the U.S. Naval Academy 380-foot wave tank. Experimental results for the probability of breaking have been compared with predictions that account approximately for non-linear effects of increased wave crest amplitudes. In this case, the peaked nature of high wave crests is accounted for theoretically, and when a suitable breaking threshold condition is applied, the probability of wave breaking at a point can be predicted with reasonable accuracy. In addition, the probability of wave breaking within a finite region, over the width of an offshore platform, for example, has been investigated analytically and experimentally. Related theoretical work enables predictions of the probability density distribution of wave crest amplitudes in random seas with significant breaking. This theory has also been verified through the experimental study.

Engineering Methods for Predicting Beach Profile Response

Researcher: Assistant Professor David L. Kriebel
Sponsor: U.S. Army Corps of Engineers

The goal of this project is to summarize the state-of-the-art in predicting beach profile response to variations in water level and wave climate. This information is being compiled in the format of an engineering design manual that would eventually be published by the Army Corps of Engineers for use by their design engineers on shoreline erosion and beach nourishment projects. The methods outlined in this report are generally based on the concept of an equilibrium beach profile, which is defined as a beach cross-section that is in dynamic equilibrium with the water level and incident wave conditions. Any variation in these conditions, such as sea level rise due to global warming or the storm surge due to hurricane landfall, will necessitate a redistribution of sand with erosion of the beach face and deposition of sand offshore. Methods presented in this report allow predictions of the extent of this shoreline erosion and address, for example, the landward limit of erosion, the general shape of the beach profile, and the offshore limit of sand deposition in deeper water.

Computational Methods for Computer-Aided Design

Researcher: Associate Professor Thomas J. Langan
Sponsor: Naval Academy Research Council (OMN)

The objectives of the research project are to develop a table calculus and computer programs based on this calculus that will permit bottom-up programming in engineering design. The table calculus was developed from experience in constructing engineering calculations with spreadsheets. A proof that the calculus is robust has established that it is complete; in principle it can be used to make any calculation that can be made with a serial computer. The programs for implementing the table calculus have been written to run on computers operating under UNIX; they are written in UNIX to make them open to the system. Work has shown that it is definitely possible to develop computer software based on the table calculus and to program engineering calculations in an organized bottom-up fashion with these programs.

Compensating for the Temperature Dependence of Bubble Dosimeters

Researcher: Associate Professor Keith W. Lindler
Sponsor: U.S. Naval Medical Center

The U.S. Navy is currently seeking an accurate and convenient method of measuring neutron radiation. One such method currently being investigated at the U.S. Naval Academy is the bubble dosimeter. In a bubble dosimeter, radiation induces small droplets of a super-heated liquid to grow into a visible bubble. Radiation dose is then determined by counting the number of bubbles formed. Unfortunately, the sensitivity of the bubble dosimeter increases with temperature. Four methods of compensating for the temperature dependence of the bubble dosimeter were investigated. Three of the methods show promise and warrant further study. The most accurate method employs the use of a thermoelectric heat pump to maintain the dosimeter at a constant temperature.

Santee Basin Pier Rehabilitation Project

Researchers: Associate Professor Robert H. Mayer and
Professor A. Mohsen Alwan (Mechanical Engineering Department)
Sponsor: David Taylor Research Center, Annapolis Laboratory

In compliance with recent environmental legislation, naval ships are being outfitted to stow plastic wastes for disposal in port. Such plastic wastes are recyclable and have been converted into structural members similar to lumber. Picnic tables, park benches, and car stops are examples of products currently being fabricated of recycled plastic. The Robert Crown Sailing Center has programmed the replacement of its floating timber piers at Santee Basin this summer. In an effort to extend the application of recycled shipboard plastic to the marine environment, the Naval Systems Engineering Department has been asked to design a floating pier of this new "structural" material which meets the requirements of the Sailing Center. If successful, the project sponsor will fund construction of at least one replacement pier of recycled plastic. The remaining piers would be of conventional timber design and construction to facilitate an economic comparison.

Decision-Making Methodology

Researchers: Professor Michael E. McCormick and
Associate Professor Robert H. Mayer
Sponsor: Naval Facilities Engineering Command,
Naval Civil Engineering Laboratory

Among the decisions facing the designer of subsea cable systems are the cable route, cable size and type, method of protection, and the installation plan. Each of these decisions can significantly affect both system cost and reliability. Decision theory is a powerful tool for optimizing the design of systems dealing with uncertainties. Proposed is a decision analysis framework which considers all the interdependent cable system design variables and uncertainties "simultaneously." Combined with estimates of the costs, benefits, and potential consequences of the various design alternatives, the methodology facilitates selection of the most acceptable cable system design.

Open-Water Powering and Seakeeping Experiments on a Conventional 140-Foot Icebreaker

Researcher: Professor Bruce C. Nehrling
Sponsor: U.S. Coast Guard

The purpose of this experimental work was to ascertain the open water resistance and seakeeping characteristics of the KATMAI BAY, an existing USCG conventional 140-foot (LOA) WYTM ice breaker. A 1:9.27 scale model of the KATMAI BAY was towed in order to accomplish the following tasks: first, to determine the effective horsepower requirements for calm water operations; second, to measure the model's pitch and heave motions, as well as its vertical accelerations, in long crest, regular, head seas; and third, to determine these same quantities when the model was heading into an irregular sea. All of the acquired data were analyzed and expanded to full scale values.

A Comparative Analysis of the Open-Water Powering and Seakeeping Characteristics of Two Very Different Ice Breaker Hullforms

Researcher: Professor Bruce C. Nehrling
Sponsor: U.S. Coast Guard

The purpose of this experimental work was to compare the open water resistance and seakeeping characteristics of an existing USCG conventional 140-foot (LOA) WYTM ice breaker with those of a prototype ice breaking hullform of similar length. Two 1:9.27 scale models were towed in order to accomplish the following tasks: first, to determine each hull's effective horsepower requirements for calm open water operations; second, to measure each model's pitch and heave motions, as well as its vertical accelerations, in long crested, regular, head seas; and third, to determine these same quantities when the models were heading into an irregular sea. All of the acquired data were analyzed and expanded to full scale values.

The Effect of 14 MeV Neutrons on Diodes

Researcher: Professor Martin E. Nelson
Sponsor: U.S. Army Electronic Proving Ground

Neutron sensitive diodes were irradiated in the U.S. Naval Academy neutron generator to determine their sensitivity to 14 MeV neutrons. The results are being evaluated as part of the TECOM project at the U.S. Army Electronic Proving Ground at Fort Huachuca, Arizona. Neutron doses on the order of 200 rem were supplied. The data developed from the tests are still under evaluation.

Room Characterization of 14 MeV Neutron Generator Facility at the U.S. Naval Academy

Researchers: Professor Martin E. Nelson and
Ensign Robert A. Schoenwiesner, USN
Sponsor: Naval Medical Command and Naval Surface Weapons Center

The U.S. Navy is evaluating new types of neutron dosimeters such as the bubble dosimeter. These devices need to be evaluated with different neutron spectra in order to understand their energy response and to gather data on the operating limits of the devices.

The U.S. Naval Academy has a neutron generator which puts out a nearly monoenergetic beam of 14 MeV neutrons. By irradiating any neutron dosimeter with the generator, that dosimeter's response to high energy (14 MeV) neutrons can be determined. The room containing the generator has therefore been characterized to determine the dose equivalent at specific points, and to determine any dosimeter's response to 14 Mev neutrons. In this study, the room characterization was completed using an assortment of computer codes, detectors, and foil activation techniques.

Study of Neutron-Induced Upset Events in Computers

Researcher: Professor Martin E. Nelson
Sponsor: International Business Machines

Recently, International Business Machines (IBM) has become concerned that neutrons can induce upset events within the memory of a computer. Computer memory devices work on the basis of being able to process small electrical signals. Neutrons, when they interact with the materials within a computer (most likely silicon), undergo nuclear reactions which create ionizing particles. These particles can produce a current within the computer, and if the current is above a threshold value, an upset event can occur. These upset events result in changing the stored information on a memory byte. In studying this problem some of the technical questions that arise include: (1) the device's critical charge for upset; (2) the device's cross section (i.e., upsets per neutron seen by the device); and (3) energy deposition by the neutron within the device. The problem is more pronounced in large scale integration devices (LSI) or very large scale integration (VLSI) such as employed in aircraft or missile systems. The source of these neutrons could be either those found in the natural background or in a weapon environment.

Photo-Neutron Production Studies at High Energy

Researcher: Professor Martin E. Nelson
Sponsor: Naval Surface Warfare Center and Naval Medical Center.

This study has been initiated to investigate the neutron dose received from photo neutrons produced from medical x-rays. Bubble dosimeters and other neutron sensitive devices were tested at the Centennial Medical Center in Nashville, Tennessee.

Reliability-Centered Maintenance

Researcher: Associate Professor Kenneth L. Tuttle
Sponsor: Naval Sea Systems Command
Maintenance Office (NAVSEA 915/935)

The purpose of this research was to develop faculty expertise and upgrade the Marine Propulsion Laboratories at the U.S. Naval Academy for instruction of midshipmen in modern maintenance engineering concepts. The objectives are as follows: (1) to develop instructional capabilities in maintenance engineering; (2) to introduce Reliability-Centered Maintenance (RCM) to naval officers; and (3) to develop long range planning for introduction of maintenance engineering into the curriculum. The Diesel Engine Room Laboratory was upgraded to allow operation of the GM 3-71 diesel engine at four different loads rather than one. Several start-up problems have been solved, and progress is being made toward the addition of significant new engine monitoring capabilities. The Naval Academy has joined the local developer of the system, Diesel Engine Monitoring and Analysis (DEMA), in further development of this technology for the U.S. Navy.

Model Testing of Low Crested Breakwaters

Researcher: Midshipman 1/C Brian L. Davies, USN
Adviser: Assistant Professor David L. Kriebel
Sponsor: Trident Scholar Program

Small-scale model tests were conducted in the Coastal Engineering Wave Basin to assess the wave transmission characteristics of low-crested or "reef" breakwaters. The goals of the study were to quantify the amount of wave transmission permitted by these structures for various structure heights, water depths, and incident wave conditions. Tests were conducted on cross-sections of both solid and rubble breakwater models using both regular and random waves. Results indicate that for deeply submerged breakwaters, wave transmission is very high and, in some cases, the breakwater may have little effect at all on attenuating wave energy. For higher breakwaters, wave transmission is governed by two processes: over-topping due to wave runup and flow through the permeable rubble structure itself. For these conditions, a new parameter based on the breakwater freeboard, wave runup, and incident wave height has been found that describes most of the observed variation in wave transmission. This parameter is capable of describing wave transmission in both regular and irregular waves, if the irregular waves are characterized by their significant wave height and peak spectral period.

Open-Water Resistance and Seakeeping Characteristics of Ships with Icebreaking Bows

Researcher: Midshipmen 1/C Casey V. Moton, USN
Advisers: Professors Roger H. Compton and Bruce C. Nehrling
Sponsor: Trident Scholar Program

Most research conducted on icebreaking ships has concentrated on their performance in ice fields. One area of their operations which has been neglected is the performance of such ships during their transit from their homeport to the ice field. Powering requirements are dominated by resistance in ice, and, of course, seakeeping is of little importance in ice-covered waters. The recent interest in "ice-capable" ships, with both a light icebreaking mission requirement and either a cargo-carrying or a research mission requirement, dictates that ships designed to meet such requirements have greater emphasis placed on their open-water transit characteristics.

The experimental research undertaken as the core of this Trident Scholar project shows how variation of icebreaking hull shape parameters will affect open-water powering and seakeeping performance. Based on a current U.S. Navy ice-capable ship hullform, a parent hull and four systematically varied hullforms were designed, fabricated, and tested in calm water and regular waves in the U.S. Naval Academy's Hydromechanics Laboratory 380-foot towing tank.

Independent Research

Convolution Method for Predicting Beach Profile Response

Researcher: Assistant Professor David L. Kriebel

The goal of this project is to develop analytical methods for predicting the beach profile response to elevated water levels that might result from sea level rise or storm surge conditions. In the first part of this project, simple geometrical arguments are used to derive the maximum potential erosion that can result from a given near-shore water level. These solutions assume that the water level is maintained steady until the profile reaches a new equilibrium form and position. In the second part of this project, Laplace Transform methods are used to derive the time-dependent beach profile response toward equilibrium for various water level time-histories. The result is a simple convolution integral from which analytical solutions for erosion can be obtained. This project was funded by the University of Delaware Center for Applied Coastal Research.

Linear Wave Theory Correction

Researcher: Professor Michael E. McCormick

The theory of Airy was reexamined to determine the nature of the inconsistent wave pressure prediction. Starting from Euler's equation applied to irrotational flow, the equation was integrated in space from a finite free-surface deflection to a depth. This method produces a pressure expression that is consistent with that physically observed on the free-surface.

Fifteenth Personal Dose Intercomparison Study

Researcher: Professor Martin E. Nelson

Dosimeters entered in the Fifteenth Personal Dose Intercomparison study were irradiated with fourteen MeV neutrons by the U.S. Naval Academy neutron generator. The devices irradiated include the DT-648 dosimeter used by the U.S. Navy. The results are being analyzed and evaluated by the participants.

Reactants for Engines to Run Submerged

Researcher: Associate Professor Kenneth L. Tuttle

The purpose of this research is to compare reactants designed for engines to be used in small, manned submarines which operate on the ocean floor at depths down to 20,000 feet. One objective is to indicate problems and advantages associated with each heat engine. Another objective is to show calculated results for combinations of potential reactants. Assuming a thermodynamic efficiency of 26.5 percent and an average power of about 20 kilowatts for 48 hours on station, the amount of each reactant and size of tank have been determined. The chemical assumptions and constants used for the calculations are being provided to permit verification of the results.

Reducing Gas Turbine Duct Size at Main Deck Penetration

Researcher: Associate Professor Kenneth L. Tuttle

The concept being presented is a proposed design for gas turbine intake and exhaust ducts that will permit smaller cuts in the main deck. Higher gas velocities and smaller ducts are possible without incurring unacceptable pressure losses. The size of the openings required for the intake and exhaust ducts to penetrate the main deck on U.S. Navy ships has always been a cause of concern because of the degradation of this important strength member.

The proposed design is superimposed on the drawings of the DD963 forward engine room. A well-rounded inlet in the transition section of the duct replaces the tapered transition. The size of duct is reduced prior to penetrating the main deck. The size is limited in the intake duct to the size needed for engine removal. The intake duct can retain its reduced size for the short run to the module. Pressure loss calculations have been made to compare existing ducts with the proposed design.

Thermodynamics of Heat Engines

Researcher: Associate Professor Kenneth L. Tuttle

The purpose of studying thermodynamics is to identify and correct those theories which are not correct. Thermodynamics is an old science, and many of the theories developed by leading scholars over the centuries result in confusion in the study of thermodynamics. Although no theory can be proven correct, it is possible to disprove theories which are incorrect. It is customary to disprove a thermodynamic theory by proving that it violates either the first or second law of thermodynamics. The theory which this research is currently attempting to disprove is that the energy involved in any non-flow process is equal to the change in internal energy. The change in energy in any non-flow process is equal to the change in enthalpy. Heat added or rejected is equal to the change in enthalpy of the working fluid plus the displacement work. The displacement work is equal in magnitude but not in kind to the difference between internal energy and enthalpy. This theory violates the first law of thermodynamics. It leaves the pressure-volume energy unaccounted for. The first law states that energy can neither be created nor destroyed.

A Probabilistic Approach for Determining the Effect of Corrosion on the Life Expectancy of Marine Structures

Researcher: Associate Professor Gregory J. White

One of the problems in the analysis of marine structures is the effect of exposure to a corrosive environment on strength and survivability. This problem takes two forms: loss of strength due to wastage of the material, and loss of function due to localized pitting penetrating the material. The research underway in this effort attempts to establish a means of quantifying both general wastage and localized pitting of steel plating in a probabilistic format. Wastage rate and pitting rate are treated as random variables in a stochastic process. Initial estimates of both effects are included in the design of a structure, then updated through Bayesian methods during the lifetime monitoring of the structure.

Research Course Projects

Transverse Stability of Planing Boats at Planing Speeds

Researcher: Midshipman 1/C William S. Abrams, USN
Adviser: Professor Roger H. Compton

The overall transverse stability of planing boats at post-hump speeds was investigated using a 1:8 model of a current U.S. Coast Guard hull. The results of a series of tests in which static heeling moments were applied to the moving model which was free to heel, trim, and rise (or sink) were presented and discussed. Experimental techniques are described and data compared to available related results.

The results of this experiment show that the dynamic stability changes in incremental amounts as variables of ship speed, heeling (righting) moment, and the longitudinal centered gravity.

Passive Neutron Signatures

Researcher: Midshipman 1/C John H. Bruggeman, USN
Adviser: Professor Martin E. Nelson

The goal of this project was to study the feasibility of using bubble dosimetry as an alternative to current methods for arms treaty verification. The concentration was on evaluating the ability of the BD-100R bubble dosimeters to discriminate between two different materials.

The testing began with experimentation to determine if the dosimeters met the manufacturer's published sensitivities. The dosimeters were irradiated with a source of known activity, and the results were compared with the expected, calculated results, as well as the results from a Helium-3 detector.

Next, testing was conducted to determine the effects of varying temperature on the bubble dosimeters. A tank was constructed in which water could be heated to a desired temperature. Again the results were compared with what was expected as calculated from the manufacturer's literature.

Experiments were then conducted in order to calculate an efficiency between the bubble dosimeters and the Helium-3 detector. This efficiency was used to compute the time of testing and volume of bubble material needed to produce results of the desired accuracy. Finally, tests were conducted with the bubble dosimeters surrounded by lead and then paraffin in order to determine if the dosimeters could discriminate between these two materials.

The experimentation and calculations indicate that it would be feasible to construct a bubble detector of sufficient volume to distinguish between different materials. The results of the initial tests show that more advanced temperature control would be needed in order to make the bubble dosimeter useful in a typical "field" environment.

Efficiency of the Human Engine Underwater

Researcher: Midshipman 1/C Scott A. Chandler, USN
Adviser: Lieutenant Commander Patrick K. Poole, USN

The operating parameters of The Human Engine were determined by experimental measurement of a diver in a test bed at various positions and work rates. These parameters were used to develop an analytic model of power generation, air consumption, and optimum performance conditions.

Nuclear Power Plant Simulator Evaluation

Researcher: Midshipman 1/C John C. DeVine, USN
Adviser: Professor Martin E. Nelson

The objective of this research project was primarily to become familiar with the PWR.EXE nuclear power plant reactor simulator program, and to evaluate its usefulness in a laboratory format as an instructional tool for students in the Reactor Physics II class.

A study was first performed of the Reactor Physics II syllabus and the topics that the simulator would be used to illustrate. This program of study consumed the first six weeks of the research semester.

The remainder of the semester was used to experiment with the simulator and the various experimental procedures proposed by the PWR.EXE simulator manual. For each of the experiments, the procedure was followed as documented in the instruction manual. The procedure was then evaluated, and adjusted as necessary to make the experiment useful within the Reactor Physics II syllabus.

It was concluded that the program has limited potential as an educational tool. A few characteristics of the program, including its time-consuming nature and difficulty in achieving repeatable results, make extensive use of the program unrealistic.

Breakwater Effectiveness

Researcher: Midshipman 1/C Richard W. Gordon, USN
Adviser: Professor Michael E. McCormick

An experimental study was performed to determine the effects of a rubble-mound breakwater on both salient formation and long-shore transport. The study was performed on a steep beach with refracting waves. The breakwater model was oriented at three different angles with the shoreline, including 0° and one positive and one negative angle. Because of beach steepness, the Hau-Sylvester geometric analysis of equilibrium salients was shown not to apply.

Carbon Dioxide Absorption into Seawater as a Scrubbing Method

Researcher: Midshipman 1/C Robert W. Keefe, USN
Adviser: Associate Professor Marshall L. Nuckols

This project investigated the feasibility of a carbon dioxide scrubber system for an underwater habitat utilizing the natural absorption characteristics of seawater. Tests were conducted in the Ocean Engineering Laboratory using equipment constructed for a previous related research project to develop a set of curves describing the absorptive properties of the scrubber under varying environmental conditions. Concept feasibility was proven and scrubber sizing was made to support life in a fixed underwater platform.

Analysis of Viscous Drag Forces on Moored Ships in Shallow Water

Researchers: Midshipmen 1/C Dave L. Kennedy
and Juan J. Orozco, USN
Advisers: Assistant Professor David L. Kriebel
and John J. Zseleesky, Naval Architect

Laboratory experiments were performed on two ship hullforms to investigate the variation of steady-current forces in shallow water. The first phase of this study involved physical model tests with small models (1-on-80 scale ratio) in the Naval Academy 120-foot towing tank. These models were towed at various steady speeds with angles of attack ranging from 0° to 180° in order to measure the surge forces, sway forces, and yaw moments. Results were then compared with earlier tests performed with larger models (1-on-25 scale ratio) in the 380-foot towing tank in order to document scale effects associated with use of the smaller facility. These scale-effects tests were then followed by a systematic study of the effects of reduced water depth. The surge and sway forces, along with yaw moments, were measured at various water depth-to-ship draft ratios. Results indicate that viscous forces on ships in shallow water steady-currents may be two to three times larger than forces at the same current-speeds in deep water conditions.

Study of Radon Measurement Techniques

Researcher: Midshipman 1/C Christopher D. Lopes, USN
Adviser: Professor Martin E. Nelson

The objective of this project was to study the current methods of radon detection and concentration measurement, with the goals of observing time variation of radon concentration in houses and testing the accuracy of detection methods. The study involved using different methods of radon detection and comparing the results over time, as well as researching results from other studies. The project involved taking data from three different houses in the Annapolis area for a period of about three months. Data were taken once per week at two sites in each house. Raw data from the liquid scintillation counter and sodium iodide detector systems were then analyzed to identify the level of radon in pico-curies per liter-standard unit of concentration measurement. It was determined from the project data that there is not significant variation or any identifiable trend over time in concentration. It was observed that liquid scintillation counting is more sensitive over a wider range than traditional sodium iodide detection methods. In two of the three houses tested in the Annapolis area, a level above the current EPA action level of four pci/l was detected consistently.

Side-By-Side Effective Horsepower (EHP) and Seakeeping Testing in the U.S. Naval Academy 380-Foot Towing Tank

Researchers: Midshipmen 1/C Douglas R. Mewhirter
and Mark H. Oesterreich, USN
Adviser: Professor Roger H. Compton

The purpose of this project was to examine the feasibility of side-by-side testing of ship models in the 380-foot tow tank in the Hydromechanics Laboratory. Effective horsepower testing was done first. The models were installed so that they were separated by 33% of the width of the tank. The models were then run at varying speeds in order to obtain EHP curves for comparison with curves calculated from tests done with the models run individually. The side-by-side and the single curves did not correspond well, so the models were mounted and tested with 50% of the tank width between them. This action did not significantly reduce the interference effects between the models. The researchers concluded that side-by-side EHP testing is not feasible.

Next, the seakeeping test was done. This test included a pitch and heave comparison. With 50% of the tank width between them, the models were run at two different speeds into a range of wave frequencies. The side-by-side transfer functions did not correspond well. The results were not so far off, however, as to preclude a qualitative comparison between hulls.

Hullform Generation

Researcher: Midshipman 1/C Fiore L. Nardo, USN
Adviser: Professor Rameswar Bhattacharyya

The objective of this project was to create a hullform generation algorithm which could be written and used on a personal computer. Several different methods of generating offsets for a hullform with specific characteristics were tested. The final program consists of a cubic spline fairing of existing parent hullform offsets. The new offsets are then drawn on the computer screen, again using cubic spline interpolation. The program is also capable of allowing the user to modify the offsets interpolated in order to deviate as much as desired from the parent hullform. Finally, the program incorporates several procedures which calculate the ship's characteristics, as well as predict its performance and stability. Series 60 ship data were used due to ready availability and the many regression equations available in series 60.

Effect of Exhaust Headers on a 289-Cubic Inch Ford V-8 Engine

Researcher: Midshipman 1/C Eric E. Otten, USN
Adviser: Associate Professor Kenneth L. Tuttle

The purpose of this research was to determine whether header systems designed for a 289-cubic inch displacement Ford V-8 engine are able to improve the performance over that of the stock exhaust manifold system. The research was conducted in the Marine Propulsion Laboratory engine test cell. This research showed not only that the commercial headers tested improve volumetric efficiency and therefore engine torque and power, but also that the stock exhaust pipe, muffler, and tail pipe assembly improved the performance of the stock exhaust manifold.

Bi-Directional Wave Energy Turbine Study

Researcher: Midshipman 1/C Joseph G. Rehak, USN
Adviser: Professor Michael E. McCormick

A bi-directional, radial turbine was designed, constructed, and tested in both a wind tunnel and the 385-foot wave and towing tank. The results were compared with those of the bi-directional counter-rotating turbine, developed at the Naval Academy, and found to be superior. The radial turbine was found to have higher torque at operational speeds, and was far easier to construct. Hence, the radial turbine was judged to be more cost effective than the counter-rotating turbine.

Hydrodynamic Loading of Sailing Yacht Keels

Researcher: Midshipman 1/C David S. Steel, USN
Adviser: Professor Roger H. Compton

The structural failure of the keel-hull attachment on a modern open-ocean racing yacht prompted the laboratory investigation of keel loading--side force, bending moment, and torsion--as functions of hull speed, heel angle, and leeway angle. The design and fabrication of an apparatus to support a model keel, to provide reasonably realistic flow around the root of the keel, and to allow the measurement of the desired loads were accomplished. Initial bench calibration of the apparatus showed minimal cross-talk among measured signals and reasonable linearity.

The Effects of Shallow Water on a Destroyer-Type Hull Both with and without a Large Bow-Mounted Sonar Dome

Researcher: Midshipman 1/C Peter A. Young, USN
Adviser: Lieutenant Commander David D. N. Vann, USN

The objective of this project was to study the effects of shallow water on a destroyer-type hull both with and without a large bow-mounted sonar dome. These effects were studied at speeds typical of shallow water operation. This was accomplished using two models, one without a dome (FF-A) and one with a dome (FF-B). Resistance and trim were recorded for both models at various depths (including deep water) and speeds. Wave profiles and wake patterns were also observed. All experiments were conducted in the 120-foot towing tank at the U.S. Naval Academy Hydromechanics Laboratory. The results obtained show that there was a significant difference in resistance between the two models, with FF-B having the consistently higher resistance. FF-B experienced only slightly greater responses in trim, and in all cases paralleled the responses observed for FF-A. In all cases, it was noted that the maximum sinkage occurred at roughly 81 to 83 percent of critical speed.

Publications

BRAUN, John L., Lieutenant, USN, and William C. DUERDEN, Jonathan W. LEBARON, and Hyon S. LIM, Midshipmen 1/C, USN, "Comparative Testing of Pontoon-Based Flotation Systems for the U.S. Army's Bradley Fighting Vehicle," *Division of Engineering and Weapons Report* EW-11-91, May 1991.

This report describes tests of the pontoon-based flotation devices for the U.S. Army's Bradley Fighting Vehicle. The pontoons were variations of those developed as a result of research done here at the Naval Academy in the fall of 1990. The tests made use of an existing 1/5 scale model of the Bradley Fighting Vehicle. Testing evaluated the performance of these pontoons in the following areas: freeboard; water entry and exit on varying slopes at creep speed; calm water resistance; and a qualitative assessment of the dynamic water flow around the rear hatch. Particular emphasis was placed on the impact of these pontoons on the vehicle's ability to make a water entry, crossing, and exit with both the driver's hatch and the rear hatch fully open.

BHATTACHARYYA, Rameswar, Professor, co-author, "Powering Performance Committee Report," *Proceedings* of the Nineteenth International Towing Tank Conference, Madrid, Spain, September 1990, pp. 236-289.

The ITTC Powering Performance Committee has traditionally been dealing with the problem of the relationship between a certain hullform and the power to be installed. Model experiments to predict this relationship are still believed to be the most accurate means, particularly if the form at hand is not sufficiently related to experience with similar cases tested earlier.

COMPTON, Roger H., Professor, "Resistance and Seakeeping Database for USCG 157-foot WAGL," *Division of Engineering and Weapons Report* EW-8-90, June 1990.

EHP, sinkage, and trim in calm water as functions of speed for the USCG 157-foot WAGL buoy tender are derived from the results of 1/32 model tests in deep and shallow water. Long crested, head seas testing of the same model at three discrete speeds resulted in normalized response curves for pitch, heave, relative motion at station 1 (of 10), and added resistance due to encountered waves.

DAWSON, Thomas H., Professor, *Engineering Design of the Cardiovascular System of Mammals*. Englewood Cliffs: Prentice Hall, 1991.

This book applies relatively simple engineering concepts to the study of the cardiovascular system of mammals. Theoretical scaling laws are derived relating similarity in physiological parameters of the systems to mammal size. Detailed predictions of cardiac performance during rest and during extreme exercise are included, and compared with existing measurements.

JOHNSON, Bruce, Professor, co-author, "Database Systems for Hullform Design," *Transactions* of the Society of Naval Architects and Marine Engineers, Volume 98, 1990.

The conceptual design of optimal ship hullforms involves investigating the effects of hull geometry variations on hydrodynamic performance characteristics. An easily accessed hullform design database containing performance data on a wide range of previous designs can shorten the time required during early stage design to achieve the hydrodynamic performance goals of a given design. Such a database would also be extremely valuable in validating Hydro-Numeric design codes.

A survey of existing and proposed hullform design systems worldwide suggests that the development of standardized neutral formats for digital data exchange would greatly improve the ship designer's access to a wide range of existing hull geometry/ship performance data. It is proposed that the International Towing Tank Conference (ITTC) cooperate with other international standards organizations in developing standardized neutral formats for the efficient exchange of digital hullform performance data.

JOHNSON, Bruce, Professor, "On the Integration of CFD and CAD in Ship Design," *Proceedings* of the International Symposium on CFD and CAD in Ship Design, Wageningen, The Netherlands, September 1990, pp. 3-22.

The paper touched upon many aspects of CFD and CAD codes used for hullform design and the developments needed to integrate these tools into a cost effective ship design system. The conclusions were summarized as follows:

Previous attempts, such as the IPAD effort, to develop fully-integrated vehicle design systems built around the efficient use of a central database exceeded the capabilities of the hardware and software commercially available at that time. The Workstation/Mainframe/RDBMS/UNIX environment is now sufficiently developed to accomplish this task at a reasonable cost.

The work on international CAD/CAM/CIM data exchange standards by projects such as the ISO/STEP, NIDDESC, and CALS should be extended to include other CAE/CFD and model test data frequently used during the concept design phase. The ITTC community should join this effort to encourage international cooperation in ship design and to provide even more cost saving during ship and marine vehicle design.

A ship design equivalent to AGARD, possibly an international consortium, is needed to bridge the gap between basic CRD research efforts and the present design process. There is a great need to make those who are in a position to fund integration work aware of the long term cost benefits which could result by reducing the bottlenecks in the concept design process discussed in section 5. Cost sharing between the parties involved in "open system" code and code interface development is a viable alternative to the development of proprietary CAE/CAD systems which may or may not find a niche in the ship design market.

JOHNSON, Bruce, Professor, co-author, "Towards a Standard Relational Database for an Integrated Ship Hullform Design, Analysis, and Evaluation System," *Proceedings* of the International Society for Mini- and Microcomputers, International Symposium on Computer Applications in Design, Simulation, and Analysis, Las Vegas, Nevada, March 1991, pp. 170-173.

The design of ship hullforms is a complicated and time-consuming process involving (1) an accurate description of the hullform geometry and (2) a prediction of the performance characteristics of the ship. Until recently, the latter generally involved conducting physical model experiments in the form of towing tank tests which greatly increase the time needed for a design to be completed. Advances in computer technology and the use of regression analysis and numerical fluid dynamics codes have made the process faster, but the process of designing a ship is still accomplished through a series of sequential phases which have to be performed independently and frequently on different hardware. Results of one phase have to be translated to formats accepted by the next and succeeding phases and this data exchange discontinuity makes the turn around time greater. The lack of an online database containing performance data on a wide range of previous designs makes the conceptual design of new innovative (non-standard) ships quite tedious. The application of artificial intelligence techniques and ideas has so far been inhibited even though marine design would be a very good test bed for such methods. Computer-aided design and analysis systems have been developed for the automobile and aircraft industry, but they are frequently of a proprietary nature, since the aircraft or automobile design team is employed by the manufacturing company which builds the vehicles. Since ship design firms and shipbuilding companies are generally independent of each other, except in some countries such as Japan and Korea, the problem of design data exchange is receiving considerable attention on an international scale. Some attempts to develop integrated CAD systems for ship design and construction are underway. This paper addresses the problem of designing a database for storing and exchanging information about marine hullforms, to be used as the central module for an integrated ship design, analysis, and evaluation system.

KRIEBEL, David L., Assistant Professor, "Nonlinear Wave Interaction with a Vertical Circular Cylinder, Part I: Diffraction Theory," *Ocean Engineering*, **17**, 4 (1990), 345-377.

A closed-form solution is developed for the velocity potential resulting from the interaction of second-order Stokes waves with a large vertical circular cylinder. At first-order, the solution is the usual linear diffraction theory. At second-order, the solution consists of forced wave motions, due to nonlinear wave-wave interactions in the free surface boundary condition, plus scattered free wave motions, due to the interaction of the forced waves with the fixed cylinder. The velocity potentials are then used to determine the theoretical free surface elevations around the cylinder consistent with second-order. Second-order terms are found to significantly alter wave envelopes around the cylinder as a result of nonlinear diffraction. For example, the maximum wave crest run-up on the cylinder from the nonlinear theory is found to exceed that predicted by the linear diffraction theory by up to 50%. A brief comparison of the nonlinear theory with the measured run-up data is found essentially to confirm the theoretical solution.

KRIEBEL, David L., Assistant Professor, "Advances in Numerical Modelling of Dune Erosion," *Proceedings* of the Twenty-second International Conference on Coastal Engineering, Delft, The Netherlands, Vol. 3, July 1990, pp. 2304-2317.

Estimating dune erosion during severe storms continues to be a major coastal engineering problem and, as a result, predictive methods must continue to evolve and improve. While most dune erosion models in the 1970's and early 1980's were based on geometrical arguments, the more recent methods of Vellinga, based on extensive large wave tank experiments, and of Kriebel and Dean, based on a finite-difference numerical model, have been adopted recently. It has been found, however, that neither of these methods is sufficiently general for universal application, since both contain several limiting features. The goals of this paper are to review problems in the existing methods of predicting dune erosion and then to describe recent revisions to the Kriebel and Dean model. These modifications, mainly in the onshore boundary conditions, eliminate several deficiencies in the original model and enable simulation of a wider range of beach and storm conditions.

KRIEBEL, David L., Assistant Professor, co-author, "Evaluation of Viscous Damping Models for Single-Point Mooring Simulation," *Division of Engineering and Weapons Report* EW-9-90, July 1990.

Planar motion mechanism (PMM) experiments were carried out on two hullforms in order to evaluate viscous damping expressions for incorporation into a single point mooring simulation model. The existing numerical model, used by the Naval Facilities Engineering Command, does not account for viscous forces and moments arising from vessel yaw motions as a ship "kites" or "fishtails" on a single point mooring. Results of this study indicate that these forces can be easily modelled by including simple strip-theory expressions for viscous yaw damping. With the addition of these terms in the equations of motion, predictions of surge forces, sway forces, and yaw moments were much more accurate over a wide range of flow conditions.

LANGAN, Thomas J., Associate Professor, "A Computer-Aided Programming Tool for Engineering Design," *Proceedings* of the Eighth Annual Conference on University Programs in Computer-Aided Engineering, Design, and Manufacturing, The University of Michigan, College of Engineering, Ann Arbor, Michigan, 1990, pp. 190-195.

In the conceptual and preliminary stages of engineering design the engineer cannot always lay out his or her computations in a planned format. Often the engineer makes a series of computations and then makes decisions as to the direction his or her computations will proceed based on the results of these previous calculations. It is at these decisive points in the calculations that the engineer's intuition and knowledge play their key roll; these are some of the key decision junctures, which one tries to model in expert systems. In a truly interactive environment the engineer should be free to build his computational program in a bottom up fashion without getting bogged down in programming details; this is an approach contrary to modern day computer practice which emphasizes top down programming. Spreadsheets provide a structured environment for bottom up programming and have proved useful in design computations; however, they are often restrictive both in size and flexibility. It is not difficult to saturate a spreadsheet with engineering calculations; one arrives at thirty minute calculations per single point too often. There is presently no automatic way to convert a spreadsheet into a FORTRAN or other similar computer program for computation and increased speed. These problems with spreadsheets are due to their nature. They are a "monolithic" software which present the user with a "closed" environment; however, the way they allow one to compute is extremely important. The purpose of the software discussed in this paper is to provide an open environment with bottom up programming for design computations.

MAYER, Robert H., Associate Professor, and Michael E. MCCORMICK, Professor, "Decision-Making Methodology for Subsea Cable System Design," *Division of Engineering and Weapons Report* EW-5-91, April 1991.

Decision theory is a powerful tool for optimizing the design of systems dealing with uncertainties. Proposed herein is a decision analysis framework which considers all the interdependent cable system design variables and inherent uncertainties "simultaneously." Combined with estimates of the costs, benefits, and potential consequences of the various design alternatives, the methodology facilitates selection of the most acceptable cable system design. If appropriate, this techno-economic approach may be developed into a detailed model with accompanying software which can aid designers in selecting economic subsea cable system designs while achieving acceptable reliability levels.

MILLET, Marshall, Ensign, USN, and Martin E. NELSON, Professor, co-authors, "An Evaluation of the BD-100R Rechargeable Neutron Dosimeter," *Health Physics*, **60** (1991), 325-329.

The purpose of this paper is to present data gathered in the evaluation of the BD-100R neutron bubble dosimeter done at the University of Maryland and the Naval Research Laboratory. The performance of 12 dosimeters has been followed over 15 exposure-recharge cycles under a wide range of exposure conditions. Included in this paper are the results from tests on dose rate dependence, neutron energy dependence, β and exposure, and recharge cycle performance. A statistical analysis of the reusability performance of the dosimeter as a function of dose equivalent is also presented.

NEHRLING, Bruce C., Professor, "Open Water Powering and Seakeeping Experiments on a Conventional 140-foot WYTM Ice Breaker," *Division of Engineering and Weapons Report* EW-6-90, July 1990.

The purpose of this experimental work was to ascertain the open water resistance and seakeeping characteristics of the KATMAI BAY, an existing USCG conventional 140-foot (LOA) WYTM Ice breaker. A 1:9.27 scale model of the KATMAI BAY was towed in order to accomplish the following tasks: first, to determine the effective horsepower requirements for calm water operations; second, to measure the model's pitch and heave motions, as well as its vertical accelerations, in long crested, regular, head seas; and third, to determine these same quantities when the model was heading into an irregular sea. All of the acquired data were analyzed and expanded to full scale values. These results are presented in tabular and graphical form. Along with acquiring and analyzing the above data, the general behavior of the model was observed and recorded on video tape.

NEHRLING, Bruce C., Professor, "A Comparative Analysis of the Open Water Powering and Seakeeping Characteristics of Two Very Different Ice Breaking Hullforms," *Division of Engineering and Weapons Report* EW-7-90, July 1990.

The purpose of this experimental work was to compare and contrast the open water resistance and seakeeping characteristics of an existing USCG conventional 140-foot (LOA) WYTM ice breaker with those of a prototype ice breaking hullform of similar length. Two 1:9.27 scale models were towed in order to accomplish the following tasks: first, to determine each hull's effective horsepower requirements for calm open water operations; second, to measure each model's pitch and heave motions, as well as its vertical accelerations, in long crested, regular, head seas; and third, to determine these same quantities when the models were heading into an irregular sea. All of the acquired data were analyzed and expanded to full scale values. These results are presented in tabular and graphical form. When comparing these results, it should be noted that while each model had the same LPP, their displacements were quite different.

NEHRLING, Bruce C., Professor, "An Experimental Investigation Into the Stability and Motions of a Damaged SWATH Model," *Proceedings* of the Fourth International Conference on Stability of Ships and Ocean Vehicles, September 1990, pp. 433-440.

The objective of this experimental work was to observe and partially quantify the stability and seakeeping characteristics of a dead-in-the-water scale model of a Small Waterplane Twin Hull (SWATH) both before and after simulated flooding had occurred. First, a conventional inclining experiment was conducted in order to establish the model's intact displacement and center of gravity. In addition, the model was suspended in air and swung as a compound pendulum in order to determine its mass pitch and roll gyradii. Next, one intact and two damaged conditions were modeled. In each condition, the untethered model was repeatedly subjected to both moderate and severe, irregular, long crested seas. In each sea state the model was pitch positioned to experience head seas, following seas, and beam seas. Roll and pitch motions were measured with a gyroscope. This SWATH, even though dead-in-the-water, had sufficient stability to survive the specific intact and damaged conditions and sea states which were modeled.

NUCKOLS, Marshall, L., Associate Professor, "Midshipman Elective Laboratory Training Program -- 1990: Naval Coastal Systems Center," *Division of Engineering and Weapons Report* EW-11-90, September 1990.

During the 1990 summer intersessional period, six midshipmen 1/C spent a 4-6 week period at the Naval Coastal Systems Center in Panama City, Florida, to participate in ongoing research and development projects. The objective of the Laboratory Training Program is to allow midshipmen to apply their academic training and to enhance their awareness of the development and applications of new technology for defense support.

This report consolidates the individual midshipmen research reports submitted following their TDY at the Naval Coastal Systems Center.

NUCKOLS, Marshall L., Associate Professor, "The Liquid-Filled Suit-Intersuit Concept: Passive Thermal Protection for Divers," *Undersea Biomedical Research*, **18**, 3 (1991), 168-172.

The liquid-filled suit-intersuit concept is intended to provide passive thermal protection for cold underwater missions of long duration. Conventional passive approaches use microfibrous batts beneath lightweight dry suits. The insulation thickness to maintain thermal comfort during long missions at low metabolic levels would be excessively bulky and overly buoyant for subsequent swimming scenarios.

The liquid-filled suit-intersuit can provide the resting diver with a liquid layer having a density approximately that of water, and low thermal conductivity. This results in added insulation without the additional buoyancy and bubble migration to shoulders and neck region that occurs when inflating dry suits with a gas. When the diver is required to swim from a free-flooding submersible, the liquid can be drained from the interlayer to reduce the insulation, so that the diver is essentially swimming in a conventional dry suit with a Thinsulate undergarment (Thinsulate is a registered trade name used by 3M Corporation for its microfibrous polypropylene material). This concept can also be beneficial during extended in-water decompressions for deep salvage missions; as the diver rests during a decompression stage, the suit-intersuit can be inflated with insulating fluid.

The primary advantage of the liquid-filled suit is that the diver can be protected from the cold without an active heating source. A beneficial side effect is that the insulating liquid is unaffected by suit squeeze, giving the feet and legs further protection. By selecting an insulating liquid that has a specific weight approximately that of water, minimal buoyancy variations will occur as the fluid level in the suit is varied.

POOLE, Patrick K., Lieutenant Commander, USN, "An Analytical Model of the Floating Dry Dock ARDM-3," *Naval Engineers Journal*, **103**, 2 (March 1991), 50-54.

The characteristics of a floating dry dock and the ship to be docked can be programmed into an analytical model developed on a personal computer to generate accurate predictions of all parameters of interest to the docking officer. The dry dock model allows for the rapid generation of the ballast tank levels required to raise the ship and dock while providing the expected dock draft, basin height, stability parameters, and longitudinal deflection predictions at all critical times during the docking evolution for any realistic ship load and desired position. Such a model is developed herein for the floating dry dock ARDM-3, located at the Charleston Naval Shipyard.

POOLE, Patrick K., Lieutenant Commander, USN, "A Propeller Design Process for Human-Powered Submersibles," *Proceedings*, Marine Technology Society, Vol. 2, September 1990, pp. 501-506.

A propeller design process for human-powered submersibles is presented. The process described is based on simple momentum theory with modifications to account for the energy lost in rotational motion which is prevalent in low speed propellers typical of those in human-powered propulsion. The process gives designers a complete mechanism to generate relatively high efficiency propellers specifically suited for their submersible while allowing for a variety of design options.

POOLE, Patrick K., Lieutenant Commander, USN, "A Step-by-Step-Propeller Design Process," *Journal of International Human-Powered Vehicle Association*, (1991), 2-5.

A propeller blade design process for human-powered marine vehicles is presented. The process described is based on simple momentum theory modified to account for the energy lost in the rotational motion prevalent in low-speed propellers and typical of those in human-powered propulsion. The process gives the designer a complete mechanism to generate relatively high-efficiency blades specifically suited for their individual application while allowing for a variety of design options.

TUTTLE, Kenneth L., Associate Professor, "A Maintenance Engineering Laboratory," *Proceedings* of the American Society of Engineering Education Annual Conference, Toronto, Canada, June 1990, pp. 1004-1007.

Maintenance Engineering is not new, but it is changing. In two decades new concepts such as Reliability Centered Maintenance (RCM) have been introduced and begun to replace more expensive, less effective maintenance practices. The U.S. Navy maintains more equipment than most organizations, and the importance of maintenance cannot be exaggerated. The U.S. Naval Academy graduates many of the Plant Engineers serving on ships and other duty stations. In order to use RCM concepts effectively, the Navy needs its officers to be instructed in the modern maintenance concepts the Navy uses.

The Naval Sea Systems Command, NAVSEA, has supported a program to introduce instruction in Maintenance Engineering at the U.S. Naval Academy. The Diesel Engine room in the Marine Propulsion Laboratories was used as the first laboratory to instruct the midshipmen in Maintenance Engineering. A Diesel Engine Monitoring and Analysis (DEMA) system was added to the laboratory on a GM 3-71 Diesel Engine. The DEMA system is used to introduce concepts of maintenance, to demonstrate modern maintenance practices, and to involve the student in Maintenance Engineering.

TUTTLE, Kenneth L., and Keith W. LINDLER, Associate Professors, "Thermodynamic Power Cycles Using Personal Computers," *Computers in Education Journal*, 10, 4 (October-December 1990), 62-64.

There is no better way to study thermodynamic power cycles than to use a computer. The computer can make the laborious calculations around the cycle and answer questions such as: "What effect does ambient air temperature have on the Ideal Brayton Cycle thermal efficiency?" Intuitively, all good engineers know that reducing the temperature of the air that an engine breathes will improve the ideal cycle efficiency. Intuition is not a reliable indicator. Work the cycle and learn that neither compressor inlet nor turbine inlet temperature affect the Ideal Brayton Cycle efficiency. The reason most good engineers do not know this is because working the cycles is too laborious. If existing engineers had computer programs to help with cycle analysis, more of what they know would be correct.

TUTTLE, Kenneth L., Associate Professor, "Making Room for More Math," *Proceedings* of the American Society of Engineering Education (ASEE) Annual Conference, Toronto, Canada, June 1990, pp. 1452-1454.

Most engineering faculty probably feel that more higher level mathematics courses would improve the quality of the engineers graduating today. The failure to increase the course work is not owing to disagreement over which courses to add. More likely the barrier to progress is deciding which courses to remove from the curriculum. At the college level there are too many courses that need to be taken and too little time to take them. In these rapidly changing times, some interesting courses have begun to be offered at the secondary and elementary, kindergarten, and even pre-school levels. With leadership and coordination, these schools will become responsible for making room for more math at the college level. We must take the lead. We must do the leading. We must provide the leadership. It is the colleges that drive the education process. We must lead the way. Instead of accepting less and less from schools unable to provide the requisite background, we can choose to accept more and more from those schools able to provide what we tell them we need.

TUTTLE, Kenneth, L., Associate Professor, co-author, "Final Report Assessment of Chemical Fuel Requirements for Submersible Propulsion Applications," David Taylor Research Center Report DTRC-PASD-CR-5-91.

The purpose of this research is to compare reactants that have been identified for use in closed-loop, submerged heat engines. One objective is to indicate problems and advantages associated with each available heat engine; however, the main objective is to show calculated results for thirteen combinations of potential reactants. Eleven different fuels and two different oxidizers were included. Using an overall thermodynamic efficiency of 26.5 percent, and engine on each fuel produces an average power of about 20 kilowatts for 48 hours on station plus six hours to descend 6000 meters and six hours to ascend. The tabulated results show the amount of each reactant and size of tank required. The chemical assumptions and constants used for the calculations have been provided to permit verification of the results.

WHITE, Gregory J., Associate Professor, co-author, "Life Expectancy Assessment of Marine Structures," *Journal of Marine Structures*, 3 (1990), 301-317.

In this paper, a methodology for structural life assessment is suggested. The methodology is based on probabilistic analysis, using reliability concepts and the statistics of extremes. The methodology results in the probability of failure of a structural system according to the identified failure modes as

a function of time, i.e., structural life. The results can be interpreted as the cumulative probability distribution function (CDF) of structural life. Due to the unknown level of statistical correlation between the safety margins of components of the system, limits or bounds on the CDF of structural life can be established.

WHITE, Gregory J., Associate Professor, co-author, "Semivariogram and Kriging Analysis in Developing Sampling Strategies," *Proceedings* of the First International Symposium on Uncertainty Modeling and Analysis (ISUMA), University of Maryland, College Park, Maryland, 3-5 December 1990, pp. 421-427.

The study in this paper looks at using the concepts of semivariogram analysis and Kriging estimation to develop strategies for corrosion rate estimation in steel plating. This involves determining the number and location of thickness measurements to be taken, so that a desired level of confidence is achieved in the estimation of the corrosion rate.

WHITE, Gregory J., Associate Professor, co-author, "Parametric Evaluation of Marine Structural Life Expectancy Using Reliability-Based Methodology," SSC/SNAME Marine Structural Inspection, Maintenance, and Monitoring Symposium, Arlington, Virginia, March 1991, B-1-B-7.

The estimation of an absolute life expectancy is a complex process, and the results are expected to have relatively large levels of uncertainty. In this study, a parametric sensitivity analysis of structural life expectancy due to the variation in several variables was performed. The sensitivity of the structural life expectancy of the forward bottom plating of three patrol boat designs was evaluated with respect to variations in plating thickness, panel size, operational profile, and loading condition.

WHITE, Gregory J., Associate Professor, co-author, "A Probabilistic Approach for Determining the Effect of Corrosion on the Life Expectancy of Marine Structures," SSC/SNAME Marine Structural Inspection, Maintenance, and Monitoring Symposium, Arlington, Virginia, March 1991, J-1-J-8.

The problem of the loss of structural material to corrosion has been a thorn in the side of marine designers since metals first went to sea. In recent years tremendous amounts of money and effort have gone into the development of coating and protection systems to mitigate this loss of structural material. Even with these systems there are still some problems both with the pitting and general wastage of the structural material. In some recent work conducted for the U.S. Coast Guard (*ASNE Journal*, May 1989, and May 1990) the authors conducted service-life estimation of several classes of patrol boats. Part of that analysis involved considering the effects of corrosion rates on the estimated service life. This involved treating the corrosion rate as a random variable and including it in the extreme-value probabilistic analysis.

WIGGINS, Peter F., Professor, co-author, "University Papers in American Nuclear Society Transactions with Enrollment and Degrees - IV," *Transactions* of the American Nuclear Society, Vol. 62, 1990, p. 23.

Tabulations of nuclear engineering (NE) course offerings, enrollments, degrees, and papers in the American Nuclear Society's (ANS) *Transactions* were presented in 1966 (University of West Virginia) and in subsequent publications. The U.S. Department of Energy and its predecessors have compiled enrollment and degree data since 1970. Prior to this, such information was available from several sources, e.g., American Society of Engineering Education and Engineering Manpower Commission. Data vary somewhat with source, often because NE has not been well identified from parent departments. Our latest statistics are presented in this paper.

Presentations

BRAUN, John, L., Lieutenant, USN, and William C. DUERDEN, Jonathan W. LEBARON, and Hyon S. LIM, Midshipmen 1/C, USN, "Comparative Testing of Pontoon-based Flotation Systems for the U.S. Army's Bradley Fighting Vehicle," Phase III in Process Review Meeting, Denver, Colorado, 8 March 1991.

CERZA, Martin R., Assistant Professor, "Pseudo-Steady Diffusional Growth or Collapse of Bubbles Rising in Time-Dependent Pressure Fields," International Symposium on Gas-Liquid Two-Phase Flows, Dallas, Texas, 25-30 November 1990.

COWELL, James W., Jr., Lieutenant Commander, CEC, USN, "Cost Plus Award Fee Construction Contracting; Lessons Learned from Diego Garcia," Facilities Mobilization Contracting Course, Reserve Division, Naval Facilities Engineering Command, Port Hueneme, California, 19 July 1990.

COWELL, James, W., Jr., Lieutenant Commander, CEC, USN, "Comparative Testing of Alternative Flotation Devices for the U.S. Army's Bradley Fighting Vehicle," The Chesapeake Section, Society of Naval Architects and Marine Engineers, Section Meeting, U.S. Naval Academy, Annapolis, Maryland, 9 October 1990.

HARPER, Mark J., Instructor, "Theoretical Model of Neutron Bubble Dosimeter," Colloquium on Neutron Dosimetry, Naval Surface Warfare Center, White Oak, Maryland, 18 December 1990.

HARPER, Mark J., Instructor, and Martin E. NELSON, Professor, co-authors, "Superheated Drop, 'Bubble', Dosimeters," Eleventh Department of Energy Workshop on Personnel Neutron Dosimetry, Las Vegas, Nevada, 4-7 June 1991.

HARPER, Mark J., Instructor, and Martin E. NELSON, Professor, "Theoretical Model of a Superheated Liquid Drop Detector," Health Physics Society Annual Meeting, Washington, DC, 21-26 July 1991.

JOHNSON, Bruce, Professor, "On The Integration of CFD and CAD in Ship Design," International Symposium on CFD and CAD in Ship Design, Wageningen, The Netherlands, 25 September 1990.

JOHNSON, Bruce, Professor, Presentation of the Report of the Symbols and Terminology Group, the Nineteenth International Towing Tank Conference, Madrid, Spain, September 1990.

JOHNSON, Bruce, Professor, Nikolaos GLINOS, Assistant Professor (Computer Science), Nancy ANDERSON, Naval Architect, co-authors, "Database Systems for Hullform Design," Annual Meeting of the Society of Naval Architects and Marine Engineers, San Francisco, California, 2 November 1990.

KRIEBEL, David L., Assistant Professor, "Advances in Numerical Modelling of Dune Erosion," Twenty-second International Conference on Coastal Engineering, Delft, The Netherlands, 3 July 1990.

KRIEBEL, David L., Assistant Professor, "Convolution Method for Predicting Beach Profile Response," Advances in Coastal Engineering Conference, University of Delaware, Newark, Delaware, 6 November 1990.

KRIEBEL, David L., Assistant Professor, "Hydrodynamic Forces: Viscous Damping and Excitation Forces on Moored Ships," Workshop on Mooring Dynamics, Naval Civil Engineering Laboratory, Port Hueneme, California, 8 April 1991.

KRIEBEL, David L., Assistant Professor, "Similitude Issues in Ship Moorings," Workshop on Mooring Dynamics, Naval Civil Engineering Laboratory, Port Hueneme, California, 8 April 1991.

LANGAN, Thomas J., Associate Professor, "A Computer-Aided Programming Tool for Engineering Design," Eighth Annual Conference on University Programs in Computer-Aided Engineering, Design, and Manufacturing, University of Michigan, Ann Arbor, Michigan, 14 August 1990.

LINDLER, Keith W., Associate Professor, "Compensating for the Temperature Dependence of Bubble Dosimeters," Fourth Annual Neutron Bubble Technology Research Colloquium, Naval Surface Warfare Center, White Oak, Maryland, 18 December 1990.

MCCORMICK, Michael E., Professor, "The Positive Drift of the Backward-Bent Duct Barge," University of Delaware, Newark, Delaware, 13 November 1990.

MCCORMICK, Michael E., Professor, "An Analysis of the Performance of the Backward-Bent Duct Barge," Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 20 March 1991.

MCCORMICK, Michael E., Professor, "Wave Energy Conversion," MENSA Meeting, Annapolis, Maryland, 11 December 1991.

NELSON, Martin E., Professor, "Superheated Drop, 'Bubble', Neutron Dosimeter Performance in a Work Environment," The 1990 IEEE Nuclear Science Symposium, Arlington, Virginia, 22-27 October 1990.

NELSON, Martin E., Professor, and Michael J. WILSON, Ensign, USN, "Analytical and Experimental Comparison of Personnel Neutron Dose Measurement Techniques with the Bubble Dosimeter," Health Physics Society Meeting, Las Vegas, Nevada, 28 June 1990.

NEHRLING, Bruce C., Professor, "An Experimental Investigation Into the Stability and Motions of a Damaged SWATH Model," Fourth International Conference on Stability of Ships and Ocean Vehicles, Naples, Italy, 24-28 September 1990.

NUCKOLS, Marshall L., Associate Professor, "Life Support Maintenance in the Deep Sea Environment," 1990 Annual Meeting of the Society for Risk Analysis, New Orleans, Louisiana, 9 October 1990.

NUCKOLS, Marshall L., Associate Professor, "Life Support Systems Design Seminar," Naval Coastal Systems Center, Panama City, Florida, 15-20 July 1990.

POOLE, Patrick K., Lieutenant Commander, USN, "A Propeller Design Process for Human-Powered Submersibles," Marine Technology Society 90, Washington, DC, September 1990.

TUTTLE, Kenneth L., Associate Professor, "A Maintenance Engineering Laboratory," American Society for Engineering Education Annual Conference, Toronto, Canada, 25 June 1990.

TUTTLE, Kenneth L., Associate Professor, "Making Room for More Math," American Society for Engineering Education Annual Conference, Toronto, Canada, 26 June 1990.

WHITE, Gregory J., Associate Professor, "Semivariogram and Kriging Analysis in Developing Sampling Strategies," First International Symposium on Uncertainty Modeling and Analysis (ISUMA), University of Maryland, College Park, Maryland, 3-5 December 1990.

WHITE, Gregory J., Associate Professor, "A Probabilistic Approach for Determining the Effect of Corrosion on the Life Expectancy of Marine Structures," Ship Structures Committee of the Society of Naval Architects and Marine Engineers (SSC/SNAME) Marine Structural Inspection, Maintenance, and Monitoring Symposium, Arlington, Virginia, 18-19 March 1991.

WHITE, Gregory, J., Associate Professor, "Parametric Evaluation of Marine Structural Life Expectancy Using Reliability-Based Methodology," SSC/SNAME Marine Structural Inspection, Maintenance, and Monitoring Symposium, Arlington, Virginia, 18-19 March 1991.

DEPARTMENT OF

Hydromechanics Laboratory

Professor Roger H. Compton
Director

The primary functions of the Naval Academy Hydromechanics Laboratory (NAHL) are to support education and research in ship hydromechanics and ocean engineering. The facilities which constitute the NAHL are as follows:

(1) 380-foot Towing Tank (380'x26'x16') - This premier facility features two towing carriages and a servo-controlled, electro-hydraulically activated, dual flap wavemaker. Both towed and self-powered ship models can be tested in calm water, regular waves, and irregular waves. All waves generated are long-crested. Open water propeller characteristics can be determined by means of a propeller boat. Maneuvering characteristics can be evaluated by means of a large amplitude, horizontal planar motions mechanism. Most testing is done at model speeds up to 25 fps, but special tests have been run at speeds as high as 48 fps. Surface ship and submarine models can be tested. A drydock and finger pier located at the north end of the basin can be isolated from the main tank by means of closeable drydock doors.

(2) 120-foot Towing Tank (120'x8'x5.5') - Ship models up to about 6 foot in length can be towed in calm water, regular waves, and irregular waves. Only long-crested waves can be generated by a wavemaker, which is effectively a 1/3 scale model of the wavemaker in the 380-foot towing tank. Both deep and shallow water experiments are run in this facility. The tank can be configured with a false bottom to simulate various shoaling water conditions. The powered carriage can attain speeds as high as 13 fps. The tank is also equipped to perform gravity tow (constant force) model testing.

(3) Coastal Engineering Tank (52'x48'x2') - This L-shaped tank is equipped with a piston-type wavemaker and a moveable bridge for positioning wave probes. Small scale breakwaters, groins, jetties, and harbor arrangements can be studied with respect to wave reflection, refraction, transmission, and absorption properties. Wave guides allow the basin to be subdivided for multiple experimental setups.

(4) Circulating Water Channel (Test Section 5'x1.3'x1.3') - This small, free-surface water channel with a top speed of 12 fps is used primarily for flow visualization around control surface models and cavitating propeller models. Quantitative measurements of hydrodynamic forces on rudders and hydrofoils have also been made. The channel can be pressurized from +6 psig to -12 psig to adjust model cavitation numbers.

(5) Computer Workstations - A number of Hewlett-Packard workstations are available for midshipmen, staff, and faculty use to acquire and analyze measured data and to define hull shapes using the FASTSHIP program. The capability exists to use the FASTSHIP offset files to cut hull models on a numerically controlled milling machine located adjacent to the NAHL. Additionally, several Zenith PC's are available for data analysis as testing progresses.

(6) Stability/Ballast Tank (24'x12'x3.5') - This tank is used to investigate the hydrostatic stability characteristics of ship models--inclining experiments and righting arm experiments--as well as being used to ballast models in preparation for testing in the 380-foot or the 120-foot towing tanks.

All of the operating facilities are electronically linked via remote terminals to a host computer located in the control room for the 380-foot tank. The host computer not only permits speed and consistency in data acquisition and analysis from all facilities, but is integral to the control and sequencing of experimental hardware used in testing.

The NAHL staff is a small, multi-talented group which plans, sets up, performs, and interprets the measured data from experimental programs undertaken for midshipmen, faculty, and certain outside governmental agencies. The staff of 10 consists of six graduate engineers/naval architects, three engineering technicians, and an office manager/secretary. Liaison with the Naval Academy faculty is maintained by an appointed Laboratory Director who is also a member of the teaching faculty.

Notable facilities improvement begun or completed during the current reporting period includes: (1) delivery, installation, and training of the laboratory staff by MTS of a digital controller for the 380-foot tank wavemaker; (2) performance specification released for a replacement host computer to upgrade the Hydromechanics Laboratory Data Acquisition and Analysis System; (3) removal of the original operator/electronics module from the low-speed carriage in the 380-foot tank, providing a much wider open bay for test equipment; (4) wave guides installed in the Coastal Engineering Tank; (5) acquisition of a model five-

bladed FFG-7 Controllable Reversible Pitch propeller; (6) upgraded video monitoring and recording of model performance; and (7) delivery of a non-intrusive, two-dimensional motion measurement and analysis system.

Academic programs continue to reflect the benefits of the Laboratory's participation in significant research efforts for the Navy and the Coast Guard. Programs have included: (1) Nonlinear Seakeeping Research for David Taylor Research Center (DTRC), (2) Nonlinear Wave Phenomena for the Office of Naval Research(ONR), (3) Ocean Wave Group Characteristics Studies for the Naval Facilities Command (NAVFAC), (4) SWATH T-AGOS-19 Control Surface Loads for the Naval Sea Systems Command (NAVSEA), (5) Planing Hull Pressure Measurements for the Coast Guard (USCG), (6) Cruiser Radius of Gyration Study for NAVSEA, (7) Swimmer Propulsion Vehicle Evaluation for Naval Coastal Systems Center (NCSC), (8) Dynamic Modeling of Damage Condition Performance of Combatants for NAVSEA, (9) New Concept Hull Form--Comparative Seakeeping and Powering Studies for Ice Breakers--for USCG, (10) Buoy Motion Study for the Naval Civil Engineering Laboratory (NCEL), (11) Mooring Studies for NAVFAC, and (12) New 47-foot Motor Lifeboat Seakeeping Performance Evaluation for USCG.

Experimental research studies with intense student involvement have included the following: (1) Icebreaking Bow Form Variations--Open Water Resistance and Seakeeping, (2) Effectiveness of Low, Rubble Breakwaters. (3) Open water performance, ingress/egress of the U.S. Army's Bradley Fighting Vehicle flotation system variants, (4) Side-by-Side Testing of Scale Ship Models, (5) Submarine Stability Studies, (6) Transverse Stability of Planing Craft at High Speeds, (7) Loading of Sailing Yacht Keels, (8) Fleet Mooring Research, (9) Effects of Large Bow Domes on Shallow Water Performance, and (10) Support for the Naval Academy entry in the Second Annual Human Powered Submarine Race.

DEPARTMENT OF

Weapons and Systems Engineering

Professor E. Eugene Mitchell
Chair

Research within the Weapons and Systems Engineering Department continued to provide the faculty with an environment for professional growth and the opportunity to remain abreast of today's rapidly advancing systems technology. Additionally, every graduating Systems Engineering major participated in independent research, design, and development projects which reinforced the essential interface between academics and practical application.

Every faculty member, both civilian and military, participated in independent research directed toward areas of interest to the U.S. Navy, or supported midshipmen research programs in an advisory capacity. Faculty research areas included robotics and machine vision for robots, compensator design, chaos in simulations, machinery health monitoring-fault diagnosis, and several investigations involving computer control, as well as software and hardware application to specific systems problems.

Strong emphasis continues on the faculty-midshipman relationship during the student independent research course. Each midshipman was assigned both an administrative and a technical adviser. These advisers not only provide support of a technical nature, but also emphasize planning, schedule development, and effective oral and written presentations. Thus, the student is introduced to all aspects of the research process. Typical examples of the forty-eight midshipmen research topics include a three-dimensional vision system for remote vehicle guidance, voice control of a CD player, light-guided carts, machine vision targeting for the pistol range, and a three-dimensional "virtual reality" system, in which the observer's head motion controlled computer images and sound.

Funding for research activities has been available from multiple sources, including grants and contracts from various federal agencies and naval laboratories, as well as funding from within the Naval Academy. This year's sponsors include the Naval Academy Research Council, the David Taylor Research Center, and the Naval Surface Warfare Center.

Sponsored Research

Stereo Machine Vision System

Researcher: Assistant Professor William I. Clement
Sponsor: Naval Academy Research Council (ONR)

This is the second year of a study on machine vision. In particular, a stereo machine vision system was investigated for its usefulness as a passive, long-range sensor. The passive nature of the sensor is an advantage when data must be collected at great distances or when emissions control (EMCON) conditions prevail. The stereo aspect allows one to gather both range and bearing information with a single measurement. Both of these attributes suggest its use on board ship (e.g., in station-keeping and precision maneuvering duties).

This study was carried out using departmental computer and machine vision hardware and personally-developed software. The completed setup was capable of automatically focusing the cameras on the object of interest and then using stereo vision correspondence to determine range. The automatic focus information was important for the resolution of range ambiguity as well as for scene clarity.

Results of this study were published and presented at the Ninth Ship Control Systems Symposium.

Neural Network Applications

Researcher: Assistant Professor William I. Clement
Sponsor: Naval Academy Research Council (ONR)

An investigation of neural network applications to pattern recognition was begun. The goal was to compare the effectiveness of neural networks, with their highly rich and nonlinear transformation capabilities, against the linear discriminant function of the Bayes classification technique. While neural networks have their strengths, they also suffer from excessive training times and the possibility of overtraining. The goal was to learn from the neural network how to choose better pattern descriptors, so that the Bayes classifier's performance could be improved.

The foundations of this research are underway; the bulk of the work will be conducted during the summer of 1991. Departmental computer facilities will be used, along with a professional neural network software package.

Development of Interdisciplinary Robotic Systems Laboratory Software

Researcher: Professor Kenneth A. Knowles
Sponsor: Naval Academy Instructional Development Advisory Committee

The Weapons and Systems Engineering Department Robotics Teaching Laboratory facility was redesigned and updated over the summer of 1990. The cameras at each station were mounted on the forearm links of the table top instructional robots to provide integrated vision systems for motion control. In addition, speech synthesis systems were added to each station to permit audio responses by the robots. Routines utilizing the communications package in True BASIC have been developed to permit direct control (two-way communications with all of the necessary handshaking) of the robots from within student-prepared True BASIC programs. The inclusion of complete handshaking with the robot permitted real-time control for the first time in our laboratories. Complete robot control and digital vision library modules containing all of the necessary preprocessing and subroutine modules were developed to perform most of the fundamental robot control and vision processing tasks.

Optical Fiber Strain Gages

Researcher: Associate Professor Olaf N. Rask
Sponsor: David Taylor Research Center, Annapolis Laboratory

The goal of the work was the confirmation of the use in principle of the optical strain gage. The problems confronted and solved were the reduction of the vibrational sensitivity of the gage system and the reduction of polarization fading. A gage was constructed in a test specimen which performed according to the theoretical expectations. Practical problems of gage construction were confronted and solved.

Statespace Control of an ICR Gas Turbine Engine

Researchers: Associate Professors Jerry W. Watts and Terrence E. Dwan
Sponsor: David Taylor Research Center, Annapolis Laboratory

The power plant for the electric drive Naval ships of the future will be a recuperated, intercooled, variable-area-turbine-nozzle gas turbine engine. The controller for this engine will be a computer using statespace methods with several modes. This will be developed by the contractor (yet to be determined), but DTRC needs expertise in this area. A modular simulation model of the ICR engine will be developed in ACSL and a statespace controller developed using the software MATLAB.

Optical Strain Monitoring in Composite Material

Researcher: Midshipman 1/C Daniel B. Robinson, USN
Adviser: Associate Professor Olaf N. Rask
Sponsor: Trident Scholar Program

The project was designed to study the practical problems of using optical fibers as strain gages in composite materials. Optical fibers were embedded in composite specimens where their intrinsic sensitivity was measured under controlled conditions. This turned out to be .336 x 10^6 radians per unit strain. The conditions under which the optical strain gage was calibrated differed markedly from those under which it might be used on practical structures. The actual mathematical expression for the strain in the structure was required in order to interpret the optical strain gage reading. Since in a vibrating structure driven by random forces, this could not be available, the first conclusion is that optical strain gages are useful for quantitative strain measurements only under special conditions or needs. However, it was found that if the optical strain gage output was converted into an audio signal, the ear/brain combination of human processing capability permitted subtle changes in the mechanical structure to be detected. It is in the direction of qualitative structural monitoring that future work in the optical strain gage should be directed.

Independent Research

Deadbeat Response in Discrete-time Control Systems

Researcher: Associate Professor Thomas E. Bechert

Discrete-time control systems have capabilities which are not available in the continuous-time domain. One such capability is deadbeat response. The system error signal is assumed to be sampled with a sampling period of T seconds, with each sample processed by a digital controller. The controller output signal passes through a zero order hold and is applied to the controlled plant as the control force. The control force is therefore at a constant level during each sample period. With deadbeat response the system reaches steady state, with zero error, while minimizing N, defined as the number of sample periods to reach steady state. With deadbeat response the steady state error between input and output remains at zero, even between sampling instants. This description of deadbeat response is equivalent to the behavior of a finite-impulse-response filter. Thus, the closed-loop pulse transfer function of the deadbeat system is simply F(z), a finite polynomial in 1/z of order N. With the input signal assumed to be a unit step, the minimum value of N is found to depend only on the dynamic characteristics (the pulse transfer function) of the controlled plant, provided no constraints are placed on the magnitude of the control force. If the control force is found to exceed a specified upper limit, then more time must be allowed to reach steady state; that is, the minimum value of N must increase. Computation of the control force during each of the N sample periods involves a tedious long division process.

This research project concentrates on this computation of the control force. It has been shown that the long division can be replaced by a sequence of matrix multiplications, where the matrix entries are simply the given coefficients in the pulse transfer function of the controlled plant, and the coefficients in F(z). With this simplification the design equations for the digital controller are easily programmed, and the design engineer has a convenient tool for selecting a digital controller to provide deadbeat response without violating specified constraints on the control force magnitude.

Automated Extraction of Morphological, Topographical, and Time-Related Parameters from Human Bulbar Conjunctiva Images

Researcher: Assistant Professor Carl E. Wick

Medical researchers have found convincing evidence that the topography of the body's smallest blood vessels changes in the presence of certain diseases. These same researchers believe that detecting these gradual changes may give evidence of these diseases before other more classical symptoms are apparent. This research seeks to use image processing techniques to characterize automatically these blood vessels as they are observed through photographic or video images of the conjunctiva, or "white" area of the eye. Preliminary work has been directed toward understanding and modelling the physical processes involved in acquiring a photographic or video image of the conjunctival blood vessels. Future work will use these models to develop advanced vessel detection and tracking algorithms.

Research Course Projects

Configuration Specific 1-G Remote Manipulator Simulator System Simulation

Researcher: Midshipman 1/C Robert M. Gaucher, USN
Adviser: Professor Kenneth A. Knowles

The qualitative simulation of the Remote Manipulator Simulator System (RMSS) developed previously was experimentally verified utilizing the large flexible-arm hydraulic manipulator in the Systems Engineering Department. This verification required modifications to the manipulator arm to permit the gravity-induced deflections with the manipulator elbow in a yaw configuration. The simulation-predicted deflection values corresponded closely with the experimentally-obtained deflections for various configurations. The researcher believes the determination of critical configuration regions will permit the simulation to be back fitted to the large 1-G RMSS located at the NASA Goddard Space Flight Center, Greenbelt, Maryland. Such a simulation model will permit the enhanced operation of the RMSS as a useful training simulator.

Remote Manipulator Simulator System Simulation

Researcher: Midshipman 1/C Robert M. Gaucher, USN
Adviser: Professor Kenneth A. Knowles

A well-documented and fully-debugged dynamic simulation was developed for the National Aeronautics and Space Administration (NASA) Space Shuttle Remote Manipulator System Simulator (RMSS) arm, which is being assembled at the Goddard Space Flight Center, Greenbelt, Maryland. Joint motions for the six degree-of-freedom hydraulic manipulator arm are expected to be very slow, but the massive size required to handle 1000-pound objects in a 1-G environment at a 60-foot moment arm results in non-trivial static deflections, and potentially harmful dynamic oscillations. This simulation ultimately will permit the arm control program to predict necessary joint command offsets to compensate for arm droop and load deflections in any arbitrary arm configuration. It will also permit the prediction of shuttle bay boundary proximity and other safety boundary considerations.

Design Course Projects

Each Systems Engineering major enrolls in ES402: Systems Engineering Design, during his or her senior year. This course is the capstone of the Systems Engineering curriculum. The student is required to propose, design, construct, test, demonstrate, and evaluate a system of particular interest to himself and to other student researchers.

The ES402 design course requires the combined effort of the total Systems Engineering Department faculty. Military instructors normally function as project monitors and help with organization, administration, and scheduling of individual projects. Civilian faculty function as technical advisors, and military and civilian technicians supply the hands-on technical help.

Associate Professors Robert S. Reed, Olaf N. Rask, and Professor Kenneth A. Knowles provided the course coordination and administrative effort, and were assisted by Associate Professors Thomas E. Bechert, C. George Brockus, Terrence E. Dwan, and Jerry W. Watts, and by Professors Robert DeMoyer, and E. Eugene Mitchell, who provided technical and systems design assistance and expertise for the listed design course projects:

The results of academic year 1990-1991:

Voice Command Remote Vehicle

Midshipman David S. Allen, USN
Adviser: Commander William F. Ferris, USN

Mobile Surveillance Security Vehicle with 3-D Vision

Midshipman 1/C Mark D. Brazelton, USN
Adviser: Lieutenant William B. Taylor, USN

Infrared Navigation System

Midshipman 1/C Joseph R. Britton, USN
Adviser: Lieutenant Commander William D. Randall, USN

Analog Telerobotic Controller

Midshipman 1/C Scott A. Bunnay, USN
Adviser: Lieutenant William B. Taylor, USN

Plutonium Criticality Simulation

Midshipman 1/C Michael J. Carey, USN
Adviser: Lieutenant Commander David B. Barrett, USN

Voice-Activated Shower

Midshipman 1/C David L. Christel, USN
Adviser: Lieutenant Commander William R. Cox, USN

Collision Warning System

Midshipman 1/C Ahmed A. Dawood, USN
Adviser: Lieutenant Commander Jerry M. Jones, USN

Robotic Simulation Package

Midshipman 1/C William J. Devries, USN
Adviser: Captain Brent A. Douglas, USMC

A Magnetic Levitation System

Midshipman 1/C William S. Dillon, USN
Adviser: Commander Emory L. Chenoweth, USN

Morse Code Receiver

Midshipman 1/C Conrado G. Dungca, Jr.
Adviser: Lieutenant William G. A. Sympson III, USN

Vision-Controlled Robotic Workcell

Midshipman 1/C Daniel J. Durn, USN
Adviser: Lieutenant Commander Charles R. Hendrickson, USN

Vision Acquisition Tracking

Midshipman 1/C Jeffrey E. Everage, USN
Adviser: Lieutenant Colonel James F. Kendrick, USAF

Keyless Security System

Midshipman 1/C Damon S. Fetters, USN
Adviser: Captain Thomas H. Rich, USMC

Radio-Controlled Dreadnought

Midshipman 1/C James R. Fisher, USN
Adviser: Lieutenant Joseph G. Schoppy, USN

Target Compensation

Midshipman 1/C Elizabeth A. Fitzpatrick, USN
Adviser: Captain Thomas H. Rich, USMC

Voice-Activated Telephone

Midshipman 1/C Kathryn A. Fitzpatrick, USN
Adviser: Lieutenant Commander Charles R. Hendrickson, USN

Remote-Controlled Walker

Midshipman 1/C Michael C. Gerry, USN
Adviser: Commander William F. Ferris, USN

Rotating Acoustic Tracker (RAT)

Midshipman 1/C John R. Hindinger, USN
Adviser: Lieutenant Commander Jerry M. Jones, USN

Virtual Reality

Midshipman 1/C Christopher J. Jacobsen, USN
Adviser: Commander Emory L. Chenoweth, USN

Automated Control of the USNA Steam Plant

Midshipman 2/C Matthew P. Jensen, USN
Adviser: Lieutenant Commander David B. Barrett, USN

Mobile Surveillance Security Vehicle with 3-D Vision

Midshipman 1/C Charles A. Joplin III, USN
Adviser: Lieutenant Joseph G. Schoppy, USN

Star Tracker

Midshipman 1/C Heath C. Kolman, USN
Adviser: Lieutenant Commander William R. Cox, USN

Collision Avoidance Sub

Midshipman 1/C Matthew J. Lattig, USN
Adviser: Lieutenant Commander Jeffrey M. Conley, USN

Temperature Data Acquisition System: Biofeedback Applications

Midshipman 1/C Lawrence F. Legree, Jr., USN
Adviser: Lieutenant William G. A. Sympson III, USN

Visual Representation of Speech

Midshipman 1/C Mark J. Lenart, USN
Adviser: Captain Thomas H. Rich, USMC

Sound Canceller

Midshipman 1/C Sean R. Liedman, USN
Adviser: Lieutenant Commander Emory L. Chenoweth, USN

Cruise Controller

Midshipman 1/C Samantha Maez, USN
Adviser: Lieutenant Commander Jerry M. Jones, USN

Underwater Object Recognition and Categorization System

Midshipman 1/C Stephen D. Martin, USN
Adviser: Lieutenant William B. Taylor, USN

Vision-Guided Robotic Control Program

Midshipman 1/C Brian McCormick, USN
Adviser: Lieutenant Commander William R. Cox, USN

Airplane Control System Using Inertial Navigation

Midshipman 1/C Charles H. McGuire IV, USN
Adviser: Captain Thomas H. Rich, USMC

Voice-Controlled Stereo

Midshipman 1/C James D. Minyard, USN
Adviser: Lieutenant Commander William R. Cox, USN

Automated Vehicle Docking

Midshipman 1/C Travis W. Nisbett, USN
Adviser: Lieutenant Commander William D. Randall, USN

Remote 4-Wheel Vehicle

Midshipman 1/C Gary L. Null, USN
Adviser: Captain Brent A. Douglas, USMC

Voice-Activated Talking Car Alarm

Midshipman 1/C Jason R. Pace, USN
Adviser: Lieutenant Commander Jeffrey M. Conley, USN

Simulated Robotic Welder

Midshipman 1/C Dennis F. Penepacker III, USN
Adviser: Captain Brent A. Douglas, USMC

Pulsed Light Tracker

Midshipman 1/C Manuel A. Picon, USN
Adviser: Lieutenant Commander Jeffrey M. Conley, USN

A Voice Recognition Switch

Midshipman 1/C David S. Rinker, USN
Adviser: Lieutenant William G. A. Sympson III, USN

Sound Cancellation

Midshipman 1/C Dean E. Robison, USN
Adviser: Captain Thomas H. Rich, USMC

Collision Avoidance Sub

Midshipman 1/C Cesar M. Rojas, USN
Adviser: Lieutenant Commander Jeffrey M. Conley, USN

Wheeled Stair Climber

Midshipman 1/C Rodney J. Ruff, USN
Adviser: Lieutenant William B. Taylor, USN

Light-Guided Tank

Midshipman 1/C Roger A. Sanchez, USN
Adviser: Captain Scott J. Fuller, USMC

Smart Vision Payload Handler

Midshipman 1/C Nelson R. Santini, USN
Adviser: Lieutenant Commander William D. Randall, Jr., USN

Visual Acquisitional Tracking

Midshipman 1/C Michael D. Schultz, USN
Adviser: Lieutenant Colonel James F. Kendrick, USAF

Sound-Seeking Cart

Midshipman 1/C John D. Spencer, USN
Adviser: Lieutenant Stephen C. Lanier, USN

Robot Sniper

Midshipman 1/C Anthony B. Spinler, USN
Adviser: Captain Scott J. Fuller, USMC

Light Sensing and Homing

Midshipman 1/C Robert S. Steiner, USN
Adviser: Captain Scott J. Fuller, USMC

Vision Tracking System

Midshipman 1/C Christopher C. Tragna, USN
Adviser: Commander William F. Ferris, USN

Ship Control System

Midshipman 1/C Charles S. Willmore, USN
Adviser: Lieutenant Stephen C. Lanier, USN

A Secture Voice System: Encoding and Decoding

Midshipman 1/C Brian T. Woodard, USN
Adviser: Lieutenant Commander Charles R. Hendrickson, USN

Publications

BECHERT, Thomas E., Associate Professor, "Partial Fraction Expansion with Repeated Roots," Weapons & Systems Engineering Department Technical Bulletin, Series 900, No. 1, 6 July 1990.

If a function F(s) is a ratio of polynomials whose denominator contains a factor (s + a) of multiplicity n, then the partial fraction expansion of F(s) will have n terms corresponding to the repeated root at s = -a in addition to the terms corresponding to the other roots. Associated with each term in the partial fraction expansion is a constant multiplier. Finding the n unknown constant multipliers associated with the repeated root is reduced to solving a set of n algebraic simultaneous equations represented by Ax = b. The coefficients in the A matrix are simply the remainders which result from n repeated divisions of the numerator polynomial by (s + a). Actual solution of the equations for the n unknown constant multipliers, x, is a trivial task because the A matrix is a lower triangular Toeplitz matrix. A detailed numerical example illustrates the procedure, and a MATLAB computer implementation is included. An appendix provides a detailed derivation of the procedure.

BECHERT, Thomas E., Associate Professor, "The Inverse Polar Plot in Cascade Compensator Design," *Proceedings* of the Twenty-first Annual Pittsburgh Conference on Modeling and Simulation, May 1990, pp. 2425-2429.

In the design of automatic control systems, simple feedback is sometimes not sufficient to satisfy performance specifications. The control device must cause the system output to track an input reference signal with good accuracy and fast response, but without excessive overshoot. These desirable characteristics are sometimes generated by including cascade compensation in the controller. A suitable transfer function is chosen, through which the output error signal is processed before it operates on the controlled system to influence the output.

The Bode diagram has long been the preferred vehicle for the design of cascade compensators. This paper investigates use of the inverse polar plot for this purpose. For a phase lead or phase lag compensator, the inverse polar plot frequency response has a semicircular shape. This geometrically simple form is rotated about the origin to the specified phase margin angle. Its points of intersection with the Nyquist contour of the system plant then represent solutions of the system compensation design problem. The ease with which this simple form may be manipulated graphically or mentally provides the user with insights into design solutions and design tradeoffs with far greater clarity than are available with Bode design techniques. The paper includes examples of design tradeoffs among phase margin, bandwidth, and compensator high frequency gain.

CLEMENT, William I., Assistant Professor, co-author, "Design of a Snake-Like Manipulator," *Robotics and Autonomous Systems*, **6** (1990), 265-282.

Over the past decade, investigations have been made into issues which are specific to the design and control of highly-flexible manipulators--arms which are composed of a large number of small, rigid links. Of particular importance to these researchers is the means of joint actuation, since most manipulators in this category are too small to have drive motors placed directly at the joints. This paper also deals with joint actuation, but addresses the problem in a unique fashion. The result is a manipulator in which all of the joints are driven by a single prime mover and whose snake-like motion ensures obstacle avoidance.

CLEMENT, William I., Assistant Professor, "Incorporating Auto-Focus into a Machine Vision Laboratory," *CoED*, **10**, 4 (October-December 1990), 38-41.

With the current availability of low-priced hardware for the personal computer, it becomes increasingly easy to provide students with hands-on experience in the area of machine vision. Classical spatial-masking and frequency-domain techniques are quickly mastered, leaving time to experiment with applications of this theory. In this paper, one such application, an automatic focusing mechanism is a building block upon which sophisticated, autonomous vision systems can be built.

CLEMENT, William I., Assistant Professor and Kenneth A. KNOWLES, Professor, "Application of Rapid Automatic Passive Optical Ranging (RAPOR) to Ship Control," *Proceedings* of the Ninth Ship Control Systems Symposium, 10-14 September 1990, pp. 4.426-4.437.

Computer processed stereoscopic vision techniques can be used to provide totally passive automatic range and bearing information for a number of ship control applications. These applications include underway replenishment station keeping, restricted passage piloting fixes, buoy location and tracking, and anchor bearing fixes. This paper describes an automated system utilizing a microcomputer and an inexpensive commercial vision system. The image correspondence (range triangulation) problem--necessary for stereoscopic imaging--is discussed, along with a technique for simplifying and accelerating the range information processing by using preliminary automatic focus information. Several ship control applications are proposed and discussed.

DEMOYER, Robert Jr., and E. Eugene MITCHELL, Professors, "Applications of MATLAB in Undergraduate Automatic Control Systems Courses," *Transactions* of the Computers in Education Division of ASEE, **10**, 4 (October 1990), 2-4.

MATLAB, which stands for matrix laboratory, is an interactive program for scientific and engineering numeric calculation. It incorporates high quality matrix-oriented algorithms into a user friendly context, and presents results with high quality graphics. It can be used in an interactive mode, or in sequences of functions along with control structures, stored in files, which constitute a high level programming language.

Included with MATLAB is a control systems toolbox, which includes analysis and design tools in both Laplace and state space formulations. The authors have added to this toolbox by creating additional analysis and design tools. Because of the matrix orientation of the language, the looping required in more conventional languages is not present. The result is code which is easier to create and in appearance closer to textbook presentations. The resulting clarity, speed of programming, and ease of use has had a major impact on the control system courses. Students can concentrate more on the control theory and less on computational detail than has been previously possible.

KNOWLES, Kenneth A., Professor, and William I. CLEMENT, Assistant Professor, "An Instructional Robotics and Machine Vision Laboratory Station," *Proceedings* of the 1991 IFAC Conference on Advances in Control Education, 24-25 June 1991, pp. 202-207.

In support of several robotics and machine vision courses, the U.S. Naval Academy has assembled a laboratory consisting of 13 identical stations. Each station has a PC AT compatible computer, a five degree-of-freedom robot arm, a video-rate vision system, and a speech synthesis system. The robot arms are capable of teach pendant operation, or control via the attached computer. Programs written in the robot control language (a variant of BASIC) can be downloaded into, stored in, and run from robot RAM. For greater flexibility, move instructions can be generated by the controlling computer (in any desired language) and transmitted to the arm for execution via an RS-232 link. Each joint of the robot (plus the gripper) has a dedicated microprocessor for closed-loop servo operation utilizing incremental drive-motor shaft encoders and dedicated micro-switches for "home" locations. Each vision system includes an arm-mounted, RS170-compatible video camera connected to a dedicated frame-grabber and video memory board in the computer and a video monitor. This configuration permits utilizing vision feedback in the robot control process. Additionally, machine vision is addressed independent of robot operations, with most of the standard image processing techniques discussed.

MITCHELL, E. Eugene, and Robert DEMOYER, Jr., Professors, "Applications of MATLAB in an Undergraduate Systems Engineering Curriculum," *Proceedings* Internationales Symposium Ingenieurpädagogik 90, Frontiers in Education '90, (June 1990), pp. 209-211.

MATLAB, which stands for matrix laboratory, is high level interactive software for scientific and engineering calculations. Its high level instructions are easy to program, and computer results are presented with high quality graphics. In addition to the basic matrix manipulation functions are toolboxes of functions in the areas of control systems, system identification, and signal analysis. This variety of capability has made the software applicable to most of the Systems Engineering courses.

All of the control systems courses use MATLAB, for analysis and design in both Laplace and state space formulations. In a controls laboratory course, data taken by computer controlled oscilloscopes are imported into MATLAB and processed to create component parameter estimates. The ultimate result is a graphical comparison of predicted to actual closed loop response. Another major use is in communication courses, where both system identification and signal analysis toolboxes are used in conjunction with computer-controlled instrumentation.

WATTS, Jerry W., Associate Professor, "Chaos in Simulations," *Proceedings* of the Twenty-first Annual Pittsburgh Conference on Modeling and Simulation, 2-4 May 1990, pp. 2415-2418.

The modelling of real systems requires introduction of chaos to give them a sense of naturalness. A simple second order system which conventionally is simulated as a smooth damped oscillatory curve in one dimension is made chaotic by increasing the spring constant parametrically beyond the ability of the integration step size to handle the increased frequenty. At some degree of chaos, the response has a more natural look.

WATTS, Jerry W., Terrence. E. DWAN, and C. George BROCKUS,, Associate Professors, *Optimal State Space Control of a Gas Turbine Engine*, ASME paper 91-GT-219, June 1991.

An analog fuel control for a gas turbine engine was compared with several state space derived fuel controls. A single spool, simple cycle gas turbine engine was modeled using ACSL (high level simulation language based on FORTRAN). The model included an analog fuel control representative of existing commercial fuel controls. The ACSL model was stripped of non-essential states to produce an 8-state linear state space model of the engine. The A, B, and C matrices, derived from rated operating conditions, were used to obtain feedback control gains by the following methods: (1) state feedback; (2) LQR theory; (3) Bellman method; and (4) polygonal search. An off-load transient followed by an on-load transient was run for each of these fuel controls. The transient curves obtained were used to compare the state space fuel controls with the analog fuel control. The state space fuel controls did better than the analog control.

Presentations

BECHERT, Thomas E., Associate Professor, "A New Compensation Design Technique," Weapons and Systems Engineering Department Seminar Series, Annapolis, Maryland, 25 October 1990.

BECHERT, Thomas E., Associate Professor, "Control Constraints in Deadbeat Response," Twenty-second Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 2 May 1991.

CLEMENT, William I., Associate Professor, and Kenneth A. KNOWLES, Professor, "Application of Rapid Automatic Passive Optical Ranging (RAPOR) to Ship Control," Ninth Ship Control Systems Symposium, Bethesda, Maryland, 13 September 1990.

CLEMENT, William I., Associate Professor, "Exact Damping Ratio Specification on the Root Locus Plot," Twenty-second Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 1-3 May 1991.

DEMOYER, Robert Jr., and E. Eugene MITCHELL, Professors, "Applications of MATLAB in Undergraduate Automatic Control System Courses", Computers in Education Division, American Society for Engineering Education, Lincoln, Nebraska, 26 June 1989.

DWAN, Terrence E., Associate Professor, "Optimal State Space Control of a Gas Turbine Engine," International Gas Turbine Institute, Orlando, Florida, 5 June 1991.

DWAN, Terrence E., Associate Professor, "Simulations in Signal Processing," Twenty-second Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 2-3 May, 1991.

DWAN, Terrence E., Associate Professor, "Encouraging Mathematics Departments' Participation in Engineering Curricula," Annual American Society for Engineering Education, Toronto, Canada, 26-29 June 1991.

KNOWLES, Kenneth A., Professor, "Rapid Numerical Computation of Functions of Central Moments in Binary Digitized Images," Twenty-second Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 2-3 May 1991.

MITCHELL, E. Eugene, and Robert DEMOYER, Jr., Professors, "Applications of MATLAB in an Undergraduate Systems Engineering Curriculum," *Proceedings* Internationales Symposium Ingenieurpädagogk '90, Frontiers in Education '90, Vienna, Austria, 27 June 1990.

RASK, Olaf N., Associate Professor, "Strain Measurements in Composite Structures Using Fiber Optics", Twenty-second Pittsburgh Modeling and Simulation Conference, Pittsburgh, Pennsylvania, 2-3 May 1991.

RASK, Olaf N., Associate Professor, "Theory of Composite Structures," ASEE Mid-Atlantic Section Meeting, Brooklyn, New York, 17 April 1991.

SMALL, Robert H., Visiting Professor, "Simulation of Naval Combat Systems," Twenty-second Annual Modeling and Simulation Conference, Pittsburgh, Pennsylvania, 2 May 1991.

WATTS, Jerry W., Associate Professor, "A First Order Lag Heat Exchanger Model with Varying Time Constants," Twenty-second Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 3-4 May 1991.

WATTS, Jerry W., Associate Professor, "Optimal State Space Control of a Gas Turbine Engine," International Gas Turbine and Aeroengine Congress and Exposition, Orlando, Florida, 3-6 June 1991.

WICK, Carl E., Assistant Professor, "Use of an Illumination Model in the Recovery of Blood Vessel Topography from Human Bulbar Conjunctiva Images," Twenty-second Annual Pittsburgh Modeling and Simulation Conference, Pittsburgh, Pennsylvania, 3 May 1991.

DEPARTMENT OF

Computer-Aided Design/Interactive Graphics

Donald W. Garner
Branch Head

The Computer-Aided Design/Interactive Graphics (CADIG) Branch supported a number of research efforts within the Division of Engineering and Weapons during the 1990-1991 academic year. The efforts supported included Professor Chih (Bob) Wu's research into the thermodynamics of energy conversion, Dr. David A. Blank's research into heat transfer characteristics, and Associate Professor Gerald F. Hall's research into the aerodynamics of rotor blades.

The support provided by CADIG included computer facilities, system installation and configuration, programming, publication graphics, and networking. Aside from various computer systems and their utilities, applications, and peripheral equipment for researchers to use, CADIG maintained a connection to the Defense Data Network, which allowed researchers remotely to access computer systems or to communicate with other persons involved in their research. Also, CADIG maintained a connection to an international news network which allowed researchers to exchange ideas and materials, as well as questions and answers with other researchers and professionals on particular topics on a daily basis.

The members of CADIG's staff involved in supporting research efforts during the year were: Linda A. Adlum, Robert A. Disque, Jean Y. Edgar, Carolyn A. Mayr, and J. Douglas Richardson.

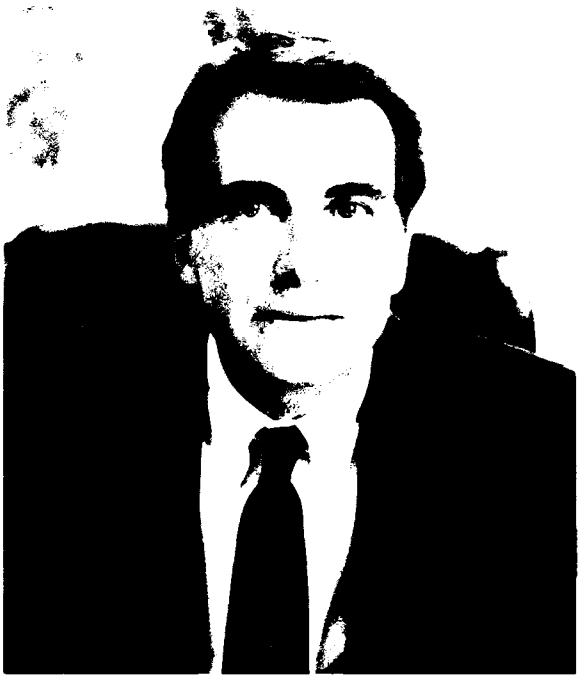
Division of English and History

SHAKES
PEARE
Henry the Fourth, Part I
Henry the Fourth, Part I
WILLIAM SHAKESPEARE

DEPARTMENT OF

English

Professor Charles J. Nolan, Jr.
Chair



The English Department faculty was extraordinarily productive this academic year, publishing a range of books and journal articles and giving a number of conference papers. Nine Naval Academy Research Council-sponsored projects are documented here, nine new NARC grants were awarded, and over a dozen independent projects were in progress during 1990-1991. Assisted by institutional support, department scholars published a total of eight books: these include two edited collections of critical essays, a comprehensive reference text, and two groundbreaking studies in critical theory and practice. Two other faculty members published original fiction--two novels and a collection of dramatic readings. The poets on our faculty continued to write and publish their works as well as read their poetry in public forums.

More than a dozen scholarly articles were printed in literary journals; the diverse topics of these essays indicate the faculty's versatility. Representative subjects include Old English narrative poetry, Chaucerian satire, the early British novel, *Mark Twain*, sports literature, dance criticism, and the art of teaching. A similarly extensive range of interests is reflected in the papers that department faculty read at national and international conferences. From Switzerland to Senegal, from San Antonio to Salisbury, English faculty members read almost thirty papers to their colleagues from other schools, states, and countries. In these and other less easily documented activities, the English Department extends and enhances the Academy's reputation in the scholarly world.

Sponsored Research

Kosinski's Games of Justice and Private Revenge

Researcher: Professor Neil Berman
Sponsor: Naval Academy Research Council (OMN)

Although Jerzy Kosinski's fiction has generally been ignored by critics of sport literature, the overt emphasis on polo and other varieties of horsemanship in *Passion Play* marks a logical extension of Kosinski's preoccupation with game and play forms throughout his fiction, especially in the middle novels. While the most specific foreshadowing of Kosinski's use of polo comes in *Steps*, his second novel, with its title of *Passion Play*, announces the penchant for gamesmanship that is central to both *Cockpit* and *Blind Date*.

The Kosinski hero, like the author himself, is best understood as a gamesman, a consummate player, albeit one who thrives on games of mastery, games which involve great danger and physical skill. From the tense and dangerous scenario Kosinski enacted to escape from Poland, chronicled most specifically in *Cockpit*, to the emphasis on disguise (sham military uniforms and medals, escape routes in apartments, late-night jaunts in New York carrying subtle, hidden weapons), the public persona Kosinski projected is mirrored in his fiction by protagonists whose will to survive, whose penchant for an idiosyncratic "justice," is largely determined by their essential gamesmanship. However, the most essential elements of the play-attitude--joy, freedom, and creativity--are, at best, only partially recovered in the earlier novels, and the interest in gaming is largely portrayed as dis-play. However, in *Passion Play*, with the creation of Fabian, Kosinski finally presents a protagonist whose gamesmanship is manifested as sport and whose varieties of horsemanship fully recover the essential joy, freedom, and creativity of mature human play.

Staged Versions of the First World War

Researcher: Assistant Professor Allyson Booth
Sponsor: Naval Academy Research Council (OMN)

Soldiers home on leave from the trenches of World War I went to the theatre for escape--an entirely understandable motivation in men, who, on a regular basis, inhabited a grisly landscape consisting mainly of rats, guns, and mud. During the war years, musical comedies, burlesques, and jingoistic pageants were the staples of London's West End theatre district, not plots detailing morale in the trenches or dilemmas on the home front. The few exceptions--John Galsworthy's *The Mob* (1914), Alan Monkhouse's *Shamed Life* (1916), and J. M. Barrie's *A Kiss for Cinderella* (1916)--prove the rule, for these plays only managed to stay alive for short runs.

In the decade after the Armistice, however, a few plays did achieve moderate commercial success: Monkhouse's *The Conquering Hero* (1923) made a profit, and Somerset Maugham's *For Services Rendered* (1932) stirred up considerable controversy, even though it lasted for only 78 performances. The most decided success story, though, was R. C. Sherriff's *Journey's End* (1928)--a trench drama that ran for 594 consecutive performances at the Savoy.

The commercial success of plays whose message was an (arguably) cynical one suggests that the public had got beyond some of the mindless "patriotism" that characterized much of the initial response to war. But what insights precisely were playwrights offering in these productions? Were they just parroting the blase dismissiveness of a jazz generation anxious to forget Flanders and Passchendaele? Or did these plays of the twenties and early thirties represent a healthy recomplication of issues that had been dangerously simplified in the course of war? Such questions and their answers are the focus of this research.

The Beautiful Reclaimed: Sublime Suppressions of the Artfulness of Art

Researcher: Associate Professor Laura Claridge
Sponsor: Naval Academy Research Council (OMN)

The researcher seeks to discover why Romanticism as a literary phenomenon exacts as part of its credo a transcendence that sublimates the artifact until its object status is effaced. This problem funds at a foundational level the period under study, so that its reconceptualization will enable scholars to explore anew the relationship of the Romantic ideological definitions of the beautiful and the sublime to the now familiar notion that Romanticism romanced itself with the Cartesian antimony of subject/object organizations of the world.

Dancing in Very Narrow Spaces

Researcher: Assistant Professor Anne Marie Drew
Sponsor: Naval Academy Research Council (OMN)

This project begins as a comparative analysis of two modern dramas; the work could lead to significant insights into the influence of one dramatist upon another. The researcher is writing an article which compares George Bernard Shaw's play, *Too True to Be Good*, with Harold Pinter's *A Kind of Alaska*. Both are plays about diseased women who come to life after decades of illness. The article uses a paradigm developed by Dr. Oliver Sacks in his book *Awakenings*. In that work, Dr. Sacks chronicled his work with victims of the sleeping sickness epidemic which ravaged five million lives between 1916 and 1927. In 1969 several such patients were "awakened" with the drug LDOPA, after having been asleep for decades. The emotional sequence of their awakening provides a structure which illuminates the connections between Shaw's play and Pinter's later treatment of similar subject matter.

Dominance and Dissolution: A Family History

Researcher: Assistant Professor Bruce E. Fleming
Sponsor: Naval Academy Research Council (OMN)

A number of works in world literature attempt to portray the development of families over several generations. At one extreme, such family epics conceive of the role of the individual as being merely part of a collective. At the opposite extreme to these are works such as those of the Modernist movement which mirror the contents of the minds of single individuals. Between these extremes lie novels dealing primarily with a single generation of a larger family. Yet most such works insist that each generation is only one link in a larger chain, thereby failing to capture the sense which most individuals involved in the family relationship have of their particularity.

The purpose of this project was to study some of the principal works of fiction which fall in this middle area, and to begin preliminary sketches for a work of original fiction that would avoid both extremes sketched above. This work would be set in the United States in the 1970's, and be concerned largely with relationships between a single couple in a single generation of their marriage.

Work on this project consisted of basic research and analysis of novels and work dealing with the family by such authors as Thomas Mann, Sue Miller, Samuel Butler, Elizabeth Bowen, Andre Dubus, John Updike, and Raymond Carver. It also included the preparation of sketches toward an original work of fiction with two main characters, to take place in Virginia during the early 1970's.

Interactive Computer Editing Program

Researcher: Professor Allan B. Lefcowitz
Sponsor: Naval Academy Instructional Development Advisory Committee

The purpose of this project was to develop a stand-alone, interactive computer program to instruct students in editing techniques. Using a program-writing program, the researcher developed a series of databases that interact through hypertext. Students can read entire paragraphs, select sentences in need of editing, edit those sentences, and receive an immediate comparison sentence against which to judge their performance in the editing process. The program is finished, and the researcher is currently expanding the database, as well as refining the ease of using the program.

Westerly in the Rebellion: Local History and Literature in the War Between the States

Researcher: Associate Professor Robert D. Madison
Sponsor: Naval Academy Research Council (OMN)

It has been commonplace to say that the horror of the Civil War radically changed the American mind and changed the course of American culture, but no one has been able to point to just where and how the change came about. For historians, of course, the Civil War years form some of the richest ground for scholarly inquiry--ground which has certainly today, a hundred and twenty-five years after the war, not yet been exhausted. The same thrust in social and economic historical inquiry that focuses on local history to solve national problems could be followed by a cultural or literary historian in order to learn more about national trends.

The investigator studied the cultural manifestations of the war in southern Rhode Island, particularly the town of Westerly. The ultimate goal was to produce a long article or short monograph on Westerly's reaction to the greatest event in American history.

The researcher indexed the *Narragansett Weekly* for the war years for letters and original articles pertaining especially to Westerly soldiers and the impact of the war on Westerly. The revised 1865 Rhode Island *Adjutant General's Report* and several Rhode Island regimental histories--especially those by Westerly resident Frederick Denison--were consulted to glean anecdotal and biographical material on Westerly companies and individuals, and descendants of Westerly veterans were contacted. Isaac Smith, an expert on the history of Rhode Island granite, was consulted in regard to the hundreds of Civil War monuments produced in Waverly following the war. With Charles Hathaway, a Gettysburg National Battlefield guide who specializes in Rhode Island history, a canvass of existing Westerly monuments was made, and a detailed photographic record was made of the major sculptures.

Word Keys to Chaucer's Narratives

Researcher: Associate Professor Timothy D. O'Brien
Sponsor: Naval Academy Research Council (OMN)

This study analyzes the significance of patterns of verbal play in Chaucer's narrative poems. Specifically, the project examines this narrative trait in the tales of five of the Canterbury pilgrims: the Miller, the Merchant, the Shipman, the Friar, and the Clerk. The study also has the more comprehensive aim of trying to define the place of this narrative trait in a theory of Chaucerian narrative and of identifying the intellectual and popular traditions out of which it emerges.

The Twentieth-Century Novel and Rereading

Researcher: Instructor Gregary J. Racz
Sponsor: Naval Academy Research Council (OMN)

This doctoral thesis uses the Reader-Response theories of the late 1960's to early 1980's to survey clusters of critical commentary about the second-time act of reading. Beginning with Iser and Fish, this work discloses the conflation of reader and text underlying the attempt to pinpoint when the rereading moment occurs as opposed to the subsequent secondary stage of interpretation. It proceeds to examine the later post-structuralist phase in this field of inquiry, questioning the postponement in critical practice of the "literary" actualization of a text until the second reading by such theorists as Riffaterre and Stierle, who also maintain in contradictory fashion that this same determination precedes even the first reading.

The second half of the thesis applies this theoretical foundation to modern narrative fiction, taking as its point of departure the critical commonplace that Modernist novels were written to be reread and need subsequent stages of reading in order to be properly "understood." Using Frank's theory of spatial form, this project relates patterns of repetition in modern fiction to the well-wrought, architectonic quality of these texts, arguing for the Modernist paradox of apparently self-contained, textually-based meaning that clashes with gestures toward a more contextualized significance. Finally, the study ends with a consideration of novels that may be read in various orders, thus problematizing the very concept of rereading.

Independent Research

Catching a Market: The Publishing History of Joseph Heller's Catch-22

Researcher: Major Jonathan R. Eller, USAF

Heller's pioneering view of postwar America and his experiments with form and humor are perennial sources of literary criticism, but an equally fascinating story has never been told--the rise of *Catch-22* to market prominence in a culture where the novel of literary merit rarely survives a first printing. Understanding what makes this book an enduring part of our culture will remain incomplete until the publishing record becomes a part of the critical canon.

Catch-22 initially generated mixed reviews, and never achieved bestseller status in America. That Heller's views survived and, in time, came to epitomize a new awareness among a new generation of readers can be traced in large part to fundamental changes in the way literature is published and marketed in this country. Changes in advertising strategy, in particular, helped Heller's controversial first novel stay alive in the east coast book market until word-of-mouth praise (an ' ver- night bestseller status in Great Britain) took it to national prominence. Within a year, the unprecedented publicity generated for the hardbound edition of *Catch-22* propelled Heller into the middle of a revolution in paperback publishing, already underway, which served to introduce him--along with other, postwar fiction writers--to the mass reading public. Dell's editors added wholesale availability and low paperback prices to the marketing scheme, and quickly turned the "Catch Cult" into the "Catch Craze." By the mid-sixties, the combination of new marketing methods and the commitment of a number of agents, editors, and reviewers transformed momentary national prominence into enduring international popularity.

This paper has been accepted for publication in the 1992 volume of *Prospects*, a journal of American Studies edited at Columbia University and published by Oxford University Press.

The Body Eclectic: Sources of Ray Bradbury's Martian Chronicles

Researcher: Major Jonathan R. Eller, USAF

Between 1941 and 1949, Ray Bradbury wrote at least 40 science fiction stories about Mars, focusing on traditional American themes of exploration and the pioneer spirit extended to the new frontiers of space. In 1949, Doubleday publishers contracted for a novel based on these stories, and Bradbury heavily revised a select group of them, added new ones, and wrote eleven bridging chapters for the new book. The *Chronicles* continued to evolve after publication, resulting in five variant forms of the text which remain in print today.

The complex textual history of *The Martian Chronicles* remains the great untapped source of information about Bradbury's process in writing his first novel. Viewed as process, the transformation of these tales helps to define the structural unities of the book, and to determine just what kind of book it is.

This study also includes annotated checklists of the individual *Chronicles* chapters, the variant *Chronicles* editions, and Bradbury's unchronicled Martian stories.

Robert Penn Warren: A Descriptive Bibliography 1922-1991

Researcher: Major Jonathan R. Eller, USAF

This revised edition of the standard Warren bibliography updates the record of his work from 1922 until his death in 1989, and includes posthumous editions published through 1991. Books by Warren, as well as those edited or compiled by him, are fully described in this volume, which includes first edition title page facsimile, state and printing variations, subsequent editions, and holdings for each book.

Warren's shorter work in periodicals, newspapers, anthologies, and other publications is listed and annotated in subsequent sections. Significant secondary work also appears in this fully indexed and illustrated guide to textual sources.

The Stories of Ray Bradbury: An Annotated Finding List

Researcher: Major Jonathan R. Eller, USAF

This finding list is designed to checklist and annotate Bradbury's American, Canadian, British, and Australian story publications through the first fifty years of his career, and beyond (1938-1991). It includes the first complete listing of story appearances in magazines, magazine reprints, and Bradbury's own collections, and identifies which stories evolve into (or from) other genres. These texts often show significant authorial revision, and represent the versions of his story texts over which he exercised authorial control. The researcher's purpose in presenting the listing is two-fold: first, to provide a quick reference for readers who need a particular Bradbury story in any or all of its revised forms; and second, to offer other researchers a focused record of the way Bradbury has, over half a century, revised his stories into novels, plays, screenplays, teleplays, and even musical theater.

The Ray Bradbury Pocket Companion

Researcher: Major Jonathan R. Eller, USAF

The project aims at completion of a concise, yet complete, true companion to Bradbury's fiction, covering his most significant work in all its forms and genres--stories, story collections, novels, radio/screen/teleplays, and drama. Each entry is comprehensive, including cross-references to later publication in periodicals, in Bradbury's own story or drama collections, novels, or other generic forms. The fiction titles appear individually, arranged by date of first publication. Each entry includes a plot summary, with subsequent coverage of revisions and character development. Thus the fiction companion allows readers to trace the evolution of one of the most textually complex and prolific talents in contemporary literature, a master of fantasy, science fiction, mystery, detective, and horror genres, an artist who has been both commercially popular and critically acclaimed.

"Time out 'a Mind" : Charles Johnson's Use of Anachronism in Middle Passage

Researcher: Professor Fred M. Fetrow

Charles Johnson's first-person narrative about the experiences of a newly-freed slave as a cook's assistant on a slave ship abounds in lore and language concomitant with the history and cultures depicted. Such narrative voice provides a ring of authenticity that helps lend credibility to the tall-tale nature of the narrative. In the midst and in spite of this apparent concern for plausibility, a scrupulous reader notes many troubling instances of anachronistic fact and phrasing, examples which seem to jar against not just the facts of history, but against the reader's credulity with regard to the entire narrative.

Upon close consideration of the nature, number, and textual location of these examples of anachronisms, however, the reader can discern a pattern and a purpose. Johnson punctuates the early section of the novel (approximately the first hundred pages) with several "out-of-sync" references to alert the reader to the timeless applicability of the book's important thematic concerns. By shifting our focus ever so slightly, ever so temporally, Johnson reminds his readers of the unchanging attitudes and cultural malignities which extend beyond his narrative and its time-frame. Those apparent flaws in the textual narrative mode can finally be recognized as minor but important elements of technique--a method perfectly suited to the depiction of moral madness which transcends its historical antecedents.

A Study of English Performance by NAPS Students at USNA

Researcher: Visiting Instructor Richard Flinn

As part of the researcher's teaching sabbatical for 1990-1991, he is surveying the performance of students of the Naval Academy Preparatory School (NAPS) in English during their academic work in that discipline at the U. S. Naval Academy. By using the shared computer network to collect and correlate statistics on grades in English at both institutions, the placement of those students in varying versions of English coursework, and their respective SAT verbal scores, the researcher seeks patterns of significance. He hopes to measure or at least clarify the sequences of student performance beginning with NAPS and ending with USNA graduation, with a particular interest in Plebe year.

This information, coupled with the researcher's interviews of several USNA English Department faculty members, should assist in the effort to modify the NAPS English curriculum to keep that program responsive to the needs of a changing Naval Academy and its English Department.

The Vietnam War in Literature: An Annotated Bibliography of Secondary Sources

Researcher: Professor Philip K. Jason

This reference volume will make available to students a reliable description and appraisal of the commentary on imaginative literary responses to the Vietnam War. After a section of background sources (in history, political science, and other disciplines), the bibliography will classify the literary works by genre: literary nonfiction, fiction, poetry, and drama. Under each broad heading, authors will be listed alphabetically followed by their individual works. The commentary selected for annotation will be available in most college libraries and accessible to the non-specialist. Annotations will average 75 words. Approximately 600 entries are planned. The preliminary draft is 50% completed.

Henry Fielding's Novels and the Classical Tradition

Researcher: Assistant Professor Nancy A. Mace

Although scholars have noted that Henry Fielding often uses classical allusions and quotations in his novels, they have underestimated the importance of the classics to our understanding of his audience, sources, characterization, and rhetorical techniques. By studying his classical references within the context of what readers in the eighteenth century knew about ancient literature, moderns can gain new insights into Fielding, his contemporary readership, and the geneology of his fiction.

The researcher has completed the draft of this book-length study of the subject. Revisionary work will update some of the initial research and bring this project closer to fruition.

The Artistry of John Irving's Novels

Researcher: Professor Charles J. Nolan, Jr.

The researcher continues a careful and thorough reading of John Irving's novels and the criticism written about them to see if several ideas he has about the way Irving structures his works might enrich reader understanding of this talented contemporary figure. Specifically, in two recent novels Irving seems to arrange his texts so that there are dramatic and bipolar shifts in tone. In his earlier works, Irving relied upon a three-part structure to shape his subject matter, and one of the best analyses of his recent *The Hotel New Hampshire* argues that Irving continues his tripartite method in it. But such a view fails to account for the tonal antithesis that is an important aspect of the novel's impact upon its readers. *The Cider House Rules* also embodies tonal dichotomies, as Irving resolves the issues he addresses in that book. The questions of structure and tone (and other standard literary devices), then, are the energizing principles of the project and will be the focus of further research.

Forty Minutes for a Train to a Fine Time: Biblical Allusion and the Central Conflict in Hemingway's "Hills Like White Elephants"

Researcher: Associate Professor Timothy D. O'Brien

This study argues for a reexamination of what is readily accepted as the central conflict between different aspects of the natural setting described in Hemingway's short story. The conflict, in most accurate terms, occurs between the natural setting, on the one hand, and the artificial elements of the story's setting, on the other hand. The relationship between this conflict and the tension between the two characters of the story is enhanced, moreover, by a set of Biblical allusions emerging from the dialogue.

Benito Perez Galdos's Gerona

Researcher: Instructor Gregary J. Racz

This first English translation of Perez Galdos's early historical novel (1874) rides the wave of the current revival of interest in Galdosiana in the English-speaking world and is one of a spate of recent translations that should help garner a long-overdue reputation for this pivotal author outside his native Spain. Perez Galdos is, perhaps, the most influential Spanish novelist after Cervantes, but his work (over ninety novels, in addition to critical essays, plays, social commentary, etc.) is virtually unknown to English-language audiences. This novel about the blockade of the Spanish port town of Gerona during the Napoleonic Wars straddles the line between the traditional realism of the nineteenth century and the emerging modernist aesthetic, displaying both the sentimentalism of its day and the nascent attention to the workings of literary language evidenced in his later, more important works. The translation is due to be published by the Edwin Mellen Press in 1991.

Assignments from Heaven; Assignments from Hell

Researcher: Instructor Patricia P. Sine

The difficulties writing center clients have with writing assignments often stem from the assignments themselves. To assess the causes of these problems, the researcher collected and analyzed sample problematical assignments and developed a list of common obstacles to successful completion. She also reviewed a collection of successful assignments and consulted the literature on writing assignments in order to prepare a list of the characteristics typical of good writing assignments. Positive and negative assignments and characteristics apply across the curriculum, regardless of subject matter; these good and bad features transcend specific disciplines and departments.

The House as Central Image and Symbol in Mary Gordon's Fiction

Researcher: Associate Professor Eileen Tess Tyler

Mary Gordon is a highly acclaimed writer of contemporary American fiction. Writing from a strong Irish-Catholic background, Gordon has explored in her four novels and many short stories human love and its limitations and the familial, religious, and cultural legacies impinging upon modern American individuals and communities. All of Gordon's fiction is bound together by one crucial image that comes to have considerable symbolic import--the image of the house. This project will demonstrate the many ways in which houses and the idea of shelter are integral to Gordon's style, settings, themes, characterization, and plot structures. It will also place Gordon's fiction in the contexts of Roman Catholicism and of the novelistic tradition of fiction by and about women, showing how Gordon draws from those traditions in emphasizing houses and shelter.

Research Course Projects

Literary Responses to the Stuart Navy

Researcher: Midshipman 1/C Patrick S. Edmonds, USN
Adviser: Professor Michael P. Parker

During the reign of the Stuarts, the English royal navy grew dramatically from a small and irregular force into the most powerful maritime force in the world. This development did not pass unremarked by literary figures. Poets like Edmund Waller penned grandeloquent panegyrics on Charles I's rebuilding of the navy; Andrew Marvell lauded the victories of Blake during the Protectorate; Samuel Pepys provided a fascinating account of the day-to-day workings of the navy in his *Diary*. In this project, the researcher has examined these literary treatments of the royal navy, looking particularly at the range of responses and the differences among individual writers with the goal of devising a model to explain them.

The work is ongoing; preliminary findings suggest that the increasing activity of the navy led to a shift in the literary genres in which it was treated. Over the course of the century, panegyric gave way to narrative; poets experimented with new metaphors and techniques, such as the "advice to the painter," to depict naval engagements; and biblical allusion cedes entirely to neoclassical references. In sum, the treatment of naval subjects echoes in little developments in English poetry as a whole; the career of Waller, in particular, increasingly appears to be crucial to understanding what happened to the navy and to English literature in the mid-seventeenth century.

Publications

ARBUTHNOT, Nancy P., Associate Professor, poems. "Haitian Night," *The Windhorse Review* (April 1990); "Seal Cove," *The Sucamochee Review* (June 1990); and "Cafe Omero," *New Virginia Review* (Fall 1990).

BERGMANN, Harriet F., Associate Professor, "'A Piercing Virtue': Emily Dickinson in Margaret Drabble's *The Waterfall*," *Modern Fiction Studies*, 36, 2 (Summer 1990), 181-193.

Margaret Drabble's novel, *The Waterfall*, has as its heroine a poet who is modeled in many ways upon the persona of Emily Dickinson's poetry. Drabble's heroine, Jane Grey, is, like Dickinson's, in love with the idea of renunciation. Like the poet's persona, Drabble's Jane Grey assumes a universe of necessity and absoluteness. Because love is paramount for both figures, salvation in the form of a lover, while seeming blasphemous, is all that is possible. While Jane's lover is realized, Dickinson's seems to be imagined. Both figures finally accept their own femaleness and succeed as writers.

BERMAN, Neil, Professor, "W. C. Heinz's *The Professional* and the Subversion of Play," *Aethlon: The Journal of Sport Literature*, 7, 1 (Fall 1989), 95-106.

Unlike Ernest Hemingway, Leonard Gardner, and other writers in the canon of American boxing fiction, W. C. Heinz has been virtually ignored by literary critics interested in sport and play. Indeed, if Hemingway himself had not written that *The Professional* is "the only good novel about a fighter I've ever read . . ." it might not have been reissued by Arbor House in 1984, twenty-six years after its initial, successful publication. Now that *The Professional* is back before the reading public, the above captioned article places this important work in the growing canon of sports fiction and, more specifically, in the sub-genre of boxing fiction. While most contemporary sports novels allow for at least a partial recovery of the joy, freedom, and creativity of mature human play, that recovery is apparently impossible in boxing fiction. Any potential expression of the play-attitude in boxing fiction is overwhelmed by the larger vision and context of such fiction, which denies the validity of male camaraderie in and about the ring, which completely excludes women from any meaningful participation in the sport, and which, because of its naturalistic technique, consistently places an overriding emphasis on fate and immutable destiny.

CLARIDGE, Laura, Associate Professor, co-editor, *Out of Bounds: Male Writers and Gender(ed) Criticism*. Amherst: University of Massachusetts Press, 1990.

Out of Bounds explores how certain male writers from the American and British canon have responded to the confines of the masculine code of language. The essays analyze characters, authorial inscriptions, narrative and poetic forms, and the relation of gender and genre.

DREW, Anne Marie, Assistant Professor, *The Innkeeper's Wife: And Four Other Dramatic Readings for Christmas*. Nashville: Abingdon Press, 1990.

This volume contains five dramatic readings: "The Innkeeper's Wife;" "Gold, Frankincense, and Doubt;" "The Shepherd's Daughter;" Gabriel's Dilemma;" and "Herod's Christmas Eve Journey." Designed for an intergenerational audience, the readings are intended for congregational use during Christmas programs and services.

DREW, Anne Marie, Assistant Professor, *Rainbows in the Twelfth Row*. New York: Trillium Press, 1991.

She has a retarded cat, a lousy pitching arm, two ornery brothers, and her best friend has betrayed her. For a girl named after the stars, it's going to be a rough summer. Written for a middle school audience, the novel captures the frustrations of Oriana Linton, a fifth-grader whose best friend has become inexplicably vicious. Oriana's first exposure to cruelty is tempered by a cat who creates chaos, brothers who create a pitching machine, and a church cook who thinks that carrot sticks are better than brownies. The book gives middle school readers a chance to experience one of life's hurts--a friend's betrayal--but the story ends with great hope.

FLEMING, Bruce E., Assistant Professor, *Art, Artifact, and the Innocent Eye: An Essay in Post-Romantic Literary Theory*. Lewiston, New York: Edwin Mellen Press, 1991.

This book-length essay in aesthetics and literary theory proposes a theory of art in general that will not be susceptible to the endemic problems of Modernist literary theory. It suggests that we speak of art when a situation is created in which the divergent elements of work, spectator/reader, world,

and author/artist are, if only momentarily, fused into a unit. In arriving at this formulation it rejects a number of notions current on the contemporary scene, as for example that art is communication; it also speaks to the speech act theory of Austin and Searle.

FLEMING, Bruce E., Assistant Professor, "Paradox on the Pacific," *Dance Magazine* (February 1991), 76-77.

This article reports on and interprets the cross-cultural dance presented in the 1991 Los Angeles Festival. It suggests that there is a paradox implicit in the fact that dances from cultures that are not technologically advanced seem to be sought by our own culture, yet that precisely the products of those qualities of our own world to which these less advanced cultures present an alternative are necessary to importing them (such as airplanes and microphones) and making them accessible to our own cultural scene.

FLEMING, Bruce E., Assistant Professor, "Midshipmen on Parade," *Dance Magazine* (October 1990), 24-25.

This article analyzes a midshipmen dress parade in the terms of contemporary dance and theater, pointing out both its similarities and divergences from many of the developments on the recent theater/dance scene. Particular reference is made to the works of the Russian choreographer George Balanchine.

HILL, John M., Professor, *Chaucerian Belief: The Poetics of Reverence and Delight*. New Haven: Yale University Press, 1991.

To interpret Chaucer's purposes in the *Canterbury Tales*, specialists usually undertake either a moral and often patristic line of inquiry or else a stylistic and rhetorical one. In the first, Chaucer's fictions become either exemplary or allegorical; in the second, they become artifacts emphasizing their idiosyncracy, their rhetorical style. Although these lines can merge, usually they leave us with unhappy choices: either a moral Chaucer with an oddly experimental side; or a nascent sceptic who ironically frames his moral tales.

Chaucerian Belief cuts through this dilemma radically: it has Chaucer undertaking a comprehensive exploration of truth in all fictions (his experiemental side) within a commitment to the affective dimensions of knowing anything complex or anything placed beyond immediate experience (which includes depictions of human feeling, action, and motivation in the tales we tell). This emphasis on affective cognition casts Chaucer's tellers in a more dynamic role than they would have as mere tale tellers or as objects of satire, while it separates them from the tales with which they would establish relationships. Chaucer does this as a rhetorical but non-magisterial poet who extends belief, not certitude, whenever confronting bookishly articulated truths not immediately available to experience or not fully open to reason.

HILL, John M., Professor, "Hrothgar's Noble Rule: Love and the Great Legislator," *Social Approaches to Viking Studies*, ed. Ross Samson. Glasgow: Cruithne Press, 1991.

Much commentary on Beowulf has either slighted Hrothgar's heroic role or seen it in ironic terms: what, after all, are we to think about a 'valiant' king who needs outside help against Grendel and who never does anything fierce or martial in the poem? The heroic epithets applied to him come to seem ironic, as they do when applied also to his warriors, the Danes. But this impression is faulty: Hrothgar is heroic, valiant, justifiably famous, and proud. He deserves respect, as do his people. They are strong enough not to have been attacked by neighboring people even during their bad years, when decimated by Grendel's raids. Moreover, not only Hrothgar's actual warlike past redounds to his continuing credit--his munificent, wise, and noble actions do. The mythological sanction for Hrothgar as a noble and generous king comes from the wargod Tiu--the legislator figure, not from the wargod Woden, the fierce presider over battlefield frenzy and slaughter.

Hrothgar's stature in the poem has been misunderstood because all too often he has been seen only in relation to the Wodenesque--to heroic energies fiercely marshalled. Even Beowulf, the greatest of warrior-heroes in the poem, is essentially a legislator figure: he does what is right, lawful, and fitting. His battles are settlements, not Wodenesque frenzies of killing and slaughter. The terrible king, Heremod, is in this respect the poem's most Wodenesque figure. He is also the most vilified, whereas Hrothgar deserves the respect Beowulf shows him; indeed, Hrothgar becomes the most sympathetic and emotionally-deepened character in the poem.

JASON, Philip K., Professor, ed. *Fourteen Landing Zones: Approaches to Vietnam War Literature*. Iowa City: University of Iowa Press, 1991.

This anthology of criticism provides a range of critical perspectives on the developing corpus of imaginative literary responses to the Vietnam War. Included are studies in historical criticism, genre criticism, myth criticism, and feminist criticism. Topics include attitudes toward atrocities, connections among writings by Vietnam veterans and other kinds of survivor literatures, the theme of homecoming, and comparisons with the literature of

other wars. Among the authors treated are Tim O'Brien, Philip Caputo, David Rabe, James Webb, Bobbie Ann Mason, Takeshi Kaiko, John Clark Pratt, and Gustav Hasford. The essays suggest that the literature of the Vietnam War provides an intense and complex reflection of American cultural values.

JASON, Philip K., Professor, "Vision and Tradition in Vietnam War Fiction," *America Discovered: Critical Essays on Literature and Film of the Vietnam War*, ed. Owen W. Gilman, Jr. and Lorrie Smith. New York: Garland Publishing, 1990, pp. 75-86.

While they may recognize the unique set of circumstances that characterize the Vietnam War experience, novels in the realist tradition (John Del Vecchio's *The 13th Valley*, James Webb's *Fields of Fire*, and William Turner Huggett's *Body Count*) fail to communicate that experience. Their structures and strategies reflect assuring notions of coherence even when discontinuity and disorientation are observed. Novels that break with the realist tradition (Gustav Hasford's *The Short-Timers*, Larry Heinemann's *Close Quarters*, and Tim O'Brien's *Going After Cacciato*) employ techniques that defy expectations in productive ways. By incorporating lyrical, surreal descriptions that distort time, place, and action, these works shred simplistic cause and effect assumptions and put the reader through experiences analogous to those of the war itself.

JASON, Philip K., Professor, "Sexism and Racism in Vietnam War Fiction," *Mosaic*, **23**, 3 (Summer 1990), 125-137.

Though opportunities for women changed during the 1960's and 1970's in ways that suggested fundamental progress in gender relationships, an examination of representative Vietnam War novels reveals that such changes did not, perhaps could not, survive the pressures of combat environment. Such stress magnifies and releases deep-seated but repressed hostilities. In this literature, abusive behavior toward women is tolerated--indeed, it is institutionalized. Moreover, aggressive male sexual activity is likened to killing the enemy both in language and in deed. The warrior is conditioned to view all who are marked by difference, whether of gender or race, as inferiors and as enemies. Indeed, one must kill the feminine in one's self to perform a warrior's duties. Certain works go so far as to equate women with weapons of war.

MACE, Nancy A., Assistant Professor, "Henry Fielding's Classical Learning," *Modern Philology*, **88** (May 1991), 243-260.

Two assumptions have pervaded discussions of Fielding's learning in the classics: first, that he was equally fluent in both Latin and Greek, and second, that he was influenced more profoundly by the Greek satirist Lucian than by any other classical author. When we study the contents of his library, his allusions to the classics, and his translations of ancient literature, however, we discover that, although Fielding read widely in both languages, he was unable to read Greek without the help of Latin translations or other aids. Moreover, a tabulation of his references to classical authors demonstrates that Latin poets, particularly Horace, are much more important to Fielding than Lucian, to whom he seldom alludes.

MADISON, Robert D., Associate Professor, ed., *The Life of Nelson*, Robert Southey. Classics of Naval Literature Series, ed. Jack Sweetman. Annapolis: Naval Institute Press, 1990.

This modern edition represents an effort to provide a reading text of Southey's 1830 edition of the *Life of Nelson* that is both accessible and authoritative. The average reader will find basic information on important historical figures that were better known in Southey's day than now, but the annotation was deliberately limited to keep the focus on Southey's narrative. Numbered notes are provided to accompany the original notation supplied by Southey. A brief introduction establishes a context for appreciating both this biographical account and the heroic life it depicts.

NOLAN, Charles J., Jr., Professor, "Making Connections Through Literature," *Literature and Life*. Urbana, Illinois: National Council of Teachers of English, 1990, pp. 7-12.

The author draws upon his more than twenty-five years of teaching to discuss the importance of exploring the affective realm of literature in the classroom. The critical view that underlies the argument in this article has its links to an earlier time when the connection between literature and life was taken as a given. Arguing that the place to begin a discussion of any text is at the emotional level, the author recounts experiences with students reading particular texts--experiences that reflected

the power of literature to change attitudes and perhaps behavior. The author then describes thenext step in the process of making connections between reading and living: allowing students to write about the links between the literature they are studying and their own experiences. Answering several common objections to his method, the author concludes by pointing out that the affective realm is merely the place to begin discussion of a literary work. It is, however, a place that, though it holds its own risks, is valuable in producing student growth.

O'BRIEN, Timothy D., Associate Professor, "'Ars-Metrik': Science, Satire, and Chaucer's Summoner," *Mosaic*, **23**, 2 (Fall 1990), 1-22.

This study analyzes the ways in which Chaucer's *Summoner's Tale* is part of Chaucer's complex response to intellectual and social forces of his age. The Fragment of *The Canterbury Tales* in which this tale appears satirizes friars and summoners, but it also does several other equally important things. It reinvigorates a cultural assumption, fostered in part by the medical tradition, that identified the human body with a machine. It does this by giving that neutral comparison a valuative, satirical thrust. In this section of *The Canterbury Tales*, Chaucer also exposes the limitations of a predominant method of scientific investigation: the tradition of calculationes, with its quantitative evaluation of qualitative, moral problems. Moreover, by turning several of his characters into risible scientists, Chaucer situates this method of scientific investigation within a larger social movement, the rise of individualism.

PALM, Edward F., Major, USMC, "The 'Record of Emergency Data' and the Metaphysics of the Manpower Management System," *Marine Corps Gazette* (January 1991), 51.

This piece is an ironic personal essay recounting a three-year struggle to get the computer to realize that the author's deceased mother no longer had an address in which the Marine Corps should take a continued interest.

TINSLEY, Molly B., Professor, *My Life with Darwin*. New York: Houghton Mifflin, 1991.

This novel explores family relationships and clashing values through the narration of a woman whose parents were missionaries. The narrator-heroine tells the story of her childhood in the South American rainforest and her adolescence in a rigid Christian school; she recounts her marriage to the title character, Darwin, and describes the raising of her four children. By the end of the novel, each family member has taken a step away from the chaos and dysfunction in their lives, and Hannah in particular has resolved conflicts and reached understandings.

TOMLINSON, David O., Professor, "Mark Twain and American Ingenuity," *Mark Twain: Ritual Clown*. Albany: Siena Research Institute, 1990, pp. 136-147.

In the nineteenth century, three paths marked out the expression of American ingenuity: the discovery of precious metals, the invention of new technologies, and the declaration of American independence in literature and philosophy. Mark Twain followed all three of these paths. Indeed, in his literature he continued to follow all three even when he had abandoned the search for gold and silver in Nevada and when he pursued technological invention only as a sideline. This essay points to some of the ways in which Twain pursued the ingenuity he idealized.

TYLER, Eileen Tess, Associate Professor, "*The Mouse and His Child*," *Masterplots II: Juvenile and Young Adult Fiction*, ed. Frank N. Macgill, 4 vols. Pasadena: Salem Press, 1991, pp. 982-985.

This reference article examines Russell Hoban's celebrated fantasy novel, *The Mouse and His Child* (1967). The piece analyzes the characters, plot, themes, and contexts of Hoban's novel. *The Mouse and His Child* presents the quest of two wind-up toys and their friends through a microcosm of twentieth-century life. The quest is symbolic of the human search for security in the form of a home, or "territory," for self-reliance tempered and balanced by loving relationships, and for meaningful identity in the context of the Infinite. Thus this novel attempts to define and address very basic human physical, psychological, and philosophical issues. Hoban ultimately suggests that whether God exists or not, and despite creaturely aggressiveness and vanity, life as an ongoing process of self-determination, love, and growth is possible and desirable.

WHITE, David A., Associate Professor, ed. *Shakespeare A to Z*. New York: Facts on File Press, 1990.

This volume is a Shakespeare encyclopedia that includes major essays on all the plays, including sources and performance history. The coverage of the reference book includes data on the poems, and provides information on actors of Shakespearean drama, other playwrights, contemporary historical figures, and summaries of cultural and historical movements important to Shakespeare's life and work.

Presentations

BURKE, Carol, Associate Professor, "Women in Uniform," Annual Conference of The American Folklore Society, Oakland, California, 20 October 1990.

BURKE, Carol, Associate Professor, "'If You're Nervous in the Service . . .': WAC and WAVE Training Songs of the 1940's," Popular Culture Association Annual Conference, San Antonio, Texas, 28 March 1991.

CLARIDGE, Laura, Associate Professor, "Childe Harold, Manfred, and Byronic Generation: The 1816 L-Supplement to the Word," International Byron Society Meeting, Laussane, Switzerland, 30 August 1990.

CLARIDGE, Laura, Associate Professor, "Liminal Gender: Wordsworth's Silent Women Reconsidered," German Society for English Romanticism Conference, Eichstatt, Germany, 6 October 1990.

DREW, Anne Marie, Assistant Professor, "Xeroxing and Reproductive Rights: A Response," Midwest Modern Language Association Meeting, Kansas City, Missouri, 9 November 1990.

DREW, Anne Marie, Assistant Professor, "Dancing in Very Narrow Spaces: Shaw's *Too True to Be Good* and Pinter's *A Kind of Alaska*," The Pinter Festival, Columbus, Ohio, 25 April 1991.

ELLER, Jonathan R., Major, USAF, "Catching a Market: The Publishing History of *Catch-22*," Popular Culture Association Annual Conference, San Antonio, Texas, 27 March 1991.

ELLER, Jonathan R., Major, USAF, "Workshopping Student Papers in the Classroom," Naval Academy Writing Center Faculty Colloquium, Annapolis, Maryland, 8 April 1991.

FETROW, Fred M., Professor, "The Evolutionary Muse: Robert Hayden's Poems of Childhood," Annual Convention of the Northeast Modern Language Association, University of Connecticut, Hartford, Connecticut, 5 April 1991.

FLEMING, Bruce E., Assistant Professor, "Brothers Under the Skin: Achebe on *Darkness*," Annual Convention of the Northeast Modern Language Association, University of Connecticut, Hartford, Connecticut, 4 April 1991.

FLEMING, Bruce E., Assistant Professor, "Vers l'independence litteraire americaine," Biennale des Arts et des Lettres de Dakar, Dakar, Senegal, 15 December 1990.

FLEMING, Bruce E., Assistant Professor, "Looking Out: Critical Imperatives for World Dance," Annual Convention of the Dance Critics Association, Los Angeles, California, 1 September 1990.

FLEMING, Bruce E., Assistant Professor, "Film Theory's Central Myth," Annual Literature/Film Association Conference, Salisbury State University, Salisbury, Maryland, 4 June 1991.

HILL, John M., Professor, "Reimagining the Social World in Beowulf," Annual Convention of the Northeast Modern Language Association, University of Connecticut, Hartford, Connecticut, 6 April 1991.

JASON, Philip K., Professor, "Teaching the Literature of the War vs. Teaching the War Through Literature," Popular Culture Association Annual Conference, San Antonio, Texas, 27 March 1991.

MADISON, Robert D., Associate Professor, "The Naval Muse: Poems of the Late Rebellion," Popular Culture Association Annual Conference, San Antonio, Texas, 29 March 1991.

MADISON, Robert D., Associate Professor, "Cooper, Hennepin, and the Inland Sea," American Literature Association, Washington, DC, 24-25 May 1991.

PARKER, Michael P., Professor, "Our Nation's Glory, and Our Nation's Crime: Poets, Politics, and Inigo Jones's Restoration of St. Paul's Cathedral," Seventh Citadel Conference on Literature, Charleston, South Carolina, 2 March 1991.

PARKER, Michael P., Professor, "Waller's Plot Discovered: Politics, Percys, and the Arrangement of the 1645 *Poems*," Literature and Politics in the Seventeenth Century, University of Central Florida, Orlando, Florida, 9 March 1991.

SINE, Patricia P., Instructor, "Assignments from Hell: Writing Center Solutions," Conference on College Composition and Communication, Boston, Massachusetts, 22 March 1991.

SINE, Patricia P., Instructor, "Using the Journal Effectively," Interdisciplinary Faculty Workshop, English Department, U. S. Naval Academy, Annapolis, Maryland, 15 February 1991.

SINE, Patricia P., Instructor, "Assignments from Heaven; Assignments from Hell," Writing Center Writing Across the Curriculum Faculty Workshop, U. S. Naval Academy, Annapolis, Maryland, 6 March 1991.

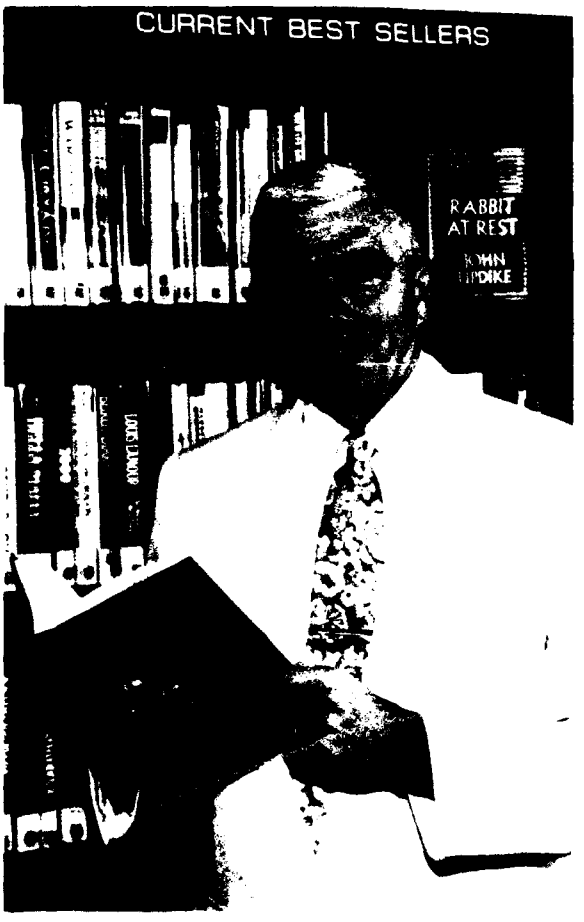
TINSLEY, Molly B., Professor, "Fiction Reading," Montpelier Arts Center, Laurel, Maryland, 19 October 1990.

TOMLINSON, David O., Professor, "Jane Austen's *Pride and Prejudice*: A Lecture Discussion for Citizens of Howard County," Florence Bain Senior Center, Columbia, Maryland, 4 October 1990.

TOMLINSON, David O., Professor, "Exploring Drama and the Use of Linkway," Nimitz Library Staff/English Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 16 October 1990.

TOMLINSON, David O., Professor, "Using Computers in the Writing Process," Office of the Defense Management Command, Baltimore, Maryland, 13 February 1991.

TOMLINSON, David O., Professor, "Russell Baker's Growing Up," Speaking Books Program, Howard County Library System, Fairhaven, Maryland, 2 May 1991.



DEPARTMENT OF

History

Professor Craig L. Symonds
Chair

Two years ago in this space, I described academic year 1988-1989 as a "seed bed" year, promising that ongoing faculty research projects would "yield fruit in the next few years." To sustain that analogy, academic year 1990-1991 marked the beginning of the harvest season. Two History Department faculty members published new books, and five others completed major works, all of which have been accepted for publication and which will appear in the fall of 1991.

Professor Ken Hagan saw the publication of his history of the U.S. Navy, *This People's Navy*, which appeared in February and which was received with both critical and popular acclaim. This is the first major synthetic interpretive history of the Navy since Harold and Margaret Sprout's *Rise of American Naval Power* in 1939. Hagan argues that the U.S. tradition of guerre de course was an appropriate strategy for most of its history, and that the ghost of Alfred Thayer Mahan played an undue and unfortunate role in defining U.S. policy in the years since 1890. In recognition of this seminal history, the History Department nominated Professor Hagan for the Researcher of the Year Award.

In addition, Assistant Professor Brian VanDeMark published *Into the Quagmire*, an analysis of the policies under Lyndon Johnson that led to the escalation of the Vietnam War. Professor VanDeMark also worked as a research assistant to Clark Clifford in the preparation of his memoirs, entitled *Counsel to the President*, which appeared this year. In the spring, Assistant Professor Mary A. DeCredico won further honors for *Patriotism for Profit*, her study of Confederate mobilization in Georgia, when she was awarded the Jefferson Davis Prize by the Confederate Memorial Library Society.

Five other books, Associate Professor Robert Love's two-volume history of the U.S. Navy (Stackpole Press), Associate Professor Dan Masterson's account of *Militarism and Politics in Latin America* (Greenwood Press), Assistant Professor Sam Nelson's history of life and work in central Africa (Yale University Press), Professor Craig Symonds' biography of Confederate General Joseph E. Johnston (W. W. Norton), and the second volume of Associate Professor William Cogar's *Dictionary of U. S. Admirals* (USNI Press) have all been completed and accepted and will appear in the fall. Associate Professor Jack Sweetman saw two of his books appear in revised and enlarged editions.

In addition to these major works, History Department faculty published twelve articles, two book forewords, and two chapters in published collections. Faculty members also delivered thirty-two scholarly papers, eight of them by Professor Robert Artigiani.

No less important, History Department faculty worked with midshipmen on their research projects which included one Trident paper, seven Honors papers, and several independent study projects. Midshipman 1/C Brian Hussey completed an impressive Trident project on the Atlantic convoys under the direction of Associate Professor Love, and Midshipmen 1/C Slate Johnson and Peter Schommer shared top honors for their papers delivered at the Regional Phi Alpha Theta (History honor society) conference at Shepherd College, Shepherdstown, West Virginia.

Sponsored Research

Alfred the Great: War and Kingship in Dark Age Britain

Researcher: Associate Professor Richard P. Abels
Sponsor: Naval Academy Research Council (OMN)

The purpose of this project was to test the hypothesis that warfare decisively shaped Alfred's conception of kingship, his program of educational and cultural reform, and his practice of politics.

During the 1989-1990 NARC research, the available secondary and primary sources for King Alfred's reign and those of his contemporaries on the Continent were surveyed. The tentative conclusion reached is that one cannot draw a neat line between Alfred's civil and military reforms. An examination of the historical context of Alfred's educational reforms reveals that they were undertaken with an eye toward the king's military needs. The ideology of kingship implicit in the translations that Alfred himself undertook or ordered others to do represented a radical transformation in the concept of the Anglo-Saxon polity. Rather than a freely-chosen lord, a king, according to Alfred, was instead a sacred person who held his office by the grace of God. The result was a more exalted conception of royalty, one that placed the king far above his nobles and made treason an offense against God. This view of kingship is best understood within the context of the military threat presented by the Vikings. Alfred's view of kingship was in turn powerfully shaped by Carolingian models. In essence, Alfred consciously cast English monarchy in Continental terms. This helped further the integration of England into the Western European Community, reflected in the marriage of five of Alfred's granddaughters to Frankish princes.

A Question of Will Power: A Comparative Study of the Investigation and Treatment of War Neuroses in England, Austria, Germany, and America, 1914-1922

Researcher: Associate Professor Theodore W. Bogacz
Sponsor: Naval Academy Research Council (OMN)

This study treats the impacts of the "shell-shock" crisis on England, Austria, Germany, and America, 1914-1922. The crisis of war neurosis in the First World War had the most profound implications both for the military and civilian society. A comparative investigation of national responses to this crisis dramatically contrasts differing national attitudes toward such fundamental questions as the diagnosis of mental illness and its treatment, the degree to which men are morally responsible for their acts, and ultimately definitions of bravery and cowardice in war. Such a comparative perspective also reveals contrasting national attitudes toward a crucial agent of cultural change, namely, Freudian psychoanalysis. Finally, this study assesses the results of several official commissions (particularly in England and Austria) that were established in 1920 to investigate the shell-shock crisis. The researcher is continuing to do research for this project and is now studying the American investigation and treatment of war neurosis.

A People Go To War: The Confederate Homefront, 1860-1865

Researcher: Associate Professor Mary A. DeCredico
Sponsor: Naval Academy Research Council (OMN)

Historians of the American Civil War have examined many facets of the Confederate experience. Though each year sees the appearance of new monographs, little work has been done on assessing the total homefront experience. During 1990, the researcher continued to delve into specific areas of the Confederate homefront, including state and local poor relief, the role of women, the role and status of blacks, and industrialization and mobilization. Both secondary treatments and primary source materials were consulted.

The researcher journeyed to two noted Southern history collections: the South Caroliniana Library at the University of South Carolina and the South Carolina Historical Society. Both repositories contain extensive manuscript holdings that deal specifically with life behind the lines during the Confederate fight for independence. These two sources provided documents unobtainable elsewhere; hence, the research added significantly to the final product.

This is still a new project and will undergo continued streamlining. It is anticipated that the research will ultimately produce an article and a book-length work.

The Strange Political World of George Wyndham

Researcher: Associate Professor Nancy W. Ellenberger
Sponsor: Naval Academy Research Council (OMN)

This project examines the political attitudes of George Wyndham, the early twentieth-century Conservative politician whose service as a cabinet minister in the Balfour administration (1900-1905) was followed by gradual disillusionment with mainstream conservatism and the promotion of increasingly extreme rightwing causes. Wyndham has usually been dismissed as a disgruntled Tory reactionary, emotionally and intellectually distressed by developments that threatened the landed society to which he belonged. This study puts Wyndham into the context of the "radical right," a group of activists who believed that threats to Britain's international predominance and internal stability required a dynamic, "constructive" Conservative response. The movement contributed much to the climate of crisis in Edwardian Britain and provided the intellectual background to Oswald Moseley's later fascist movement.

The project will produce an article for submission to a scholarly journal on modern British studies.

Emergence of the Modern American Navy, 1865-1915

Researcher: Professor Frederick S. Harrod
Sponsor: Naval Academy Research Council (OMN)

The project seeks an increased understanding of the process of innovation, modernization, and change within the Navy through the study of the emergence of the "new Navy" during the period 1865-1915. Its purpose is to examine the many intertwined threads of change over a prolonged period. By this means it will correct simplistic views based on narrowly-based research. During 1990-1991 the researcher continued work begun in previous years and gave expanded attention to the decade of the 1890's.

Indexing the *Maryland Gazette*

Researcher: Professor John W. Huston
Sponsor: Naval Academy Instructional Development Advisory Committee

Work continued throughout the intersessional period as well as the academic year on indexing of the *Maryland Gazette*, a project begun in 1988. By now establishment of categories for material has become much clearer than when the project was initiated. Equally clear seems the correctness of the decision made earlier not to include material from the first pages or so of the journal which were clearly copied from and related exclusively to European affairs. Although continuation of this procedure will affect slightly the utility of the index to researchers looking for broad implications of the Colonial period, the elimination of this material will enhance the utility of the index to those concerned primarily with the American colonies of the European powers in this time period.

Effort was expended in comparing the material and categories chosen against the printed index of the *Virginia Gazette*. This was an extremely fruitful expenditure of time, since the time period, culture, economic, and political structure of the two societies were so similar. On the other hand, striking differences existed which of necessity must be established or maintained in the indexing of the *Maryland Gazette*.

Much material was extracted which has been incorporated directly into the course material for HH345 and HH346. The volume of material to be indexed increased significantly during the prelude to and operation of the French and Indian War, as Maryland was a key participant in its early years.

The Great American History Machine

Researchers: Assistant Professor John G. Kolp and Professor Philip W. Warken
Sponsor: Naval Academy Instructional Development Advisory Committee

An experimental instructional system has already been developed and tested at Carnegie-Mellon University which allows students to undertake active projects in "doing history." The Great American History Machine, as it is called, (a) includes software to digitize any historical map; (b) a data management system to link statistical information to the maps; (c) statistical software to categorize and display the data in charts and graphs; and (d) software to display the statistical information on the maps residing in the system. An initial database provided with the software includes census data for all counties in the United States from 1840 through 1970.

The investigators acquired the "Great American History Machine" software and data files from Carnegie-Mellon, acquired a SUN 3/80 workstation to test and evaluate the system, learned to use the system, including the UNIX operating system, developed four exercises to provide initial tests of classroom use, and prepared a series of exercises for classroom use.

The Atlantic Fleet and the U-boat War, 1941-1942

Researcher: Associate Professor Robert W. Love, Jr.
Sponsor: Naval Academy Research Council (OMN)

From February 1941 to the fall of 1942, during the second phase of what Churchill termed the Battle of the Atlantic, the Navy's newly-assembled Atlantic Fleet was thrown into the scales with the Royal Navy--and the Canadians--to counter Germany's U-boat offensive against Allied transatlantic shipping. The researcher studied the records of the Atlantic Fleet for 1941 and 1942, the records of the General Board (which decided ship characteristics), the files of the Eastern and Gulf and Caribbean Sea Frontiers, all of which are held by the National Archives, and, in London at the Public Record Office, the records of the Battle of the Atlantic Committee and the (Washington based) British Admiralty Delegation. In January 1942, following America's entry into the war, U-boats entered the Western Atlantic and conducted a savage, seemingly successful offensive along the East Coast, but by this time escort, patrol, and anti-submarine doctrines of the Atlantic Fleet had already been tested against the German U-boats from September to December 1941, and the major problems had clearly been identified. What had not been done was to ask how to respond when shipping was close offshore, without adequate port direction, ocean escort groups, and the total absence of air cover and radio intelligence. The Atlantic Fleet was now tasked with the defense of U.S. troop shipping to Europe, and the Navy assumed in 1941, and early 1942, that troop shipping and support logistics shipping deserved an absolute priority over the defense of merchant shipping, but how to distribute a small number of overworked ocean escorts when both troop and merchant shipping were under siege in both the Atlantic and Pacific posed an entirely new dilemma. The result was the loss of merchant and tanker shipping off the East Coast in the first six months of the war. The results of this research will culminate in a paper to be delivered at a session on "FDR as Commander-in-Chief" at the Roosevelt Institute's forthcoming conference on "Roosevelt and the War" in December 1991 in New York.

The Illuminating Mind in Twentieth-Century American Photography

Researcher: Associate Professor David P. Peeler
Sponsor: Naval Academy Research Council (OMN)

This project is an examination of the growth of American photography in the twentieth century. It explores the ideas and values of leading American photographers, and the ways in which they brought those beliefs and values to fruition in their work. The project fills a gap in the existing scholarship, for while there is a substantial body of art criticism on the medium, there is little substantial scholarly treatment of the ideas associated with this broad swath of creative photography. The researcher's principal question is: In what ways did these creative individuals seek to resolve the tension that arose from working in a medium with an almost worshipful attitude toward objectivity, while daily seeing the evidence in their work that even the simplest fact cannot be presented without altering its "pure" objectivity in some way?

The Emergence of Modern Military Command Structure

Researcher: Associate Professor William R. Roberts
Sponsor: Naval Academy Research Council (OMN)

The purpose of this project is to examine the origins and consequences of the sweeping institutional changes that transformed this country's military command structure during the Truman and Eisenhower administrations, beginning with the National Security Act of 1947 and ending in 1958, when Congress altered that act.

Historians have usually attributed the adoption of the 1947 National Security Act to the growing complexity of warfare that was encountered by the military leaders who commanded joint operations during the Second World War. Interservice rivalries during a period of economic retrenchment have also been identified as contributing to the emergence of

a new command structure. This investigator has sought to ascertain if other motives played a part in bringing about the changes set in motion by the 1947 law and later legislation; in the future the researcher also hopes to explore some of the consequences of this change not only for the armed services but also for the political authorities responsible for overseeing the armed forces.

The Formation of Professional Culture among Academic Historians in Russia, 1845-1925

Researcher: Assistant Professor J. Thomas Sanders
Sponsor: Naval Academy Research Council (OMN)

This study examines aspects of the elaboration of a distinct professional culture among academic historians in Russia from the time of the emergence of academic history to the consolidation of the Bolshevik control in higher education. As Peter Novick has demonstrated in his admirable work, *That Noble Dream*, the historical profession can serve as a remarkably reflective barometer of the existing socio-political environment. While articulating an abstract ideal of objective knowledge, historians pursue self-interested goals in a manner mirroring the broader biases, values, concerns, and conflicts of the society as a whole. The community of professional historians in tsarist Russia, a culture equally unsure of how to conceive of its own national past and what to make of a Westernized future, was no less sensitive. The researcher's present subject is the collective self-definition of the historical profession arrived at by practicing historians. The problem intersects with several important questions concerning any unevenly modernizing society on the eve of the modern age--the stability of the dominant intellectual climate; the role of civil society; the effect of objective criteria based on merit and achievement on an estate-based society; the impact of internationally accepted standards of quality on individual cultures; the clash of ostensibly class-blind professional standards and the "aristocratic" ethos of the educational elite; the interaction of professional development and censorship; and, lastly, the function of history in a society redefining its relationship with its own past.

Hegel's Map of the Imagination

Researcher: Assistant Professor Chip Sills
Sponsor: Naval Academy Research Council (OMN)

The researcher is revising his dissertation for publication. The project explores the problem of how a study of Hegel's *Logic* can help toward a better understanding of the ways imagination works to limit and facilitate conceptual thought. The innovation proposed by this study is to make the notion of "trope" a key for undertaking the investigation. In poetics, in science, in logic, in imaginative construal generally, the notion of trope has been employed for centuries. This cross-disciplinary phenomenon has seldom been recognized because of the peculiar jargons created by the various disciplines. Absent this recognition, few observers have tried to connect--in any rigorous fashion--the ways in which tropes have been used. The project explores these connections via an interpretation of Hegel's *Logic*, a famous but little-studied work.

The researcher's goal is to provide a useful simplification of logical/imaginative modes of construal. In addition to the intrinsic interest of such a project, the pedagogical promise is considerable. The researcher may be able, if successful, to introduce undergraduate students to a complex and systematic overview of the modes of conceptual mapping. Since one of the researcher's primary duties is the teaching of philosophy of science, this capacity should be particularly useful in presenting and discussing theoretical difficulties in contemporary physics.

Ramus and Reform: The End of the Renaissance and the Origins of the Old Regime in France

Researcher: Assistant Professor James V. Skalnik
Sponsor: Naval Academy Research Council (OMN)

This work describes the efforts of the educator and reformer Peter Ramus (1515-1572) to defend the relatively open and meritocratic society of Renaissance France against the spread of Old Regime ideas and institutions, beginning in the middle of the sixteenth century. As a leading figure in both the French Reform and the University of Paris, as well as the author of the pedagogical system known as "Ramism," he consistently promoted an ideology that would make status, influ ..e, and authority dependent on talent and achievement, rather than on birth, wealth, or co-optation by existing elites. His social ideal, which he eventually labelled "timocracy," attracted a sizable following and achieved some practical results during his lifetime. After his death in the St. Bartholomew's Day Massacre of 1572, however, his ideology fell out of favor and his reforms collapsed. In their place arose the hierarchical, oligarchic, and authoritarian society of Old Regime France.

This investigation is significant beyond the narrow focus of Ramism itself. It helps to illuminate the collapse of the Renaissance ideal in France and the spread of institutions and ideas typical of the Old Regime.

From Knowledge, Sea Power: A History of Research at the United States Naval Academy

Researcher: Associate Professor Jack Sweetman
Sponsor: Naval Academy Research Council (OMN)

The U.S. Naval Academy was founded in 1845. Its mission has always been to prepare midshipmen to become professional officers in the naval service. It has therefore and rightly remained essentially an undergraduate, teaching institution. As a natural result of the relationship between classroom teaching and intellectual creativity, however, the academy has also been the scene of wide-ranging research activities by both its faculty and, in recent years, midshipmen. It was, for example, as a lecture demonstration that in 1877 Ensign Albert A. Michelson began conducting the experiments to measure the speed of light that led him to become the first American to receive the Nobel Prize for Physics. Similarly, it was research done in support of the Academy's naval history course that, early in this century, brought the History Department the reputation it still enjoys as a center for the study of naval history. Since the 1960's, the development of a sponsored research program administered by the Naval Academy Research Council (NARC), the creation of research professorships, and the initiation of the Trident Scholar Program have greatly enhanced the research opportunities of faculty and midshipmen alike. No general history of research, broadly defined, at the Naval Academy now exists. The aim of this project is to produce such a history, approximately 10,000 words in length, describing significant research conducted at the Naval Academy from its foundation to the present and tracing the growth of the sponsored research program.

The U.S. Marine Corps: A Visual History

Researcher: Associate Professor Jack Sweetman
Sponsor: Naval Academy Instructional Development Advisory Committee

The researcher prepared a 200-slide program and an accompanying user's guide tracing the history of the Marine Corps from the Revolutionary War through the 1980's. The guide explains the subject and significance of each slide and includes a concise historical narrative surveying the Corps' major operations and institutional evolution.

The manuscript of the user's guide has been reproduced in multiple copies for HH104 and other instructors, and multiple copies of the slides have been printed by the Educational Resources Center.

Introduction to the Sailing Warship

Researcher: Associate Professor James P. Thomas
Sponsor: Naval Academy Instructional Development Advisory Committee

This project produced two audio-visual programs, which will acquaint the midshipmen with the characteristics and operation of sailing warships, and which make the material in the course relating to the sailing ship era more readily understandable. The completed program contains approximately one hundred slides plus some original work.

The program is composed of two segments: the first, "Introduction to the Sailing Warship: Part I, Warship Types and Strategic Functions," is approximately thirty-five minutes in length and explains the capabilities and implications for naval policy and strategy of the various types of sailing warships. The second segment, "Introduction to the Sailing Warship: Part II, Construction, Operation, and Armament," is approximately forty-five minutes in length and shows how sailing warships were built, rigged, maneuvered, handled tactically, and armed. Both films were used during academic year 1990-1991 in naval history classes.

The Common Soldier in the Vietnam War

Researcher: Assistant Professor Brian VanDeMark
Sponsor: Naval Academy Research Council (OMN)

Research has been initiated on a comprehensive, analytical study of the common American soldier in the Vietnam War. Its focus will be social, rather than military history. It will attempt to convey the varied experiences of GI's in the Vietnam War and, more important, what meaning everyday soldiers gave to their experiences.

Research is focused on secondary and printed primary sources--e.g., oral histories, interviews, and reminiscences. Materials in this area are abundant, but of uneven quality and scattered throughout many books and periodicals.

Use is planned of the vast numbers of unpublished letters and diaries of ordinary soldiers housed in archives around the country. Other sources will include general orders, medical records, court-martial proceedings, newspaper accounts, photographs, and sketches.

The U.S. Navy, the Neutrality Patrol, and Atlantic Fleet Escort Operations, 1939-1941

Researcher: Midshipman 1/C Brian F. Hussey, USN
Adviser: Associate Professor Robert W. Love, Jr.
Sponsor: Trident Scholar Program

This project concerns the operations of the U.S. Navy's Atlantic Squadron and Atlantic Fleet between the outbreak of World War II in Europe in September 1939 and American entry into the war with the Axis on 7 December 1941. Germany's invasion of Poland and the Anglo-French declarations of war found the U.S. Navy confident in its ability to deal with a replay of the 1917-1918 U-boat commerce raiding campaign. A fairly primitive Allied escort-of-convoy strategy had dealt a sharp defeat to the U-boat in World War I, and technology developed between the wars seemed to endow the defense with considerable advantages. The advent of radar and echo-ranging sonar, the development of long-range, all-metal, high endurance patrol aircraft and bombers, and the perfection of radio communications all served to increase the confidence of Navy men that the fleet could once again bring the U-boat to book. Vastly improved tactics, strategy, and leadership of the U-boat forces had not been taken into consideration by the prewar strategists. The uncertain political and strategic environment of the 1939-1941 neutrality years played havoc with Navy plans.

The literature on American and Anglo-American politics and diplomacy during the neutrality years is immense, but surprisingly few scholars have studied the Navy's role in the ongoing Battle of the Atlantic. All published accounts of this period--and every classified Navy or contract study--has suffered from

the belief that no OpNav-CominCh central flag message files existed. It is only within the past year that this enormous file, consisting of over 25,000 reels of microfilm and several million documents, was discovered in the attic of the Naval Intelligence Security Group headquarters in Washington, DC.

This is the first fully operational history of the U.S. Navy's Neutrality Patrol from September 1939 to August 1941 and the Atlantic Fleet's escort duty from September to December 1941. The author has explained the development of patrol, escort, and anti-submarine doctrine, the evolution of escort and anti-submarine tactics, and the role of British and Canadian naval collaboration in the creation of an American anti-U-boat strategy.

Independent Research

The Transformation of English Culture, 1910-1923: Tradition, Modernity, and the Great War

Researcher: Associate Professor Theodore W. Bogacz

This book will be a synthetic study with broad implications for the cultural and social history of modern England. The researcher is attempting to examine important aspects of English culture as they underwent radical change under the impress of total war. Among the areas under study are: the transformation of language during World War I; the reception of new views of psychology and mental illness under the impact of the "shell-shock" crisis on the Western Front; the triumph of the modernist vision in the fine arts as other styles failed to capture the nature of modern war; and ultimately the growing acceptance of the conditions of "modernity" in English culture as a whole. The years 1910-1922 in England are viewed as a period of profound cultural crisis and World War I as a radically modernizing force in all areas of English life. A major portion of the task in completing this book will be to chart the resistance to and acceptance of the forces of modernity in English culture in these revolutionary years. The researcher has completed the research for and written a substantial portion of this book.

Dictionary of Admirals of the United States Navy, Volume III, 1919-1941

Researcher: Associate Professor William B. Cogar

This research will produce the third of what will be a multivolume series on all admirals of the United States Navy. This volume will be a continuation of the first and second volumes that covered the years 1862 through 1900, and 1901 through 1918. Like its predecessors, this volume includes biographical and career information, as well as bibliographical information. The intent is to provide the world of scholarship with a reliable and convenient source on American admirals that at present does not exist. This volume is approximately one-third finished and, like the earlier volumes, will be published by the U.S. Naval Institute Press.

Roman Records

Researcher: Professor Phyllis Culham

The ultimate objective is a book on how the Romans handled problems of proof and documentation. So far the project has produced three articles in print, four presentations, and another paper now under consideration by a journal. Two university presses and one commercial press have asked the author to submit the completed manuscript to them. The Johns Hopkins University (JHU) will be assisting with this project in the fall of 1991 since the researcher will be offering a graduate course in Classics on "Roman Records and Problems in Literacy" for JHU that semester, and the University will supply library and research support.

Red Mike Edson

Researcher: Major Jon T. Hoffman, USMC

This project continues graduate school work on the life of Major General Merritt A. Edson, USMC. The objective is to complete a publishable biography on this officer who played an important role in the development of the Small Wars Manual and the Marine Raiders. The Small Wars Manual is a 1940 document that has recently been resurrected as an aid to the development of modern counterinsurgency doctrine. The Marine Raider units of World War II are predecessors of the current Marine Expeditionary Units (Special Operations Capable). In both cases, a detailed study of Edson and his accomplishments may shed light on exactly how his efforts should affect modern development in these two fields.

The research project is ongoing. The investigation into the Small Wars Manual is largely complete, and substantial groundwork has been done on the Raider Battalion.

Conceptual Obstacles to Peace

Researcher: Professor David E. Johnson

This research was the focus of a sabbatical leave during the fall semester, 1990. From the point of view of philosophy, one of the major sources of our current social and environmental crises is how we think. Our thought processes are in part determined by the concepts we use. The concept of peace stands in varying relations to other concepts in our conceptual framework. The purpose of this project is to examine those parts of our conceptual framework that make it difficult for people to accept and promote the concept of peace. In particular, the research focused on the ways in which the notions of "domination" (of one person or group by another) and "the other" work against peaceful (non-violent) relations among people. Two beliefs of militarism were critically analyzed: (1) in order to secure peace, prepare for war; and (2) it is appropriate for some people to dominate other people and the natural environment. The culmination of this research was a conference paper accepted for delivery at the international conference of philosophy in Nairobi, Kenya, as well as basic material for several other presentations and lecture topics for HP232-Ethics and HP336-Philosophy of Religion.

The Dynamics of Electoral Competition in Pre-Revolutionary Virginia

Researcher: Assistant Professor John G. Kolp

While most research on local politics in colonial Virginia has portrayed the system as static, uniform, and virtually unchanging from 1725 to 1815, this study asserts that the electoral system should be viewed as a dynamic entity responding to temporal change and to local, regional, provincial, and imperial influences. To test this assertion, every scrap of evidence on all 882 general and by-elections held between 1728 and 1775 is subjected to detailed quantitative analysis to determine the trends in electoral competition over time and the potential differences between counties and regions of the colony.

Only about one-third of the elections held during this period are found to be competitive. Findings also suggest a general downward trend in electoral competition over the period under study, as well as considerable diversity between sections of the colony that do not fit previous geographical models.

An article summarizing the results of this study has been submitted to *The William and Mary Quarterly*.

Elections and the Political Communities of Colonial Virginia, 1728-1775

Researcher: Assistant Professor John G. Kolp

Elections to the eighteenth-century Virginia House of Burgesses have been of long-standing interest to historians because of the role they played in the early political careers of a number of America's Founding Fathers. Although these men were selected for office within their local country constituencies by a substantial proportion of the adult male population, it has never been completely clear what meaning should be attached to these political events. What did this selection process prove? Was there any real difference between candidates? Did it really matter who won? Were these events merely social gatherings or was something important being decided at these elections? Despite considerable attention by scholars in several books and numerous articles, the precise way these elections fit into the social and political structure of colonial communities has remained obscure.

A preliminary answer to some of these important questions has been put forward in a doctoral dissertation completed in 1988. Examination of surviving data on all elections for this period reveals a pattern of gradual decrease in electoral competitiveness over the 50-year period, but also demonstrates substantial regional variation that detailed case studies of three counties, including the importance of tenants in the election process, the broad spectrum of issues colonial voters thought germane, the remarkable stability of voting behavior, the importance of previous officeholding to candidate success, and the role of local neighborhoods in defining electoral choice. The dissertation is being revised and re-arranged, and several chapters are being added.

A book prospectus has been submitted to the Institute for Early American History and Culture at Williamsburg, Virginia, which sponsors the publication of several manuscripts each year through the University of North Carolina Press and The Johns Hopkins University Press.

The Japanese Presence in Latin America during World War II

Researcher: Associate Professor Daniel M. Masterson

This project, which is being conducted in collaboration with Professor John Bratzel of Michigan State University, is analyzing the U.S. and Latin American governments' response to the Japanese presence in Latin America during World War II. The project's focus is twofold. Tokyo's diplomatic and espionage activities on the west coast of Latin America (Mexico, Panama, Ecuador, Peru, and Chile) will be examined in depth. Secondly, the policies of the U.S. and Latin American governments regarding the Japanese populations will also be studied in depth.

Research has been ongoing on this project for more than two years. In 1989-1990, the researcher worked in the Office of Strategic Services and State Department records at the National Archives, the Japanese Immigration Museum in Lima, Peru. He also consulted FBI records, as well as the papers of Franklin D. Roosevelt, Harry Hopkins, and Henry Wallace at the FDR Library in Hyde Park, New York.

More recently, the researcher conducted interviews with former Peruvian Japanese now residing in Chicago, examined the records of Colonel William Donovan (OSS Chief) at the Army War College, and completed research at the FDR Library.

In July 1991, the researcher completed field research in Mexico at the Archivo General de la Nacion in Mexico City. It is anticipated that field research in Ecuador, Peru, and Chile will be completed in the summer of 1992.

Out of Silence: Social Images of the Deaf in Nineteenth-Century France

Researcher: Associate Professor Anne T. Quartararo

This research project is a synthetic study of the social and cultural forces that molded the deaf community in France during the nineteenth century. The researcher is focusing on the emergence of a deaf identity during a period of intense social change in Western society. In the first part of the study, the revolutionary period is placed in historical perspective. The researcher is studying the concepts of social deviance and state charity in order to understand the "images" of the deaf community between 1789 and 1815. In the second part of the project, the researcher deals with the relationship between bourgeois and deaf culture at mid-century. How deaf people structured their lives and how the hearing community reacted to them can be interpreted through deaf literature and cultural organizations, education goals, and welfare strategy. The last segment of the study (1880-1900) deals with the concept of deaf autonomy in an industrial world. The researcher is currently preparing a scholarly paper on this last segment of the project for an international conference on Deaf History scheduled for June 1991.

The Analytical Philosophy of History in Late Imperial Russia

Researcher: Assistant Professor J. Thomas Sanders

The researcher proposes to examine the analytical philosophies of history of four eminent historians of the last years of imperial Russia: V.O. Kliuchevskii, N.I. Kareev, R.Iu. Vipper, and A.S. Lappo-Danilevskii. This group is distinguished by the fact that, in addition to being among the most prominent historians of their era in Russia, they each wrote a great deal about the philosophy of history and about historiography. This study will track their individual treatments of four prominent social problematics of that era; to wit: the idea of progress, the aspiration to a science of human affairs, historicism, and the enduring belief in the importance of the individual. This tracking will involve an in-depth analysis and comparison of those works by these four historians that specifically address questions of the nature of the historical process, historical epistemology, and the causation. Support for this project is provided by the Hoover Institution on War, Revolution, and Peace.

The Colleges of Paris in Sixteenth Century

Researcher: Assistant Professor James V. Skalnik

Over the course of the sixteenth century, the quality of higher education in the University of Paris declined, while educational opportunity became increasingly restricted to elite groups. In a deteriorating economy, college principals and professors restricted enrollment to fee-paying students and began to treat their positions as personal possessions to be traded, inherited, and bought and sold with little regard to the qualifications of the purchaser or legatee. All these developments reflect a broader adjustment of French society towards an economy of scarcity and a newly rigid social hierarchy, the hallmarks of the Old Regime. Manuscript records of the colleges housed in the Archives Nationales, Paris, will allow the researcher to investigate and validate these claims, which will contribute to historians' understanding of the origins of the Old Regime and of the impact of social change on educational opportunity.

The U.S. Marine Corps: An Illustrated History

Researcher: Associate Professor Jack Sweetman

This co-authored work is designed to provide a concise but authoritative history of the U.S. Marine Corps from the foundation of the continental Marines in November 1775 to the present. The narrative is to follow a chronological format. This researcher will contribute the chapters up to American intervention in World War One; Lieutenant Colonel Merrill L. Bartlett, USMC (Ret) will contribute the remainder. The division was predicated on the assumption that the personal experience which Colonel Bartlett--twice winner of the Marine Corps Historical foundation's prestigious, annual Heinl Award for the best article on Marine Corps history--brings to the project will become progressively more valuable as the narrative nears the present. The project length is approximately 65,000 words. The work will include numerous, carefully-chosen illustrations and maps, as well as appendices listing the Commandants of the Marine Corps, Marine Corps Medal of Honor recipients and Battle Streamers. It is anticipated that the project will be completed by early 1992.

The Great Admirals: Centuries of Command at Sea

Researcher: Associate Professor Jack Sweetman

The object of this work is to survey the careers and, most especially, to examine the leadership styles and skills of nineteen admirals--six British, four American, two Dutch, two Japanese, and one each Austrian, Danish, French, German, and Greek--who commanded in fleet engagements from the Elizabethan Age to the close of World War Two. Original essays have been prepared by a distinguished, international team of academic, official, and private historians, along with naval officers from Australia, Austria, Canada, Denmark, France, Greece, The Netherlands, the United Kingdom, and the United States. The work will be approximately 125,000 words in length. The projected completion date is fall 1991.

Joseph E. Johnston: A Civil War Biography

Researcher: Professor Craig L. Symonds

Joseph E. Johnston was the highest-ranking U.S. Army officer to resign his commission and "go south" to offer his services to the Confederacy. He commanded the Confederate armies at the Battle of Bull Run (Manassas) and Seven Pines (Fair Oaks) in Virginia, then assumed supreme command in the West in November 1862. He was closely associated with the Vicksburg campaign in the summer of 1863, but after a series of long distance disagreements with Confederate President Jefferson Davis, he was demoted to a small regional command.

In 1864, he was restored to a position of huge responsibility when he became commander of the Army of the Tennessee. His campaign against Union Major General William Tecumseh Sherman in Georgia is very controversial among historians. While many praise Johnston for conserving his army, others attack him for failing to repel Sherman. In July 1864, President Davis relieved Johnston of his command and replaced him with John Bell Hood. Johnston returned to command again in the twilight of the Confederacy and commanded its armies in its last "victory" at Bentonville, North Carolina, in March 1865.

This project is a full-length biography of this controversial Southern general.

A Topical History of the Third Reich

Researcher: Professor Larry V. Thompson

Research is being conducted for a book-length synthesis of National Socialist Germany. Topically organized, the study is both interpretive and derivative. It seeks to demonstrate the experience of everyday life under National Socialism while documenting the extent of polycratic rather than dictatorial rule exhibited by the regime. Based upon extensive archival research and current scholarship over the past quarter century, the book, when completed, will contribute to the continuing scholarly debate on whether or not the Nazis were functionalists or intentionalists in program and practice.

Visions of Nadir Shah

Researcher: Assistant Professor Ernest Tucker

The researcher's thesis project is an analysis of the historiographical perspective of the major chronicles of the life of Nadir Shah, ruler of Iran from 1725 to 1750, comparing them to contemporary documents to shed light on the differing views of contemporary observers. The research involves analyzing published editions of chronicles as well as unpublished documents from Middle Eastern archives.

Seventeenth-Century Dutch Naval Prints as a Window on the Culture of Holland's "Golden Age"

Researcher: Major Grant H. Walker, USA

This project is a continuation of the researcher's efforts to illuminate additional aspects of the seventeenth-century Dutch culture through a study of prints (engravings and etchings) of battles involving elements of the Dutch Navy in the Age of Sail. The Dutch Republic was a rich and powerful maritime culture--a true thalassocracy--which found itself embroiled in war throughout virtually the entire seventeenth century. It was also Europe's leading publishing center, and home to a group of remarkably gifted artists. A number of these artists produced and published prints of naval battles, the careful study of which reveals a great deal about what the Dutch held to be most important in cultural, political, military, and economic terms.

Research will be carried out in Amsterdam in the archives of the National Maritime Museum and the Rijksmuseum. Specifically, the researcher will seek to answer certain questions concerning the portrayal of the battle of the Downs (1639), the Dutch "Raid on the Medway" (1667), and the Battles of the Schooneveld and the Texel (1673). The researcher will read first-hand accounts of the battles and compare how different artists depicted them, all with an eye towards revealing additional facets of Dutch society and culture in the "Golden Age" of Holland.

Research Course Projects

Maverick in Moscow: Philip R. Faymonville and the Soviet Union, 1918-1943

Researcher: Midshipman 1/C Kelly W. Biggs, USN
Adviser: Associate Professor Jane Good

This paper analyzes the career of Brigadier General Philip R. Faymonville, USA, American military attache to Moscow (1934-1939) and chief of the Lend-Lease office in Moscow (1941-1943), who was secretly investigated for treasonous activities benefitting the Soviet Union. This project does not dispel the assumption that Faymonville was a traitor but instead examines his background and career and strongly suggests that he was a loyal and honorable officer. Most significant is the suggestion that the actions taken against Faymonville sprang from political rivalry and personal conflicts, not from his alleged disloyalty to the United States.

Washington and the Loyalists: 1775-1778

Researcher: Midshipman 1/C Christian M. Bonat, USN
Adviser: Professor John W. Huston

Among the reasons that the outmatched and undersupplied army of George Washington was successful in winning the American Revolution was Washington's treatment of those who remained loyal to Great Britain. British planning for the war was based upon high expectations of support from the Loyalists that did not materialize: Washington's policies aided in the thwarting of these expectations.

This study identifies and analyzes General George Washington's policy toward the Loyalists from 1775 to the aftermath of Valley Forge in 1778, concentrating on the areas of largest Loyalist strength in New York, New Jersey, and Pennsylvania. The researcher attempts to determine the origins of this policy and explain how and why it was modified during the contest.

Changing Middle Class Perceptions of Queen Victoria's Association with Empire, 1876-1901

Researcher: Midshipman 1/C Kurt L. Metcalf, USN
Adviser: Associate Professor Nancy Ellenberger

In 1876, the Conservative prime minister Benjamin Disraeli introduced into the House of Commons the Royal Titles Bill, a measure that would add "Empress of India" to Victoria's existing title of "Queen of the United Kngdom and Northern Ireland." As the debate proceeded in Parliament, this seemingly simple addition garnered increased opposition from both the London press and the opposition Liberals. Such a title was foreign and contrary to the comforting notion of the sovereign as head of a small island-nation. By 1897, however, the British middle classes seemed to embrace the imperial mission as never before. The educated public went from indifference and sometimes opposition to the empire, to an active endorsement of the imperial cause. This study focuses on how Victoria's image increasingly assumed the aura of an imperial icon and how her visible association with the empire helped make it acceptable to the middle classes.

'We Have Been Pretty Badly Whipped': An Analysis of the Performance of Upper Shenandoah Valley Home Guard Units in 1864

Researcher: Midshipman 1/C David Mark Houff, USN
Adviser: Associate Professor Mary A. DeCredico

This research course project was completed under the auspices of the History Department Honors Program and was conducted over two semesters. The research included primary archival work in Virginia. The researcher focused on the motivations and effectiveness of Home Guard units in the Staunton area during the crucial 1864 campaigns. He concluded that poor leadership and training doomed the efforts of local units to defend against regular Union Infantry and cavalry.

Slavery and the Politics of Promotion: The Case of Patrick R. Cleburne, C.S.A.

Researcher: Midshipman 1/C Slate L. Johnson, USN
Adviser: Professor Craig L. Symonds

Confederate Major General Patrick R. Cleburne was one of the most effective and respected division commanders in the Confederate armies. Yet despite his remarkable record, he was passed over several times for promotion to lieutenant general and the command of a corps. This paper argues that there were three reasons for this: (1) Cleburne was not native to the American South; a native of Ireland, he came into the culture as an adult; (2) the political schism within the Army of Tennessee put Cleburne on the opposite side of the army commander, Braxton Bragg; and (3) most important, Cleburne proposed the arming of slaves and their use as Confederate soldiers. This proposal was so controversial that Cleburne was never promoted.

Prohibition in the Free State

Researcher: Midshipman 1/C John Jones, USN
Adviser: Professor Philip W. Warken

"Prohibition in the Free State" is an analysis of the reasons Maryland voted for the Prohibition Amendment but did not pass state enforcement legislation. Prohibition succeeded in Maryland because of the ability of the Anti-Saloon League to lobby effectively, mobilize religious support, and capitalize on World War One. The reasons for its failure are more diverse. Individuals such as Governor Ritchie, Attorney General Armstrong, Congressman Hill, H. L. Mencken, and Cardinal Gibbons provided the leadership for the state in 1920. They opposed prohibition for a variety of reasons including political, ethnic, and religious arguments. Furthermore, the General Assembly of 1920 proved to be much less supportive of prohibition than its predecessor had been. The war had ended and Maryland was ready to relax. Most important prohibition failed because of the opposition of wet, wet Baltimore City. Although national prohibition lasted for thirteen more years, by 1920, America knew that Maryland would always remain the Free State.

The Catholic Sandbox: the German Bishops and National Socialism, 1933-1945

Researcher: Midshipman 1/C Peter J. Schommer, USN
Adviser: Professor Larry V. Thompson

The thesis examines the German Episcopate's response to National Socialism, assessing the degree to which the bishops adopted an "intentionalist" or "functionalist" position toward the Nazi regime. Research reveals that a functionalist attitude prevailed, inasmuch as the bishops viewed the Third Reich's anti-religious stance as the product of local Nazi hostility rather than the policy of Hitler and his major lieutenants. In reality, Hitler and his immediate entourage approached church policy cautiously and erratically. They were nevertheless determined to eliminate organized religion at a propitious future date. The bishops chose to address this threat through a "petition" policy directed at Hitler. In consequence, they generally failed to resist actions and policies that affected German Catholicism adversely at the grassroots level of governance.

This thesis received the Most Outstanding Honors Thesis Award in the History Department.

Publications

ABELS, Richard P., Associate Professor, "English Tactics, Strategy, and Military Organization in the Late Tenth Century," *The Battle of Maldon A.D. 991*, ed. G. Scragg. Oxford: Basil Backwell, 1991, pp. 143-155.

This article examines the military, diplomatic, and strategic plans undertaken by King Aethelred the Unready in his conflict with the Vikings. It also considers the military aspects of the Old English poem on the Battle of Maldon within the context of late tenth-century English battlefield tactics and campaign strategy.

ARTIGIANI, P. Robert, Professor, "Social Evolution: A Nonequilibrium Systems Model," *The New Evolutionary Paradigm*, ed. E. Laszlo. New York: Gordon and Breach Science Publishers, 1991, pp. 93-130.

The origins of species-specific human attributes--e.g., "consciousness"--are modeled using the basic concepts of irreversible thermodynamics. Environmental energy flows are shown to alter loosely organized pre-historic bands and groups, providing for the creation of information recorded in societal "cognitive maps." Driven far-from-equilibrium, the gain in coping between individuals increases until a whole greater than the sum of its parts emerges. Individual behavior is then partly controlled by the social system.

ARTIGIANI, P. Robert, Professor, "A Model of Societal Self-Organization," *Time, Rhythms, and Chaos*, ed. G. P. Scott. Ames: Iowa State University Press, 1990, pp. 101-116.

An irreversible thermodynamics model designed to track qualitative change in social systems is developed. The nonequilibrium conditions in which societal information is generated, the techniques for transferring information, the nonlinearities correlating behaviors, and the emergence of new human behaviors are deduced from an idealized energy flow. Some moral implications of the model are indicated.

ARTIGIANI, P. Robert, Professor, "Post-Modernism and Social Evolution: An Inquiry," *Journal of General Evolution*, 30, pp. 149-162.

Applied to the symbol systems recording information for guiding the behaviors structuring societies, Post-Modernist reflexivity and self-referentiality combine in a co-evolutionary model that offers hints about the creation of societal information. Although left- and right-wing ideologists lament the Post-Modernist abandonment of ultimate "reality," this paper argues that complex societies preserve flexibility by mapping themselves and their environments following a Post-Modernist model.

BRENNAN, Thomas, Associate Professor, "Social Drinking in Old Regime Paris," *The Drinking: Behavior and Belief in Modern History*, ed. Susanna Barrows and Robin Room. Berkeley: University of California Press, 1991, pp. 61-86.

This analysis of public drinking yields a unique and richly detailed vision of the culture of the urban populace. It exemplifies the role of public consumption and reciprocity in pre-modern society. Central to this study is the clash of elite and popular culture as it was articulated in the different attitudes to taverns and alcohol consumption. The elites saw in taverns the indiscipline and exuberance that they condemned in popular culture. Popular testimony presented public drinking in very different terms. The elaborate rituals surrounding public drinking and its prevalence in popular sociability and recreation all point to the importance of drink as a medium of social exchange, rather than a drugged escape from misery, and to the tavern as a focal point for men's communities.

CALDERHEAD, William L., Professor, "He Who Rules the Rimland Rules the World" Naval Institute *Proceedings*, 117, (July 1991).

During World War II hundreds of convoys carried important war material to the fighting fronts around the world. Most of these movements of supplies were routine, but, one, that of convoy AS-4, was an exception.

It carried a vital cargo of 400 Sherman tanks from New York to Egypt where Montgomery's Eighth Army was facing Rommels' Africa Korps in the summer of 1942. Because the shorter Mediterranean route was blocked by German U-boats and German air power, the convoy was forced to make the 16,000 mile trip to Egypt by sailing around the top of South Africa and up the coast to the Red Sea.

Although pursued and attacked by U-boats for a good part of the way, the convoy got through. The tanks arrived just in time to play a critical role, as several British and American army historians have noted, in the victory at El Alamein.

CLARK, Michael G., Instructor, "The Date of IG II^2 1604," *The Annual of the British School in Athens*, **85** (1990), 47-67. [William Gladstone Memorial Essay Prize, 1990]

This essay restudied an ancient Athenian inscription that records an inventory of ships and naval equipment. Earlier publications of this stone had mistakenly dated the inscription. Through a thorough investigation of the whole series of ancient Athenian naval inventories, the author was able to redate the inscription. With this new date he was then able to throw light on an obscure period of Greek history, the period of the so-called King's Peace. In addition, the article examined a number of ancient peace treaties in order to establish what were the standard terms in this period. It also investigated Athenian legal and administrative procedure. The author studied the institution known as the trierarchy and also offered a possible interpretation of an entirely different series of inscriptions, whose meaning is very obscure.

ELLENBERGER, Nancy W., Associate Professor, "The Transformation of London 'Society' at the End of Victoria's Reign: Evidence from the Court Presentation Records," *Albion*, **22** (Winter 1990), 633-653.

This article used the lists of the Lord Chamberlain of women presented at Queen Victoria's royal court functions to study changes in the composition of British high society during the nineteenth century. The records confirm what contemporary observers suspected: the number of women seeking introduction to the Queen, and hence status within the elite world of London high society, rose dramatically during the last quarter of the century. (The average number of yearly presentations nearly doubled in this time.) The composition of the drawing room participants changed markedly as well. An investigation of the social background of 300 of these women (one percent of the total) revealed a declining percentage of women from aristocratic and gentry classes, and their replacement by wives and daughters of professionals and, to a lesser degree, businessmen. The drawing room records thus provide concrete evidence of a dilution of the British elite from one based on traditional landed families to one in which wealth and personal achievement earned greater social rewards.

MASTERSON, Daniel M., Associate Professor, "The Changing Focus of *Aprismo*: Haya de la Torre, Alan García and the Anti-Imperialist Tradition in Peru," *Journal of Third World Studies*, **6**, 2 (Fall 1990), 89-116.

This article is based on research in State Department records, and documents in Peruvian archives, the FDR Library in Hyde Park, and the Luis Alberto Sanchez papers at Pennsylvania State University. Interviews with Haya de la Torre and R. Henry Norweb, the U.S. Ambassador to Peru (1941-1943) also were critically significant sources of information. The article examines the change in the anti-imperialist policy of Peru's leading political party, the *Alianza Popular Revolucionaria Americana* (APRA) party. The focus of the article is the APRA leadership's efforts to modify its harsh criticism of U.S. imperialism during World War II in order to gain Washington's support for the party's legalization in Peru. The change from APRA's anti-imperialism to anti-communism in the post war years and Alan Garcia Perez's return to anti-imperialist fundamentalism as APRA's first elected president (1985-1990) are also examined.

MASTERSON, Daniel M., Associate Professor, "Chile in World War II: A Bibliographical Essay," *Neue Forschungen zum Zweiten Weltkrieg*, ed. Jürgen Rohwer and Hildegard Muller. Kolenz, Germany: 1990, pp. 60-61.

This short review article, designed to introduce readers to the literature on Chile's involvement in World War II, places particular emphasis on Chile's efforts to remain neutral during the first years of World War because of fears of Japanese naval operation against its coastline. Sources are also cited relating to Axis espionage in Chile prior to 1943.

MASTERSON, Daniel M., Associate Professor, "La Armada de los Estados Unidos de América y el Perú, 1818-1920: Preludio a una Asociacion Amistosa," *Revista de Estudios Historico-Maritimos del Perú*, **8-9** (1987-1990), 127-136.

This article was presented in a preliminary form at the Institito de Estudios Historico-Maritimos de Peru on the occasion of the 70th anniversary of the establishment of the U.S. naval mission to Peru in June 1920. The article examines the course of U.S.-Peruvian naval relations from the first days of the Pacific Squadron's activities in Peruvian waters until the post World War I era.

MASTERSON, Daniel M., Associate Professor, co-author, "Peru and World War II: A Bibliographical Essay," *Neue Forschungen zum Zweiten Weltkrieg*, ed. Rowher and Muller. Kolenz, Germany: 1990, pp. 360-361.

This article was completed with the research assistance of Jorge Ortiz Sotelo. It reviews the literature on Peru's World War II experience, places particular emphasis on the ramifications of Peru's July 1941 border war with Ecuador, and also discusses the deportation of 1,400 Peruvian Japanese for internment in the U.S. as part of Peru's World War II security program.

PEELER, David P., Associate Professor, "Deconstructing American Photographs," *American Quarterly*, **42** (September 1990), 505-512.

This is a review article on two 1989 books on American photography, one by Maren Stange and the other by Alan Trachthtenberg. The essay places these two authors within a historiographic tradition that stretches back to Walter Benjamin, and which holds that photography is an art that does much more than make records of how things look ed. Like other created products, photographs can and do have layers of accreted meanings. The article goes on to criticize Stange and Trachtenberg for being at odds with the very tradition that they embrace: while claiming that photographs are interpretative works, both authors also lament photography's inability to give us anything such as an unmediated event.

SANDERS, J. Thomas, Assistant Professor, co-author, "Voices of Democracy: A Synthesis and an Interpretation," *Civic Arts Review*, **3** (Spring-Summer 1990), 36-40.

This article represents a summation and a commentary on the proceedings of the annual conference "Voices of Democracy," sponsored by the Center for International Studies of the University of Dayton in February 1990. The conference participants--noted scholars and public officials representing Asia, Europe, and North and South America--arrived at a remarkable consensus concerning the prospects for democratic developments in the near future. The authors, who helped plan and organize the conference, report that consensus, yet they caution that enduring socio-economic impediments, as well as the absence of a pre-existing democratic culture and the likelihood of ethnic conflict, still constitute significant hurdles to democratic progress in the world.

SWEETMAN, Jack, Associate Professor, *American Naval History: An Illustrated Chronology of the U.S. Navy and Marine Corps, 1775-Present*. Second edition. Annapolis: Naval Institute Press, 1991.

The first edition of this chronology of *American Naval History* appeared in 1984. The seven extraordinarily eventful intervening years have witnessed such notable events as the air strike on Libya (Operation El Dorado Canyon), the apprehension of the *Achille Lauro* hijackers, the Walker spy case, tanker escort in the Persian Gulf, the largest naval action fought by U.S. forces since World War II (Operation Praying Mantis), the *Iowa* turret disaster, intervention in Panama (Operation Just Cause), and, of course, Operations Desert Shield and Desert Storm. These and many other developments are included in the second edition of *American Naval History*, whose coverage extends to the return of the first ground troops from the Gulf War in March 1991. The text (exclusive of end-matter) has been expanded by forty-three pages, and a full-page map of the Persian Gulf region has been added. The four indexes and bibliography have also been updated.

SWEETMAN, Jack, Associate Professor, translator of Baron Burkard von Müllheim-Rechberg, *Battleship Bismarck: A Survivor's Story*. Second edition. Annapolis: Naval Institute Press, 1990.

When the battleship *Bismarck* put to sea on her first war cruise on 19 May 1941, Baron Burkard von Müllenheim-Rechberg was her fourth gunnery officer; her destruction nine days later left him her senior surviving officer. In the first edition of this book, published in 1980, Baron Müllenheim presented a strictly naval history of the *Bismarck*'s life and death, introducing his own recollections only to illuminate that theme. This revised edition, enlarged by some 60,000 words, includes important operational material that emerged following the appearance of the first edition--notably, the testimony of Herr Josef Statz, the only survivor from the fore part of the ship. Of more importance in the author's opinion, however, it expands the scope of the work by describing his agonizing dilemma as a professional officer who, rejecting Hitler and National Socialism, found himself the servant of a state he despised. It also relates his sometimes harrowing experiences as a prisoner-of-war in England and Canada.

SWEETMAN, Jack, Associate Professor, Series Editor, "Classics of Naval Literature."

This Naval Institute Press series is designed to provide useful new editions of classic works of naval history, biography, and fiction. In addition to the unabridged, original text, each work includes a substantial introduction and, when appropriate, notes by an authority in the field. Some editions also contain new illlustrations and maps. The following works have appeared during this reporting period:

Harold and Margaret Sprout, *The Rise of American Naval Power, 1776-1918.* Introduction by Kenneth J. Hagan and Charles Conrad Campbell. Annapolis: Naval Institute Press, 1990.

Southey, Robert, *The Life of Nelson.* Introduction and notes by Robert D. Madison. Annapolis Institute Press, 1990.

Childers, Erskine, *The Riddle of the Sands.* Introduction and notes by Eric J. Grove. Annapolis: Naval Institute Press, 1991.

SWEETMAN, Jack, Associate Professor, "Taranto: Baptism of Carrier Warfare," U.S. Naval Institute *Proceedings*, **11** (November 1990), 102-103.

Although subsequently overshadowed by the Japanese attack on Pearl Harbor on 7 December 1941, the first major carrier air strike in history was in fact made more than a year earlier, on the evening of 11-12 November 1940, by the British Mediterranean Fleet against the Italian Fleet base at Taranto. Like Pearl Harbor, the Taranto Raid achieved remarkable success. Twenty-one obsolete British Fairey Swordfish torpedo planes sank one battleship and put two others out of action for months, effectively halving the strength of the Italian Battle line. This anniversary article reviews the strategic context, planning, conduct, and consequences of the operation.

SWEETMAN, Jack, Associate Professor, "To Die Gallantly," U.S. Naval Institute *Proceedings*, **5** (May 1991), 20-21.

At the beginning of World War II, the weakness of German surface forces in comparison to those of the Royal Navy led Grand Admiral Erich Raeder, commander-in-chief of the *Kreigsmarine*, to write that they "can only show that they know how to die gallantly." Nevertheless, Raeder believed it would be possible to use his handful of heavy surface units to conduct cruiser warfare in the North Atlantic. Several reasonably successful sorties were made between 1939 and early 1941, and in May of the latter year Raeder dispatched Germany's newest battleship, the 53,000-ton *Bismarck*, to maintain the pressure. The ensuing destruction of this mighty vessel also signified the wreck of Raeder's surface strategy.

SYMONDS, Craig L., Professor, Introduction to *Jefferson Davis*, by Varina Davis. Baltimore: Nautical and Aviation Press, 1990.

This biography of Jefferson Davis by his wife was first published in 1890. For this Centennial re-print, the researcher provided a lengthy introduction.

VANDEMARK, Brian, Assistant Professor, *Into the Quagmire: Lyndon Johnson and the Escalation of the Vietnam War.* New York: Oxford University Press, 1991.

This volume is an analysis and interpretation of Johnson administration decision-making on Vietnam from November 1964 to July 1965, the months encompassing the dramatic escalation of American involvement in the Vietnam War. The researcher argues that U.S. policymakers confronted intense military, political, and bureaucratic pressures to widen the war. Unsettled by these pressures, policymakers reacted confusedly and defensively. Rational men, they struggled to control increasingly irrational forces. But their reaction only clouded their attention to basic assumptions and ultimate costs as the war rapidly spun out of control in the spring and summer of 1965.

Presentations

ABELS, Richard, Associate Professor, "King Alfred's Peace-Making Strategies with the Vikings," Ninth International Conference of the Charles Homer Haskins Society for Anglo-Saxon, Anglo-Norman, Angevin and Viking Studies, Houston, Texas, 9 November 1990.

APPLEBY, David F., Assistant Professor, "*Spiritibus immundis obsessa*: Possession and Exorcism in the Carolingian World," Twenty-sixth International Congress on Medieval Studies, Kalamazoo, Michigan, 9-12 May 1991.

ARTIGIANI, P. Robert, Professor, "Constituting the Global Order," First International Dialogue on Transition to Global Society, Geneva, Switzerland, 4 September 1990.

ARTIGIANI, P. Robert, Professor, "Contemporary Science and the Search for Social Justice," International Society of Systems Sciences, Portland, Oregon, 9 July 1990.

ARTIGIANI, P. Robert, Professor, "Social Change: Insights and Implications from Contemporary Science," Eighth International Congress on Cybernetics and Systems, New York, New York, 5 June 1990.

ARTIGIANI, P. Robert, Professor, "Image-Music-Pinball," *Foucault's Pendulum* Conference, Hamilton College, Clinton, New York, 1 April 1991.

ARTIGIANI, P. Robert, Professor, "Social Evolution," Santa Fe Institute, Santa Fe, New Mexico, 15 March 1991.

ARTIGIANI, P. Robert, Professor, "Language and Social Systems," Symbols and Information, University of Connecticut, Storrs, Connecticut, 7 October 1990.

ARTIGIANI, P. Robert, Professor, "Chaos Models and Societal Risk Analysis," Society for Risk Analysis, New Orleans, Louisiana, 18 October 1990.

ARTIGIANI, P. Robert, Professor, "Societies as Neural Networks," American Council for Mathematics Neural Networks Conference, George Mason University, Fairfax, Virginia, 19 May 1990.

BRENNAN, Thomas, Associate Professor, "Public and Private and la Police in the Old Regime," Annual Conference of Western Society for French History, Santa Barbara, California, 7 November 1990.

BRENNAN, Thomas, Associate Professor, "The Brokers of Burgundy: Policing the Early Modern Wine Trade," Annual Conference of the Society for French Historical Studies, Vancouver, Canada, 22 March 1991.

CALDERHEAD, William L., Professor, served as critic and commentator for a session on "Recent Research on Slavery," Social Science History Association, 20 October 1990.

CULHAM, Phyllis, Professor, "Gender and Negotiating Discourse: Mediated Autobiography and Female Mystics of Medieval Italy," Duquesne History Forum, Pittsburgh, Pennsylvania, 21 October 1990.

CULHAM, Phyllis, Professor, "Plutarch on the Siege of Syracuse: The Primacy of Science over Technology," International Plutarch Society, University of Genoa/Bocca di Magra, Italy, 23 April 1991.

CULHAM, Phyllis, Professor, "Fraud, Fakes, and Forgeries: The Limits of Roman 'Information Technology,'" Annual Meeting, Association of Ancient Historians, University of North Carolina, Chapel Hill, North Carolina, 18 May 1991.

CULHAM, Phyllis, Professor, "The Status of Women in the Principate," Conference on the Status of Women in Rome, Rutgers University, New Brunswick, New Jersey, 6 December 1990.

DECREDICO, Mary A., Associate Professor, "Aspects of the Confederate Homefront," Georgetown University Southern Society, Washington, DC, 19 February 1991.

DECREDICO, Mary A., Associate Professor, "Georgia's Entrepreneurs and Confederate Mobilization," Civil War Round Table, Montgomery County, Maryland, 11 October 1990.

JOHNSON, David E., Professor, "Stumbling Blocks to Peace: Security, Patriarchy, and Development," Interfaith Lecture Series, Amherst College, Amherst, Massachusetts, 14 November 1990.

JOHNSON, David E., Professor, "Should the Military Fight the War on Drugs?," Joint Services Conference on Professional Ethics (JSCOPE), National Defense University, Ft. McNair, Washington, DC, 10 January 1991.

JOHNSON, David E., Professor, "Justifying Pacifism," American Philosophical Association, Central Division Meetings, Chicago, Illinois, 25 April 1991.

MASTERSON, Daniel M., Associate Professor, "Soldiers in Search of a Mission: The Peruvian Armed Forces from Sanchez Cerro to Sendero Luminoso," Seminar on Andean Studies, George Washington University, Washington, DC, 22 March 1991.

MASTERSON, Daniel M., Associate Professor, "Issei and Nisei: Wartime Politics and the Peruvian Japanese, 1940-1945," Mid-Atlantic Council of Latin American Studies Annual Meeting, Shippensburg State University, Shippensburg, Pennysylvania, 19 April 1991.

SANDERS, J. Thomas, Assistant Professor, "Alexander Herzen Reconsidered," panel moderator and discussant, Annual Convention, American Association for Advancement of Slavic Studies (AAASS), Washington, DC, 18 October 1990.

SANDERS, J. Thomas, Assistant Professor, "Democracy and Human Rights in Eastern Europe and the Soviet Union," panel moderator and commentator, Annual Symposium on Democracy, University of Dayton, Dayton, Ohio, 24 February 1991.

SANDERS, J. Thomas, Assistant Professor, "Turmoil in the Soviet Union," Current Politics Series, St. John's College, Annapolis, Maryland, 18 April 1991.

SILLS, Chip, Assistant Professor, "Gnosticism as Heresy: From Classical Antiquity to the Present," Immanuel Episcopal Church, Chestertown, Maryland, February/March 1991.

SYMONDS, Craig L., Professor, "West Point and Frontier Warfare: Joseph E. Johnston and the Indian Wars," Twelfth Annual Meeting of the Society for Historians of the Early American Republic, Toronto, Canada, 2-4 August 1990.

SYMONDS, Craig L., Professor, "Joseph E. Johnston and Confederate Command in the West," USMC Command and Staff College, Quantico, Virginia, 31 August 1990.

SYMONDS, Craig L., Professor, "Maryland in the Civil War," St. Johns College, Annapolis, Maryland, 21 February 1991.

THOMPSON, Larry V., Professor, "Fanatics, Cynics, and Fellow Travelers: The Quest for an SS Typology," *Sprachabend*, German Historical Institute, Washington, DC, 17 April 1991.

TUCKER, Ernest S., "A Historiographical Analysis of Two Afsharid Chronicles," Middle East Studies Association Annual Meeting, San Antonio, Texas, 11 November 1990.

Division of Mathematics and Science

DEPARTMENT OF

Chemistry

Professor Mark L. Elert
Chair

The physical facilities for research in the Chemistry Department have improved this year with the completion of a new Instruments Laboratory and the acquisition of a research-grade gas chromatograph/mass spectrometer (GS/MS) and an x-ray diffractometer for determination of molecular structures. The department has a wide range of state-of-the-art instrumentation which allows the faculty to be competitive in research in all of the traditional branches of chemistry.

More than half of the twenty-five civilian faculty members in the Chemistry Department are assistant professors. These young and energetic individuals have initiated research programs which are increasingly productive, and which complement and broaden the research interests of the more senior faculty. Student interest and involvement in research have increased correspondingly, as evidenced by the three Trident Scholars who completed projects in the department this year. Two more Trident Scholars in chemistry have been selected for next year, and several other student research projects are planned or underway.

The Chemistry Department has a long tradition of collaborative research efforts with Navy laboratories and other private and government institutions. This year collaborative projects are underway with the Naval Research Laboratory, the David Taylor Research Center, the National Institutes of Health, the Armed Forces Radiobiological Research Institute, and AT&T Bell Laboratories. Other faculty members have obtained external grant support from the National Science Foundation, the Petroleum Research Fund, and the Dreyfus Foundation. In addition, Professor Edward Koubek has completed a very productive sabbatical leave at Canterbury University in Christchurch, New Zealand.

Research interests of the faculty range from fundamental studies of molecular structure and dynamics to practical investigations of chemical problems in forensics, corrosion, and hazardous material handling. This wide range of research activity helps to strengthen and invigorate the chemistry curriculum of the Naval Academy, preparing our graduates for the technical challenges they will encounter in the Fleet.

Sponsored Research

Measurement of H/D Uptake Characteristics Using a Quartz Crystal Microbalance

Researcher: Associate Professor Graham T. Cheek
Sponsor: Naval Research Laboratory (Code 6170)

Measurements of hydrogen and deuterium loading into palladium films have been carried out by observations of frequency shifts at both AT- and BT-cut quartz crystals during the loading process. These results allow frequency shifts due to film stressing to be distinguished from those caused by mass increases as H (D) enters the film. Using this "double resonator" technique, values for both film stresses and H(D) content have been determined. A particularly interesting finding has been that, in mixtures of H_2O and D_2O, the loading process is dominated by entry of H into the film, becoming completely dominant at only 10% H_2O content. This observation has been explained by the fact that the greater ease of reduction of H_2O compared to D_2O is magnified by the relatively low current levels used in this work.

Studies of Reactive Molecular Fragments by Matrix-Isolation Spectroscopy

Researcher: Assistant Professor Robert F. Ferrante
Sponsor: Naval Academy Research Council (ONR)

The purpose of this project is to prepare, identify, and spectroscopically characterize highly reactive chemical intermediates using the matrix-isolation technique. This part of the study has focused on the radical acetylnitrene, CH_3CON, one of the simplest carbonylnitrenes. Early mechanistic proposals regarding the well-known Curtius rearrangement centered on the carbonylnitrenes (R-CON). However, there was little chemical evidence, and virtually no spectroscopic proof of the existence of these species.

In this study, evidence for the trapping of acetylnitrene has been obtained. These features were produced when the parent acetyl azide was subjected to metastable energy transfer (MET) fragmentation by interaction with excited N_2 produced in a microwave discharge. This MET method has been shown to favor production of triplet state nitrenes in related azide systems. New signals attributable to CH_3CON include a weak ESR line near 8200 G, characteristic of a triplet molecule with D = 1.6 cm^{-1}, and IR bands near 1770, 1380, and 1350 cm^{-1} associated with C=O, CH_3, and C-N vibrations. Isotopic substitution with ^2H has confirmed some of these assignments. Some *ab initio* calculations also support the assignments. None of these signals can be produced by direct photolysis of the parent, which causes quantitative conversion to methyl isocyanate, CH_3NCO.

These observations provide strong evidence that acetylnitrene has been isolated for the first time. They also provide very interesting experimental verification, based on shifts in vibrational frequencies, for a surprisingly extensive electronic redistribution predicted earlier by theoretical calculations on the nitrene and its stable analog acetamide, CH_3CONH_2. Conclusion of this research will involve further isotopic substitution to enable a full normal mode vibrational analysis, and possibly some experiments with different matrix media or MET agents.

Tetraazaporphyrins: Synthesis, X-ray Crystal Structure, and Unexpected Electronic Structure

Researcher: Assistant Professor Jeffrey P. Fitzgerald
Sponsor: Petroleum Research Fund

Tetraazaporphyrins, due to their low solubility and difficult synthesis, are virtually unstudied compared to the structurally similar and biologically important porphyrins. Efforts over the past year have focused on improving synthetic routes to tetraazaporphyrins and comparing these substances to related macrocycles.

Gram quantities of soluble, octasubstituted tetraazaporphyrins have been prepared in 10 to 15% overall yield by modification of a published route. Previously, tetraazaporphyrins were produced by cyclocondensations of fumaronitrile derivatives. The yield of this transformation can be increased five fold if the fumaronitrile is first photoisomerized to the maleonitrile, which is subsequently cyclized into the tetraazaporphyrin. Once formed, the macrocycles may be substituted with any of a variety of metals.

Iron(III) octaethyltetraazaporphyrin chloride has been characterized by X-ray diffraction, the first tetraazaporphyrin to be so characterized. The tetraazaporphyrin "hole" (the gap between transannular nitrogens in which the metal fits) is 0.34 A smaller than the "hole" in comparable porphyrins. In spite of the smaller "hole" size, the iron atom is displaced less from the macrocycle plane in the tetraazaporphyrin complex than it is in the porphyrin analog.

Large displacements of iron from the plane of a porphyrin are observed for high spin complexes in which the antibonding $d_{x}2_{-y}2$ orbital is partially occupied. The structure described above suggests that the smaller "hole" size of the tetraazaporphyrin raises the energy of the $d_{x}2_{-y}2$ orbital such that it is unoccupied, thus allowing the iron atom to drop closer into the macrocycle core. Magnetic susceptibility measurements have confirmed the intermediate spin state of iron in Fe(III) octaethyltetraazaporphyrin chloride.

Electrochemical studies have shown a cathodic shift of over 400 mv in the Fe(III/II) couple of iron octaethyltetraazaporphyrin bis-pyridine versus the analogous octaethylporphyrin complex. This suggests that the tetraazaporphyrin macrocycle lowers the energy of the macrocyclic pi orbitals and increases backbonding from the metal.

The stability and activity of metallotetraazaporphyrins as homogeneous oxygen atom transfer catalysts and as electrocatalysts are being explored.

Computer Program Implementation of Hazardous Materials Used by the Navy

Researcher: Associate Professor Frank J. Gomba
Sponsor: David Taylor Research Center, Annapolis Laboratory

Using a Hazardous Material Inventory System Program on CD ROM supplied by DoD, Hazardous Material Worksheets are being developed for all hazardous material used by the U.S. Navy, with specific coding for easy retrieval of information as to health hazards and handling of such material.

High Pressure and Low Temperature Electrical Properties of Beta Alumina and Beta" Alumina: Synthesis and Characterization of New Materials

Researchers: Assistant Professor Joseph F. Lomax and
Associate Professor Mary Wintersgill (Physics)
Sponsor: National Science Foundation

β- and β"-aluminas have a number of interesting properties, many of which arise because of the ability of these materials to incorporate a very large variety of ions into their structure. The incorporation of +1 ions is common in these materials, and their ion conductivity has been widely measured. However, +2 ions are less commonly incorporated into solid state ionic materials, and +3 ions have only been incorporated into β"-alumina. The limits to the charge of ions that can be incorporated into these materials are being explored in this project. Preliminary work has demonstrated the ease by which +4 ions of titanium, vanadium, and hafnium can be incorporated. The incorporation of even more highly charged ions such as Mo^{+5} and Os^{+8} will be attempted. The mechanism for ion movement and the preferred positions for the exchanged ions in the material will be investigated by dielectric measurements at low temperature.

Molecular Orbital Studies of Conjugation in Aromatic Hydrocarbons

Researcher: Assistant Professor Wayne H. Pearson
Sponsor: Naval Academy Research Council (ONR)

Current work is an extension of work started by Midshipman 1/C James Barney, Class of 1990. The study of conjugation effects in nitrobenzenes is being extended to include para-substituted anilines. Preliminary calculations are consistent with the previous findings for para-substituted nitrobenzenes and benzoates. The amino functional group appears to participate with the benzene ring via pi bonding. However, the amino group is a strong electron donor, while the nitro group is a strong electron withdrawing group. The trends for the anilines show a dependence on the parasubstituted group, which is approximately the same magnitude as the nitrobenzenes but of opposite sign.

In collaboration with workers at the University of Missouri, x-ray crystal structures have been performed on a variety of parasubstituted nitrobenzenes. A wide range of torsion angles has been found for the various para substituents. Molecular orbital calculations are being performed in order to correlate the observed structural changes with the degree of pi bonding in these compounds.

Plebe Chemistry Laboratory Data Programs and Plebe Spreadsheet Instruction Materials

Researcher: Professor John W. Schultz
Sponsor: Naval Academy Instructional Development
Advisory Committee

The laboratory experiments in plebe chemistry commonly involve recording data and performing calculations based on the data. The Plebe Chemistry Laboratory Data Programs permit midshipmen to have the correctness of their calculations checked before submission of lab reports for grades. Chemistry Laboratory Data Programs were written for a new kinetics experiment (Experiment 13C) which was introduced during the chemistry summer school program. In addition, the programs for the gas laws experiment (Experiment 8) were completely overhauled. In both cases, it was assumed that the calculations would be done on a spreadsheet; references to this fact are included in the programs. The programs for three other experiments were updated and improved.

The first laboratory experiment performed by the

midshipmen (currently labeled as Experiment 1C) was completely rewritten. The philosophy taken was that there would be no alternative to using spreadsheets for completing the report for the experiment. The experiment requires that the midshipmen collect data during a laboratory period for three short experiments. Each midshipman is required to perform the necessary calculations and graphing by way of a spreadsheet. In support of Experiment 1C, a tutorial handout was written, covering most of the spreadsheet functionality needed for all of the plebe chemistry laboratory experiments. An effort was made to write the tutorial in such a way that the least proficient or most computerphobic midshipman would not be turned off or discouraged. Both the experiment and tutorial were used by the Class of 1994 midshipmen.

Chemical Generation of Organometallic Radicals

Researcher: Associate Professor Joyce E. Shade
Sponsor: Naval Academy Research Council (OMN)

This project involved the formation of radicals of the type $CpM(CO)_2$ where M = Fe and Ru is known to be one of the pathways of the photolysis of the corresponding dimers, $[CpM(CO)_2]_2$, where Cp = C_5H_5. The investigation of the clean formation of the analogous mono or diphosphine or phosphite radical species from the corresponding phosphine or phosphite-substituted dimers has been limited due to the lack of easy availability of the required dimeric species. Research in this project has established that the desired radicals of the form $CpM(CO)(PR_3)$ and $CpM(PR_3)_2$ can be generated from the corresponding bromide, chloride, or hydride complexes under thermal reaction conditions. When the cyclopentadienyl metal halide complexes were reacted in stoichiometric amounts with radical reducing agents such as $HSnBu_3$ or AIBN, the desired 17-electron species are obtained in quantitative yield. Reaction progress is easily followed using high-pressure liquid chromatography and infrared (IR) spectroscopy. Product identities were confirmed spectroscopically using IR and Nuclear Magnetic Resonance (NMR) spectroscopy.

On the Diffusional Encounters of Macromolecules with Cell Surfaces

Researcher: Associate Professor Boyd A. Waite
Sponsor: Naval Academy Research Council (ONR)

Signaling of cells by macromolecular messengers is a subject of paramount importance for elucidation of many biological phenomena. Immune cell activation via interaction of antigen with T cell receptors, subsequent intercellular communication within the immune network via interaction of various cytokines with their receptors on cell surfaces, and hormonal stimulation of cells via interaction with their cell surface receptors are just a few of the widely studied systems which involve this type of molecule-cell surface receptor interaction.

The purpose of this study is to continue the development of a probabilistic approach (i.e., a Monte Carlo method) which models the dynamical encounter of ligand macromolecules with membrane-bound receptors. Detailed probability distribution functions have been derived for describing the temporal/spatial nature of the encounter (and subsequent re-encounter) process involved in diffusional interactions. In addition, a graphical 'dynamical' representation was developed using a high-speed graphics workstation. These animated simulations were found to give guidance to the study, in that certain unusual features of the encounter process were evident visually in 'real time' which were not discernible simply through numerical output.

Dinuclear Reductive Elimination of Transition Metal Alkyl or Acyl Complexes with Transition Metal Hydride Complexes

Research: Lieutenant Keith E. Warner, USNR
Sponsor: Naval Academy Research Council (OMN)

The purpose of this research is to probe the details and expand the scope of the dinuclear reductive elimination reaction of transition metal alkyl carbonyl complexes. Presently, the objective is to determine the factors that give rise to different types of organic products (alkane or aldehyde) from these complexes. It is important to examine these factors independently of the pathway(s) that generate a vacant site on the alkyl carbonyl complex. Thus the direct reaction of the metal hydride with the transition metal containing the organic fragment can be investigated.

Initial efforts have been directed at the synthesis of coordinatively unsaturated alkyl and acyl complexes of osmium. When heated in CH_3CN, $Et_2Os(CO)_4$ forms isomers of the type: $Et(EtCO)Os(CO)_3s$, where s = CH_3CN. Unfortunately, ^1H NMR patterns are complex, and unambiguous identification of the species in solution was not possible. Furthermore, it was not possible to isolate these species. However, heating $R(Cl)Os(CO)_4$ complexes in CH_3CN (where R = ME, Et) has led to spectroscopically observable solvated complexes. Since these complexes are solvates, they have proven too unstable to isolate. However, they can be cleanly and reproducibly generated in solution. Furthermore, the solvate, $Me(Cl)Os(CO)_3s$, has been produced from the reaction of $ONMe_3$ with $Me(Cl)Os(CO)_4$ in CH_3CN solution.

Now that coordinatively unsaturated osmium complexes are available, kinetic investigations of the reaction of these complexes with metal hydrides can be undertaken. Further work is in progress including (1) utilization of $ONMe_3$ to generate other solvates such as η^5-CpRe(CO)(R)(COR)(s) for study with metal hydrides, and (2) extension of the dinuclear elimination reaction to transition metal carbene complexes.

Metalloporphyrins as Model Compounds for Cytochrome P-450

Researcher: Midshipman 1/C David L. Blazes, USN
Adviser: Assistant Professor Jeffrey P. Fitzgerald
Sponsor: Trident Scholar Program

The purpose of this project is to understand the role of the unusual thiolate ligand found in the Cytochrome P-450 enzyme family. The RS^- ligand is unusual, in that it is found only in the P-450 heme enzymes; most other hemoproteins are ligated by nitrogen or oxygen atom donors. The P-450 enzymes are also the only hemoproteins capable of using molecular oxygen directly to oxidize unactivated substrates such as alkanes. The connection between the thiolate ligand and the unusual catalytic properties of these enzymes remains unclear.

This investigation involved the preparation and study of a homologous series of model compounds, synthetic rhodium porphyrins coordinated by a variety of axial ligands such as thiolate, phosphine, carboxylate, imidazole, and chloride. Three proposed roles of the thiolate ligand were examined by comparing the complex containing coordinated thiolate with the other members in the series under different experimental conditions.

Results to date indicate that all the rhodium porphyrins in this series catalyze "P-450-like" shunt oxygenations. However, the thiolate ligand plays no role in either formation of the active oxidant (an iron(V) oxo complex) or in mediating oxygen-atom transfer from the iron oxo complex to the substrate. In addition, evidence was gathered which indicates that the thiolate ligand destabilizes the iron oxo intermediate. This is the exact reverse of one of the proposed roles for the thiolate ligand.

The relevance of this model study to the natural enzyme and its implications for industrial oxygenations continue to be explored.

A Fractal Computer Model of Macromolecule-Cell Surface Interactions

Researcher: Midshipman 1/C Jeffrey S. Dodge, USN
Adviser: Associate Professor Boyd A. Waite
Sponsor: Trident Scholar Program

Experiments show that cross-linking is required in order to activate immune cells, although the exact mechanism for this process and the characteristics of the cluster formed are unknown. This study created a computer model of the interactions between a large molecule with several binding sites and receptors on cell surfaces. The model was designed to provide insight into the molecular interactions, as well as information on the configurations of bound macromolecules. The model was based on the "Monte Carlo" method, and involved extensive use of graphics visual computation. This provided great flexibility by allowing visual inspection of each complex encounter, thus guiding the investigator as to which characteristics should be numerically evaluated and analyzed. Findings indicate that such macromolecular encounters maximize entropy by first binding to the end sites of the macromolecule. Gradually, subsequent neighboring binding sites attach to receptors, until finally a rapid completion of the binding process occurs. Fractal dimensions of resulting clusters were calculated at various stages during the binding process. During initial phases of macromolecular binding, the clusters form tight and compact arrangements. However, as time elapses, the clusters of receptors elongate, losing their tightness. Though the effects of this on the biochemical role of the receptor cluster are not yet known, it does provide a starting point for further investigation, both experimentally and theoretically.

Independent Research

The Photochemistry of Diethyl Methylphosphonothioate (DEMPS)

Researcher: Assistant Professor Mark L. Campbell

Work is presently being conducted to determine the viability of the photofragmentation/laser-induced fluorescence (LIF) scheme for detection of chemical agents. Experiments were performed to study the photodissociation products of the chemical agent simulant DEMPS. When DEMPS is subjected to focused ArF laser radiation, one of the photodissociation products is the PO radical. Luminescence from excited states of the PO radical has been observed with a Diode Array Rapid Scan Spectrometer (DARSS). Detection of the ground state products using LIF is planned. It is also anticipated that photodissociation of DEMPS may result in the PS radical. Future experiments will encompass the spectroscopy and reactions of the PS radical, which may appear in the laser photofragmentation of molecules like the persistent nerve agent VX.

This work was carried out in collaboration with the Chemical Research Development and Engineering Center, Edgewater, Maryland.

Electrochemical Reduction of Aromatic Ketones in a Room-Temperature Molten Salt System

Researcher: Associate Professor Graham T. Cheek

This work is a continuation of previous studies in the aluminum chloride : 1-methyl-3-enthylimidazolium chloride molten salt, a system which is characterized by a wide range of acid/base properties as well as a wide potential span. In the fluorenone system, a one-electron reduction in the basic melt gives rise to an anion radical which couples very quickly to form the pinacol product. In the acidic melt, complexation by aluminum chloride causes a positive shift of the reduction process and a much slower coupling of the anion radicals. It has also been found that the pinacol product formed in the acidic melt can exist in two conformations, one of which is unstable and rapidly forms products derived by loss of oxygen from the pinacol.

Rational Reaction Pathways of Inorganic Functional Groups

Researcher: Assistant Professor Michael R. Duttera

Inorganic functional groups as analogs to organic functional groups are investigated, employing the analogy for rational synthesis of target mixed-metal-cluster catalysts useful for bifunctional activation of polar small molecules. Initial studies are focused on model reactions of $L_xMo{\equiv}MoL_x$ (A) complexes with $Cp_2Ti(PR_3)_2$ (B) in an attempt to couple the dimolybdenum complexes in a fashion similar to what is achieved with compound (B) in the synthesis of polyacetylene. Initial studies suggest steric concerns. Further work is in progress with the Zr analog of (B) and compounds like (A) having less bulky L groups. Methods used involve extensive high-vacuum-line/Schlenk air-sensitive synthetic techniques and instrumental analysis using multinuclear NMR, IR, mass spec., UV-Vis, and GC.

Optical Methods in the Characterization of Interfaces

Researcher: Assistant Professor Robert F. Ferrante

The purpose of this project was to investigate the electrical, optical, and structural properties of Er-doped crystalline silicon, with the ultimate objective of employing this information for electronic devices. This segment focused on the correlation of infrared emission intensity with the identity and concentration of sample components, and the effect of various heat treatments on the optical signal.

Several different types of silicon wafer samples were exposed to high energy beams of Er ions at various dosages for implantation of the active emitter. Many samples were also co-implanted with one (or more) other elements; a total of ten elements, in addition to Er, were examined. Samples were annealed by four different heat-treatment regimens.

Ar^+ laser-excited photoluminescent emission near 1.5 microns was monitored for all samples at 4.2 K. Samples with particularly strong or well-defined emission spectra were further cooled to 1.2 K for high resolution studies, or were examined at 77 K and room temperature. Numerous other analytical tools were also employed, including characterization of electrical behavior by deep-level transient spectroscopy, and examination of microstructure by electron microscopy and Rutherford backscattering.

The results of this study indicated: (1) There is some optimum concentration for the implanted Er; (2) even at the optimum Er concentration, emission intensity could be dramatically enhanced by the presence of other ions co-implanted with the active emitter; (3) luminescence from some strongly-emitting samples could be detected up to room temperature--this represents the first observation of room-temperature emission from Er-doped Si; and (4) sample heat treatment after implantation has a strong effect on the optical behavior of the crystal. This research was sponsored by AT&T Bell Laboratories.

Synthesis of Nitrogen-15 Labelled Radioprotectants

Researcher: Assistant Professor Debra K. Heckendorn

Radioprotectant agents have been known since the late 1960's. Several of the compounds have been developed for military use, and one is in clinical trials for use in chemotherapy. Development of more effective agents has been hampered by the lack of a model for the mechanism of radioprotection in the body. One theory for the mode of protection suggests that these molecules hydrogen-bond to the DNA itself. An alternative theory states that radioprotection is due to the degree of supercoiling of the DNA and that the agents interact with the protein which is responsible for controlling DNA supercoiling.

To investigate these two theories, a study is underway into the preparation of nitrogen-15 labelled compounds. A series of compounds, both known radioprotectants and compounds known to have no protecting ability, is being synthesized. Once prepared, these compounds will be examined by high-field NMR spectroscopy to determine their solution conformations, their interactions with proteins, and their interactions with DNA fragments. To date, three of the desired compounds have been prepared, and their NMR properties are being investigated. This project was sponsored by the Armed Forces Radiobiological Research Institute.

Measurement of the Rate of Hydrogen Exchange on the Anticancer Compound, Cis-diamminedichloro Pt(II)*

Researcher: Professor Edward Koubek

The rate of proton exchange of the ammine protons on cis-platinum may be of importance in understanding the mechanism of action of this powerful anticancer drug. (Cis-Platinum has often been called the most effective anticancer compound known--leading to a 85-90% cure rate for certain types of cancers.) Proton exchange rates for metal coordinated ammines have been measured previously, usually by NMR. However, due to the extremely low solubility of cis-platinum, this and other techniques previously used could not be employed. Therefore, it was decided to try an IR method utilizing the newly reported fact that cis-platinum forms an insoluble adduct with Hg^{2+}. This enabled us to study the rate of proton exchange of cis-platinum in D_2O by quenching the exchange reaction with acid, adding Hg^{2+} and measuring the amount of N-D in the resulting precipitate. By using FTIR, excellent results were obtained even though extremely small samples were used (~2 mg). By carrying out the exchange reactions at various pH's and temperatures, a rate law and the activation parameters were determined. Two other related compounds were also investigated.

This project was supported by the University of Canterbury, Christchurch, New Zealand and the U.S. Naval Academy.

Study of Photoenolization in Indoles

Researcher: Assistant Professor William T. Lavell

The investigation of photoenolization in substituted indoles is the major focus of this research project. The initial impetus for this work was the possibility of developing a synthesis to the ellipticine and olivacine alkaloids.

The immediate goal was to prepare a variety of 2-methyl-3-acylindoles, with hydrogen and methyl at the N1 position. The photoenolization of six indoles (N1 substituent = hydrogen or methyl, C2 substituent = methyl, C3 substituent = formyl, acetyl and benzoyl) was studied in a variety of solvent systems; solutions were irradiated and monitored by proton NMR spectroscopy. For the six indoles studied, no photoenolization was observed. This is a function of the heterocyclic ring system, as photoenolization of similarly substituted carbocycles is a known process.

Further work to be pursued should include investigating (1) the 2-ethyl-3-acylindoles, (2) the N1-benzenesulfonyl substituted indoles, and (3) the isomeric 3-alkyl-2-acylindoles.

Synthesis of Dipolar Rigid-Rod Organic Molecules for Nonlinear Optical Studies

Researcher: Assistant Professor William T. Lavell

The goal of this project is to prepare dipolar organic materials for nonlinear optical studies. The synthesis of two broad classes of molecules is under investigation.

The first class of molecules consists of fully conjugated polymers based on repeating polar, heterocyclic monomers linked either by alkene or alkyne fragments, or by direct linking of the heterocyclic rings. As one example, the synthesis of 2-methyl-5-formylpyridine is underway, with the expectation that an intermolecular aldol reaction would give rise to alkene linked pyridine polymer with the pyridine dipole moments aligned in additive fashion. As additional examples, the synthesis of 2-bromo-5-ethynylpyridine and 2-bromo-5-ethynylpyrimidine is also planned.

The second class of molecules comprises polymers not fully conjugated. An example of this type of material is the polymeric imine which would arise from condensation of N-(4-formylphenyl)-4-aminopiperidine; the synthesis of this monomer is proposed from N-phenyl-4-piperidone.

This project was sponsored by AT&T Bell Laboratories of Murray Hill, New Jersey.

Photochemical Study of Cyano-Isocyanide-Phosphine Complexes of Iron and Ruthenium

Researcher: Associate Professor Joyce E. Shade

The chemistry of carbonyl-cyano-phosphine complexes of iron has been studied extensively for the last ten years. In general, reflux or photolytic reaction conditions have been employed to initiate the loss of a carbonyl (CO) group from cyclopentadienyl-iron-carbonyl starting materials with a subsequent inclusion of a phosphine or phosphite ligand on the metal center. The resulting complexes obtained in these studies, however, all contain at least one carbonyl group. The purpose of this research was to prepare a series of anionic, neutral and cationic cyano, mono- and bisisocyanide complexes for reaction with phosphine or phosphite groups under photolytic conditions.

Photolysis of the monoisocyanide complex, $(C_5H_5)Fe(CO)(CN)(CNCH_3)$, in the presence of a slight excess of triphenylphosphine at room temperature gave the desired product $[(C_5H_5)Fe(CN)(CNCH_3(PPh_3)]$ with loss of one equivalent of carbon monoxide. Two additional products have been obtained, however: $(\eta^5\text{-}C_5H_5)Fe(CNCH_3)_2(CN)$ and $(\eta^5\text{-}C_5H_5)Fe(CN)(PPh_3)_2$. Similar results were obtained with a variety of phosphine, phosphite, arsine, and antimony ligands. Several of the reaction products have been isolated from the fairly clean reaction mixtures, and a variety of spectral data have been obtained to verify their identity. Further purification and characterization of these compounds is continuing.

In addition, trends of reaction product yields with bulk and basicity of ligand are being studied. Effect of ligand identity (both on the metal prior to photolysis and as an incoming group), wavelength of the photolysis lamp, and temperature of the reaction mixture are being studied as they affect the reaction products obtained. Anionic and cationic starting materials are being investigated under a variety of reaction conditions in order to analyze the system for any trend which might develop as a function of complex charge.

A collaborative effort was established with Professor Antony Rest at The University in Southampton in an effort to establish conclusively the identity of the reaction intermediate(s). The results of this work have been very promising, and the identity of the reaction intermediate has been postulated, as a result of low-temperature matrix isolation studies conducted by Professor Rest. Work on the project is continuing with a shift in focus to the analogous ruthenium species.

NMR Order Parameters in Uniaxial Systems for the Carbon-Carbon Bonds of Alkyl Chains

Researcher: Assistant Professor Ronald E. Siatkowski

For an alkyl chain in a uniaxial system, the order parameter tensor for every methylene unit can be determined by analysis of a sufficiently large set of order parameters such as is provided by nuclear magnetic resonance spectroscopy. Assuming that the methylene group has a time averaged plane of symmetry, the researcher shows that the complete set of input data required to specify the tensors consists of (a) a set of order parameters of HH and CH internuclear vectors, and (b) the order parameter for only one CC bond of the chain. The order parameter of the CC bond vector propagates according to a sum rule. Thus, for the nematic phase of 4-n-octyl-4'-cyano-biphenyl (8CB), the order parameter for the C_3 axis of the methyl group predicts, in agreement with experiment, the order parameter for the long axis of the biphenyl ring system. The principal values and principal axes of the order parameter tensor for every rigid sub-unit of 8CB in its nematic phase are now known.

Research Course Projects

Synthesis of Highly-Branched Carboxylic Acids: Models to Probe Micelle Structures

Researcher: Midshipman 2/C Tony S. Clinton, USN
Adviser: Assistant Professor Debra K. Heckendorn

When surfactants, which are long hydrocarbon chains with an ionic functional group on one end, are placed in water, the surfactants come together to form groups called micelles in order to place the hydrocarbon chains away from water and near each other. The exact structure has not been determined, although three models have been proposed: the porous radial model, the coiled radial model and the parallel-correlated model. The purpose of this study, sponsored by Exxon Research and Engineering, is to determine which of these three models is closest to the actual micelle structure.

According to theory, if a highly linear surfactant is substituted with gem-dimethyl groups such that the molecule is sterically bulky near the ionic end, the micelle structure should be more stable. On the other hand, if the molecule is bulky near the hydrocarbon end, then the micelle should be destabilized. To prove this theory, three similar dodecanoic acids will be needed.

The first goal of this project was the introduction of the gem-dimethyl regiospecifically into a dodecanoic acid. A flexible procedure applicable to all desired materials was developed based upon a cuprate addition, followed by a Wittig reaction and thiophenol addition to the Wittig product. This procedure was very general and was applied to prepare precursors for all three desired surfactants.

Preparation of dodecanoic acids from these precursors varies slightly, depending upon the exact dodecanoic acid desired. Lithiation of the appropriate thiophenol addition product, followed by trapping with carbon dioxide lead to one of the desired surfactants. For the other two, a protocol was developed on a model system. This protocol involves trapping the lithiation product with an aldehyde. Subsequent reduction of the alcohol formed gave a precursor suitable for conversion into a carboxylic acid. This protocol must now be applied to the remaining two surfactant substrates.

Synthesis and Characterization of 17-electron Organometallic Complexes

Researcher: Midshipman 1/C Julie A. Hansen, USN
Adviser: Associate Professor Joyce E. Shade

Photolysis of the dinuclear iron complexes, $[CpFe(CO)]_2$-u-DPPM and DPPE, where DPPM and DPPE are $(Ph_2P)_2CH_2$ and $(Ph_2P)_2C_2H_4$, respectively, has been conducted in chloroform using infrared light. In contrast to the simple iron carbonyl dimer $[CpFe(CO)_2]_2$ which forms $CpFe(CO)_2Cl$ under photolytic reaction conditions, the phosphine-containing materials yield a golden dimeric product which contains the phosphine substituent intact as a bimetallic bridge and yet contains no chloride substituents. In addition, formation of a formyl substituent on one of the previously symmetrical cyclopentadienyl rings has been confirmed spectroscopically. The proposed mechanism for the formation of such a complex appears to involve a radical intermediate and follows a modified Reimer-Tiemann reaction. Such a pathway is believed to be unprecedented in the photochemistry of bimetallic complexes.

Synthesis of Substituted Cyclopentanes: Preparation of a Key Intermediate

Researcher: Midshipman 1/C Marco A. Juarez, USN
Adviser: Assistant Professor Debra K. Heckendorn

Dolabellane diterpenes, a class of compounds isolated from marine organisms, is synthetically interesting and challenging. Synthesis of these compounds involves the formation of an eleven-membered ring fused to a five-membered ring. Much of the work involved in synthesizing the dolabellanes lies in production of the precursors that lead to them. One desired precursor is an oxabicyclo[3.3.0]octane system which will be converted to the cyclopentane portion of the dolabellanes. A productive reaction scheme must be developed to synthesize the bicyclic precursor. Additionally, the stereocenters on the ring must be considered in further reactions to insure that the proper cyclopentane rings are produced. Controlling the substitution of the cyclopentane precursor is the key to determining which dolabellane diterpene will be formed.

Two routes to the bicyclic precursor were investigated to determine which would be most applicable. The initial route used a cyclization of an epoxide to form the bicyclic system. The epoxide was synthesized very efficiently in two steps from ethyl acetoacetate; this procedure was applicable to a series of derivatives. Attempts to cyclize these epoxides led to unexpected results. The constraints of cyclization were investigated using computer-assisted molecular modelling techniques; several unusual geometric constraints of these systems were discovered.

A more successful route to the desired compounds was then developed. This route uses a Dieckman cyclization of a lactone precursor. The lactone was prepared by a Diels-Alder reaction, reduction/addition, and ozonolysis procedure. This three-step procedure was high yielding and effective in producing several lactones. These lactones were then successfully converted to the desired oxabicyclo[3.3.0]octane systems.

Initial studies on addition of nucleophiles to the bicyclic structure have given useful information that will direct future studies. The bicyclic system has been successfully deprotonated, and conditions for alkylation are under investigation. Investigating the effects of a large array of reagents on the bicyclic ring may elucidate other pathways to explore. Examining the effects of the functional groups around the ring would also be interesting. Once such studies have been completed, these bicyclic systems will be used to prepare substituted cyclopentane rings, including dolabellane diterpene intermediates.

Defects in Oxide Materials

Researchers: Midshipmen 1/C Anthony J. Lesperance
and Todd A. Jones, USN
Adviser: Assistant Professor Joseph F. Lomax

Solid ion conductors are of industrial importance as solid state separators for batteries. One of the best of these materials is β"-alumina. The parent material has a layer of aluminum oxides separated by an array of oxide pillars. This makes a spacious hall where the charge compensating sodium ions can move about freely. The robust nature of this hall is illustrated by the fact that many different ions can be exchanged for the sodium, including +2 and +3 ions. The object of this research was to see if the limitation of ion insertion and movement could be pushed even further. A new class of compound was synthesized and characterized that had exchanged the sodium ions in β"-alumina with Ti^{+4}, V^{+4}, and Hf^{+4}. Not only are these compounds new, but the solid state ion exchange with +4 ions is unprecedented.

New Methods for the Analysis of Sulfur in Coal

Researcher: Midshipman 1/C Alexander E. Stewart, USN
Advisers: Professor Edward Koubek and
Associate Professor Graham T. Cheek

Two new methods for the determination of sulfur in coal were investigated. Both methods involved the high temperature fusion of powdered, sulfur-containing coal in a mixture of MgO and Na_2CO_3 (Eschka mixture). This process converts sulfur into sulfate which was then analyzed by two separate procedures. The first utilizes a precipitation titration with a standard solution of Ba^{2+}. Sulphonazo III was used as the indicator (Budesinsky, B. and Urzalova, D., Z. anal. chem., 210, 161 (1965)).

The second process involved the use of ion-chromotography. Both of these methods were found to yield good results when analyzing standard (NBS) sulfur containing coal samples.

The Controlled Photocatalytic Degradation of Organic Pesticide Residues on Plant Surfaces

Researcher: Midshipman 1/C Jeffrey S. Weiss, USN
Adviser: Professor Edward Koubek

It has been reported that aqueous solutions containing TiO_2 photocatalyze the degradation of organic residues in aqueous waste streams. It was therefore decided to mix various metal oxides with methoxychlor, a common organic pesticide, to see if one could control its residence time in the environment.

Various amounts of several metal oxides were mixed with methoxychlor and applied to test plates exposed to direct sunlight. Amounts of methoxychlor before and after exposure to sunlight were determined by means of gas chromotography. Very little photocatalytic decomposition was noted except in the case of AgO. However, although this oxide is unsuited for agricultural use, it may prove more effective than TiO_2 in treating aqueous waste streams.

Publications

CAMPBELL, Mark L., Assistant Professor, and Boyd A. WAITE, Associate Professor, "The K_a Values of Water and the Hydronium Ion for Comparison with other Acids," *Journal of Chemical Education*, **67** (1990), 386-388.

Statements in general treatments of chemical principles are often inconsistent in describing the acid strengths of water and the hydronium ion. A formally correct method (based on principles of thermodynamics) has been obtained in this study which provides a totally consistent description of the acid strengths of these simple but very significant species. By treating water or hydronium ion as a solute (i.e., by "labeling" a certain fraction of the water or hydronium ion), it is possible to calculate the thermodynamic equilibrium constants governing the acid reactions of the two species. Results indicate that the inconsistencies in general chemistry treatments (and physical chemistry treatments) arise mainly due to a loose management of standard state definitions. This treatment provides a clear resolution of this inconsistency.

CAMPBELL, Mark L., Assistant Professor, "The Correct Interpretation of Hund's Rule as Applied to 'Uncoupled States' Orbital Diagrams," *Journal of Chemical Education*, **68** (1991), 134-135.

Hund's rule is typically incorrectly applied by freshman chemistry text authors in describing electron configurations of free radicals. In this article, the correct application is forwarded, so that future texts can be written with the correct interpretation of Hund's rule.

CHEEK, Graham T., Associate Professor, "Electrochemical Reduction of Fluorenone in a Room-Temperature Molten Salt," *Proceedings* of the Seventh International Symposium on Molten Salts; Montreal, Quebec, Canada. The Electrochemical Society Proceedings, **90-17** (1990), 325-335.

The electrochemical reduction of fluorenone in the aluminum chloride: 1-methyl-3-ethylimidazolium chloride molten salt system has been investigated. In the basic melt, a one-electron reduction produces the anion radical which rapidly couples to give the pinacol product. Complexation of fluorenone by aluminum chloride in the acidic melt results in a positive shift of reduction potential, giving rise to a lower yield of pinacol product (30-40%) than in the basic melt. The coupling rate of the anion radicals in the acidic melt is approximately 1000 times slower than in the basic melt.

CHEEK, Graham T., Associate Professor, co-author, "Quartz Crystal Microbalance Study of Palladium/Hydrogen Interactions," *Proceedings* of The First Annual Conference on Cold Fusion; Salt Lake City, Utah. National Cold Fusion Institute, 1990, pp. 57-61.

The loading of hydrogen (H) and deuterium (D) into palladium films deposited on quartz crystals has been carried out by electrochemical reduction of H_2O and D_2O, respectively. This work has shown that in order to obtain an accurate value for H(D) content in the films, the stress caused by H(D) loading in the films must be taken into account. Considering that this stress causes frequency shifts in opposite directions for AT and BT-cut quartz crystals, measurements at both types of crystals are employed to determine a quantitative value for both H(D) content and film stress.

ELERT, Mark L., Professor, co-author, "Incorporation of Reactive Dynamics in Simulations of Chemically Sustained Shock Waves," *Shock Compression of Condensed Matter - 1989*, ed. S. C. Schmidt, J. N. Johnson, and L. W. Davison. Amsterdam: Elsevier Science Publishers B.V., 1990, pp. 263-266.

A two-dimensional molecular-dynamics model of a chemically sustained shock wave in a molecular solid is discussed. A many-body expression that realistically describes chemical bonding in condensed phases is used for the interatomic potential. The results demonstrate that simple reactive collisions are sufficient to self-sustain a shock wave with a velocity that is comparable to experimental detonation velocities. Features characteristic of macroscopic detonations such as an intrinsic detonation velocity and a following flow are observed on a microscopic scale.

ELERT, Mark L., Professor, co-author, "Some One-Dimensional Molecular Dynamics Simulations of Detonation," *Shock Compression of Condensed Matter - 1989*, ed. S. C. Schmidt, J. N. Johnson, and L. W. Davison. Amsterdam: Elsevier Science Publishers B.V., 1990, pp. 275-278.

One-dimensional molecular dynamics simulations of the onset of detonation have been performed using

three-body potentials which accurately reproduce the effects of endothermic bond breaking and exothermic bond recombinations. A stable detonation wave of reasonable velocity can be produced from the impact of a plate upon a stationary array of diatomic molecules. The onset of detonation has been studied using a variety of potential forms including LEPS and Tersoff potentials. Properties of the detonation front, including front velocity, reaction zone width, and product distribution, have been studied as functions of barrier height, exothermicity, and other relevant potential function parameters. A model is proposed to explain the self-regulating detonation front velocities observed in these simulations in terms of atomic-scale kinetics.

FERRANTE, Robert F., Assistant Professor, "Vibrational Frequencies in the A ^{3}E State of Methylnitrene," *Journal of Chemical Physics*, **94** (1991), 4678-4679.

New observations have enabled the identification of another excited state vibration in the A ^{3}E - X $^3A_2$ ultraviolet absorption spectrum of matrix-isolated methylnitrene. Two progressions in the C-N stretching frequency ν_3 were detected in both CH_3N and CD_3N, with average intervals of 710 cm^{-1} and 695 cm^{-1}, respectively. For each isotopomer, corresponding lines in the pair of progressions are offset by frequencies appropriate for a methyl vibration. This provides the first clear evidence for excitation of the CH_3 symmetric deformation (umbrella mode) ν_2 in the upper state of the transition, with vibrational frequencies of 1166 cm^{-1} for CH_3N and 1044 cm^{-1} for CD_3N. These observations confirm earlier speculation on the absorption spectrum of matrix-isolated CH_3N, and correlate with unidentified lines in the gas phase emission spectrum. The use of a new precursor, methyl isocyanate, in the generation of this radical is also of interest.

HEUER, William B., Assistant Professor, co-author, "Linear Chain Organometallic Electron Transfer Complexes: Synthesis, Crystal Structures, and Magnetic Properties of 1:1 and 2:1 Decamethylferrocenium Salts of Tris[bis (trifluromethyl)ethylene-1,2-dithiolato]molybdate Anions," *Chemistry of Materials*, **2** (1990), 764-772.

The synthesis and crystal structures of two organometallic electron-transfer salts $[Fe(C_5Me_5)_2]_x\{Mo[S_2C_2(CF_3)_2]_3\}$, (x=1,2) were reported. For x = 1, the structure consists of discrete linear stacks of alternating S = 1/2 $[Fe(C_5Me_5)_2]^+$ cations and S = 1/2 $\{Mo[S_2C_2(CF_3)_2]_3\}^-$ anions. Magnetic susceptibility results for this salt were interpreted in terms of weak one-dimensional ferromagnetic interactions between the cations and anions within the stacks. For x=2, the structure contains interpenetrating linear arrays of alternating S = 1/2 cations and S = 0 anions. Magnetic susceptibility results indicated presence of weak antiferromagnetic interactions between the S = 1/2 cations. These results were interpreted using the extended McConnell theory of ferromagnetic coupling in molecular crystals, and implications for the design of molecular ferromagnets were discussed.

LAVELL, William T., Assistant Professor, co-author, "4-Piperidinylimino: A Nearly Linear Head-to-Tail Linking Group for Dipolar Chromophores, "*Journal of Organic Chemistry*, 56 (1991), 2282-2284.

The general aim of this project is to design new organic materials for non-linear optical applications. The most promising organic materials at this time are highly dipolar, extended molecules. The goal of this work was to investigate the geometry of alignment of two individual dipolar fragments held together by a 4-aminopiperidine linking group. The dipolar molecules were synthesized using established chemistry from commercial materials in a small number of steps. The dipole moments were obtained from capacitance measurements using standard techniques. Dipole moments for the individual monomers were available from the literature, or by measurement. The measured moment for the 4-aminopiperidine linked molecule is within experimental error of the maximum possible moment predicted for ideal alignment of the individual monomers. A polymeric target structure was proposed for further investigation.

LOMAX, Joseph F., Assistant Professor, John J. FONTANELLA, Professor, Mary C. WINTERSGILL, Associate Professor, (Physics), and Anthony J. KOTARSKI, Midshipman 1/C, USN, "Dielectric Loss in Vanadyl Pnictates," Materials Research Society Symposium *Proceedings*, Vol. 210, Solid State Ionics II, eds. G. Nazri, D. F. Shriver, R. A. Huggins, and M. Balkanski. Pittsburgh: Materials Research Society, 1991, pp. 681-686.

The results of audio frequency complex impedance studies for vanadyl phosphate and its hydrates ($VOPO_4 \cdot nH_2O$; n = 0,1,2) are reported. Measurements were made at seventeen frequencies between 10 and 10^5 Hz over the temperature range 5.5-380K. Two low-temperature features were observed and are correlated with particular water species between the $VOPO_4$ layers. In light of chemical evidence and complex impedance measurements on related compounds, it is speculated that $VOPcO_4 \cdot nH_2O$(PC=P,As) can be thought of as a mixed nonstoichiometric compound $[VO(HPcO4)]x[VOPcO_4]_{1-x} \cdot nH_2 \cdot$ and the solid

Brønsted acid nature of the compound is related to proton movement between layer pnictates and introlayer waters.

MASSIE, Samuel P., Professor, "And The Beat Goes On," *Journal of the National Technical Association*, **64** (1990), 20-25.

This article is a historical look at Blacks in science, with special emphasis on the five eras into which they can be divided, and including some of the personalities that have made this history significant.

MASSIE, Samuel P., Professor, "Science and Mathematics in the Twenty-first Century," *THE COLLEGE DIGEST*, Special Issue (1990-91), 77.

This is a brief discussion of the potential future activities in science and mathematics. This magazine is directed toward minority students deciding on colleges and careers, and the object of this article was an invitation to consider careers in science and mathematics.

SHADE, Joyce E., Associate Professor, co-author, "Photochemistry of Some Iron and Ruthenium - (n^5-Cyclopentadienyl)Carbonyl Dimers in Frozen Gas Matrices at ca. 12K," *Journal of the Chemical Society*, Dalton Transactions (1990), 2833-2841.

The photochemistry of $[(n^5\text{-}C_5H_5)_2M_2(CO)_4]$, (I, M = Fe; II, M = Ru) and $[CH_2\{(n^5\text{-}C_5H_4)M(CO)_2\}_2]$, (V, M = Fe; VI, M = Ru) have been studied in frozen gas matrices (Ar, CH_4 and N_2) at ca. 12K. In addition, the photochemistry of II in poly(vinyl chloride) (PVC) films at ca. 12K has also been examined. Low energy photolysis of I and II was found to induce opening of trans-carbonyl-bridged species affording terminal carbonyl species. Photolyses into the electronic absorption band maxima of these new terminal-carbonyl species yielded 17-electron radical species, $[(n^5\text{-}C_5H_5)M(CO)_2]$, as well as small amounts of triply-carbonyl bridging species, $[(n^5\text{-}C_5H_5)_2M_2(u\text{-}CO)_3]$. Photolysis into the electronic absorption maxima of trans-carbonyl-bridged I and II complexes yielded the triply-carbonyl bridging species directly. Photolysis of V, which is exclusively bridging and is constrained by the methylene linkage between the rings to be in a cis conformation, at a range of wavelengths showed no evidence for carbonyl-bridge opening. Photolyses into the electronic absorption maxima of V resulted in carbonyl ejection and formation of a new species whose spectrum is consistent with its having three terminal carbonyl groups and an Fe-Fe double bond. Photolysis of VI which exists in a cis-terminal conformation also resulted in carbonyl loss and formation of a species similar to that observed for V. These results are discussed in terms of their relationship to previous photochemical studies of I and II, and an overall model for the photochemical behavior of I and II is presented.

Presentations

FERRANTE, Robert F., Assistant Professor, "Spectroscopy of Reactive Fragments in Glassy Matrices," AT&T Bell Laboratories, Murray Hill, New Jersey, 13 July 1990.

FERRANTE, Robert F., Assistant Professor, "Spectroscopic Search for Matrix-Isolated Acetylnitrene," Two-hundredth National Meeting of the American Chemical Society, Washington, DC, 29 August 1990.

FERRANTE, Robert F., Assistant Professor, co-author, "Room Temperature Luminescence at 1.55 Micrometers in Erbium-Implanted Silicon," Materials Research Society Fall National Meeting, Boston, Massachusetts, 27 November 1990.

FITZGERALD, Jeffrey P., Assistant Professor, "Metalloporphyrins as Model Compounds for Cytochrome P-450," American Chemical Society National Meeting, Atlanta, Georgia, 14-19 April 1991.

HECKENDORN, Debra K., Assistant Professor, "Synthesis of Polymethylated Carboxylic Acids as Model Surfactants," Exxon Research and Engineering, Clinton, New Jersey, 2 August 1990.

HECKENDORN, Debra K., Assistant Professor, "Synthesis of Substituted Cyclopentanes: the Preparation of an Oxabicyclo[3.3.0] octane Precursor," Two-hundred First National Meeting of the American Chemical Society, Atlanta, Georgia, 15 April 1991.

LAVELL, William T., Assistant Professor, "Study of Photoenolization in Indoles," Two-hundred First National Meeting of the American Chemical Society, Atlanta, Georgia, 14 April 1991.

LOMAX, Joseph F., Assistant Professor, John J. FONTANELLA, Professor, and Mary C. WINTERSGILL, Associate Professor, (Physics), "Dielectric Loss in Vanadyl Phosphate and its Hydrates," Gordon Conference on Solid State Ionics, North Conway, New Hampshire, 18-22 June 1990.

LOMAX, Joseph F., Assistant Professor, John J. FONTANELLA, Professor, and Mary C. WINTERSGILL, Associate Professor, (Physics), "Dielectric Loss in Vanadyl Phosphate and its Hydrates," Two-hundredth National Meeting of the American Chemical Society, Washington, DC, 24-30 August 1990.

LOMAX, Joseph F., Assistant Professor, John J. FONTANELLA, Professor, Mary C. WINTERSGILL, Associate Professor, (Physics), and Anthony J. KOTARSKI, Midshipman 1/C, USN, "Dielectric Loss in Vanadyl Pnicates and their Intercalation Compounds," Meeting of the Material Research Society, Boston, Massachusetts, 26 November-1 December 1990.

MASSIE, Samuel P., Professor, "The Flight of the Bumblebee," Atlanta, Georgia Public School Honor Students; presented as a part of the 1990 National Black College Alumni Hall of Fame activities, Atlanta, Georgia, 22 September 1990.

MASSIE, Samuel P., Professor, "The Mission of the Naval Academy," Frederick Douglass Senior High School, Naval Junior ROTC Unit, Atlanta, Georgia, 21 September 1990.

MASSIE, Samuel P., Professor, "Why Science?," Saginaw High School Student Assembly, Saginaw, Michigan, 16 October 1990.

MASSIE, Samuel P., Professor, "Why Teach?," Saginaw High School Faculty, Saginaw, Michigan, 16 October 1990.

MASSIE, Samuel P., Professor, "A Look at Blacks in Science," Tri-Cities (Michigan) Chapter, National Organization of Black Chemists and Chemical Engineers, Saginaw, Michigan, 16 October 1990.

MASSIE, Samuel P., Professor, "Historical Prospectives on Afro-Americans in Science," Participant in M.I.T. Symposium honoring Professor Henry C. McBay as Martin Luther King Visiting Professor, Cambridge, Massachusetts, 17 January 1991.

MASSIE, Samuel P., Professor, "An American Odyssey-from Banneker through Bouchet and Carver to Massey and On," University of Maryland Afro-American Department, College Park, Maryland, 16 March 1991.

MASSIE, Samuel P., Professor, "An American Odyssey," Sigma Xi Lecture, Illinois Institute of Technology, Chicago, Illinois, 11 April 1991.

PEARSON, Wayne H., Assistant Professor, "The Integration of Spreadsheets into the Scientific Curriculum," Carleton College, Northfield, Minnesota, 21 March 1991.

SHADE, Joyce E., Associate Professor, co-author, "Chemical Generation of Organometallic Radicals," Fourteenth International Conference on Organometallic Chemistry, Detroit, Michigan, 19-24 August 1990.

SHADE, Joyce E., Associate Professor, and Julie A. HANSEN, Midshipman 1/C, USN, "Photochemistry of $[CpFe(CO)]_2$-u-DPPM and DPPE: An Unexpected New Radical Reaction Route," Twenty-fifth Middle Atlantic Regional Meeting (MARM) of the American Chemical Society, Newark, Delaware, 21-23 May 1991.

SIATKOWSKI, Ronald E., Assistant Professor, co-author, "Synthesis of a Major Human Metabolite of Ibuprofen," Meeting of the Yardley-Makefield Lions, Yardley, Pennsylvania, 23 April 1991.

SIATKOWSKI, Ronald E., Assistant Professor, co-author, "Synthesis of 2-[p-(2-methyl-2-hydroxypropyl)-phenyl]propionic acid," Annapolis Chapter of Sigma Xi, United States Naval Academy, Annapolis, Maryland, 16 January 1991.

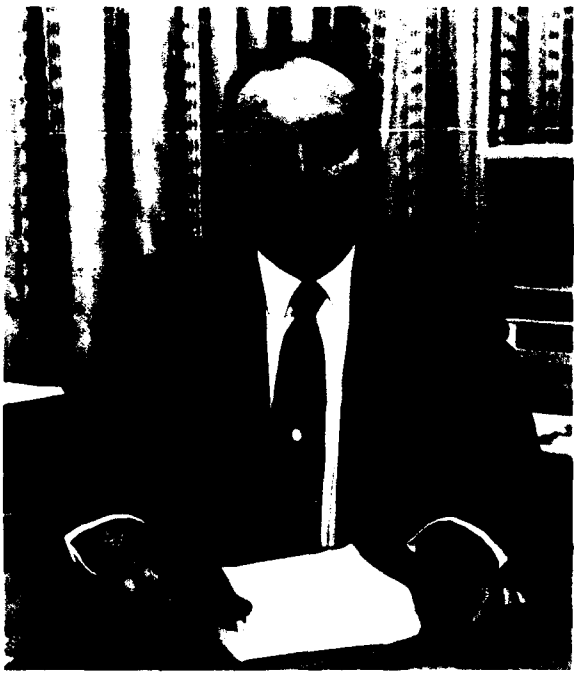
DEPARTMENT OF

Computer Science

Associate Professor Frederick A. Skove
Chair

During the past year, in addition to internal research such as project courses and receiving approval for a Trident Project for 1991, the faculty has been very active in securing outside reimbursable funds. This academic year, this relatively small department produced twenty-five publications and made twenty-six presentations at conferences and seminars. The external sponsors who supported this performance include the Defense Mapping Agency, the Naval Research Laboratory, the Army High Performance Computing Research Center and the Defense Advanced Research Projects Agency. Internal research includes a study to develop short and long range communication networks between the Candidate Guidance Office and the Naval Academy Information Officer Program.

The Computer Science Department encourages its entire faculty to engage in research, because midshipmen, as well as faculty, benefit from their instructors' technological currency.



Sponsored Research

Interactive Maps

Researcher: Professor Frank L. K. Chi
Sponsor: Defense Mapping Agency

In keeping with the developing advancements and new technologies in the areas of computer graphics and automated charting systems, the main effort of this work is to create a graphics package for displaying interactive maps of the United States or a specified state on computer screen. The development and implementation of this prototype package will, by far, outweigh the capabilities and benefits of currently used paper maps as educational tools and as evaluation testbeds of new concepts related to interactive computer graphics. The paper maps present a large amount of static information, while the computer display, although not able to convey the same amount of information at once, has a dynamic capability to change and update the information Furthermore, not available with paper maps, the electronic charts can amplify information about particular map features as desired, in addition to the ability to change resolution clarity, adjust display areas, and highlight relevant features. By the interaction capability alone, this package will increase productivity. As an educational tool or as a testbed for evaluating developing issues, this prototype package allows much more flexibility, maneuverability, and faster learner feedback than static display maps.

A Relational Database for Hullform Design

Researcher: Assistant Professor Nikolaos Glinos
Sponsor: Defense Advance Research Project Agency

The design of ship hullforms is a complicated and time-consuming process involving (1) an accurate description of the hullform geometry and (2) a prediction of the performance characteristics of the ship. Until recently, the latter generally involved conducting physical model experiments in the form of towing tank tests which greatly increase the time needed for a design to be completed. Advances in computer technology and the use of regression analysis and numerical fluid dynamics codes have made the process faster, but the process of designing a ship is still accomplished through a series of sequential phases which have to be performed independently and frequently on different hardware. Results of one phase have to be translated to formats accepted by the next, and succeeding phases and this data exchange discontinuity make the turn around time greater. The lack of an on-line database containing performance data on a wide range of previous designs makes the conceptual design of new and innovative (non-standard) ships quite tedious. The application of artificial intelligence techniques and ideas has so far been limited, even though marine design would be a very good testbed for such methods. Computer-aided design and analysis systems have been developed for the automobile and aircraft industry, but they are frequently of a proprietary nature, since the aircraft or automobile design team is employed by the manufacturing company that builds the vehicles. Since ship design firms and shipbuilding companies are generally independent of each other, except in some countries such as Japan and Korea, the problem of design data exchange is receiving considerable attention on an international scale. Some attempts to develop integrated CAD systems for ship design and construction are underway. This research addresses the problem of designing a database for storing and exchanging information about marine hullforms, and will be used as the central module for an integrated computer-aided ship design, analysis, and evaluation system.

Validation of Knowledge-Based Systems

Researcher: Professor Patrick R. Harrison
Sponsor: Naval Research Laboratory (Code 5510)

This is an ongoing research program concerned with the validation of Knowledge-Based Systems (KBS). Last year produced a general model of KBS validation that provided a basis for this year's effort. This year the model was elaborated, using operational analysis to define classes of measurement operations on tasks or functional objects. The concept of validation layers (levels of abstraction) has also been introduced to define different levels of validation with different measurement operations. This provided a means for scaling the validation approach. This model is being tested using two large expert systems as test beds.

Parallel Free-Text Search on Connection Machines

Researcher: Assistant Professor Eun K. Park
Sponsor: Naval Research Laboratory, (Code 5150)

The primary objective of this research is to study the relative merits of existing "NRL finder" and other free-text search algorithms and to compare them to make suitable recommendations. These findings can provide algorithms for parallel free-text retrieval on connection machines that can be used for indexing, searching, and retrieval of large unstructured databases.

Stress and Decision Making in a Communications Context

Researcher: Assistant Professor Kay G. Schulze
Sponsor: Naval Research Laboratory, (Code 5532)

The goal of this research is to investigate the interaction of increased load and time pressure in a communication task environment and to simulate the added stress that might arise from external events by using a concurrent computer task to reduce available resources. The research program will have several stages over approximately three years. The first objective will be to develop a computer concurrent task with the desired characteristic of being able to add to the cognitive loads. Within the framework of a communications environment, a problem will be selected for which decision problems can be generated. The independent variables of primary concern will be time pressure and load pressure. Since time limitation can affect the amount of information that is available as well as the time in which to use it, message rate will also be varied. The final stage will be to investigate possible ways of reducing communication errors or load.

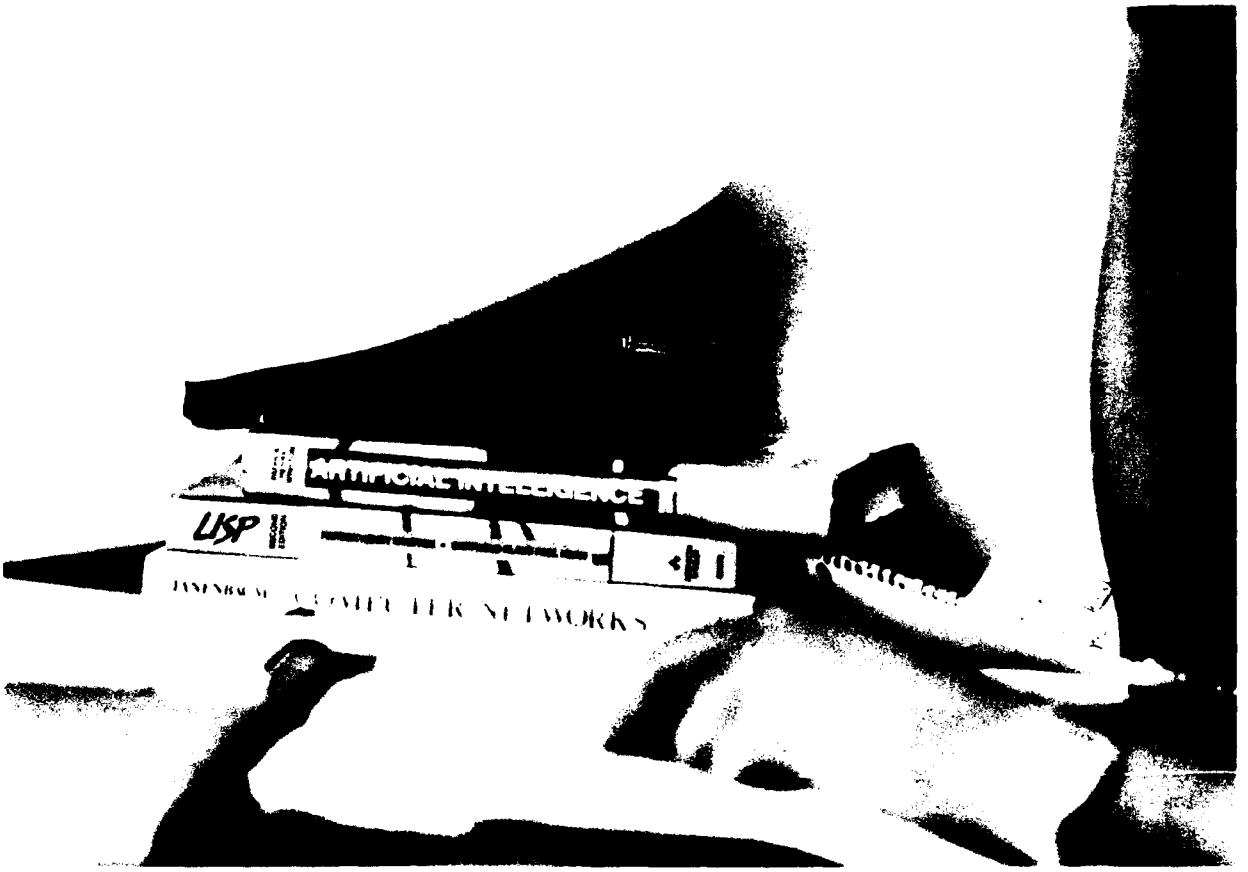
The first objective of this project is nearing completion. A concurrent tasking involving the selection of the larger of three numbers with a range of one to three digits has been developed and is in the process of being validated.

The Effects of Stress on Communication Behavior in the Context of a Team Decision Task

Researcher: Assistant Professor Kay G. Schulze
Sponsor: Naval Research Laboratory, (Code 5532)

The goal of this research is to investigate the way in which the communications interface affects communication strategies and decision performance in a team decision-making context. The initial emphasis is on an individual in a team decision hierarchy. The team leader has responsibility for making decisions at an intermediate level based on information collected by the team. The leader functions as part of the command team and also contributes to higher level decisions. The cognitive issues involved in communicating with team members in situations involving workload and time stress will be investigated.

The project's aim is the development of a computer communication simulation to be used in conducting experiments with two alternative communications interfaces, one that is similar to the currently-used LS-653 and the other a graphical interface. In the initial experiment, each of the communication interfaces will be tested under conditions of high and low communication load, using two levels of decision problems that vary the working memory load by requiring few or many pieces of information to classify the target as a threat or not a threat. During the remainder of FY91, the researcher will develop a simulated communication environment for AAW problems, incorporate the communications interfaces into this environment, and conduct pilot tests.



Independent Research

Communication Network Between CGO and NAIO

Researcher: Assistant Professor Kijoon Chae

The objective of this research is to develop short and long range communication networks between the Candidate Guidance Office (CGO) and the Naval Academy Information Officer (NAIO) program. The network will enhance the availability of candidate and administrative information flow to the NAIO and provide fast and reliable information exchanges between the CGO and the NAIO.

Using Primary Decomposition Algorithms to Categorize Some Ideals in Algebraic Topology

Researchers: Assistant Professor Nikolaos Glinos and
Associate Professor George Nakos (Mathematics)

The researchers want to examine and categorize the ideals generated by the coefficients of the p^kseries, which in previous research work was computed to a high degree. It is suspected that the ideals generated by the coefficients of the series are primary. Methods for primary decomposition of finitely generated polynomial ideals exist and are based on the existence of Grobner bases for the ideal. In this case the polynomials generating the ideals have integer coefficients, and so Grobner bases over the integer domain Z are needed. Currently the implementation of a Grobner basis algorithm over Z is underway, using the computer algebra language MATHEMATICA.

Elementary First Integrals of First Order Non-Linear Differential Equations

Researcher: Assistant Professor Nikolaos Glinos

A first integral of a system of differential equations is a function which is constant on solution curves. If it can be expressed in terms of exponential, logarithmic, and algebraic functions, then it is called elementary. An elementary integral provides an implicit solution of the system of differential equations. The researcher uses the Prople-Singer method to compute elementary first integrals of first order non-linear ordinary differential equations. The method is also extended to differential equations with transcendental coefficients. The above method is implemented in MACSYMA. B.F. Cavines, of the University of Delaware, is a co-researcher on this project.

Parallel Algorithms for Constrained Nonlinear Global Optimization

Researcher: Assistant Professor Andrew T. Phillips

This proposal requested support for a research program on designing parallel algorithms for large-scale constrained nonlinear global optimization problems. The overall objective of this work was to design and implement new algorithms which, by taking full advantage of parallel computing capabilities, would efficiently solve large-scale constrained nonlinear global optimization problems on the shared-memory CRAY 2 supercomputer.

Constrained global optimization problems arise in many important areas of science and technology and include scheduling and allocation problems with non-convex objective functions and a variety of computer-aided-design and computational geometry applications. These kinds of optimization problems may possess many constrained local optima, but an acceptable solution to the problem requires that a global optimum, or a good approximation of it, be obtained. Because of the inherent difficulty of computing the global optimum, the emphasis of this research will be on the design and implementation of efficient algorithms which obtain an approximate solution to these problems on parallel computers in a reasonable amount of time. Typically these algorithms will find both an approximate solution and guaranteed bounds on this solution, with the accuracy of the approximate solution and the tightness of the bounds depending on the amount of computation performed. In view of this approach, primary interest is placed on the average, rather than worst case, behavior of these algorithms, and the performance analysis of this behavior of these algorithms will require a combination of both theoretical investigation and extensive computational testing.

This research is being conducted in collaboration with the Army High Performance Computing Research Center and the Minnesota Super Computer Institute.

Research Course Projects

An Arrival Time Tracking Task: The Design and Development of a Stress Task

Researcher: Midshipman 1/C Kristin C. Mawanay, USN
Adviser: Assistant Professor Kay G. Schulze

A microcomputer-based arrival time tracking task is examined. This paper includes a brief description of tracking and stress tasks, the building blocks needed to code the task, and an extensive description of the program itself. The process for validation of a stress task will also be described. The paper also illustrates the task's experimental significance at the Naval Research Lab (NRL), Washington, DC.

Publications

CHAE, Kijoon., Assistant Professor, "Performance Evaluation of FDDI Network and Interconnected Heterogeneous Networks," *Proceedings* of the IEEE Fifteenth Conference on Local Computer Newtorks, Minneapolis, Minnesota, October 1990, pp. 75-83.

In this paper, interconnected heterogeneous networks are presented and their performances are analyzed. The interconnected networks consist of a token ring, fiber-distributed data interface (FDDI) network and a carrier sense multiple access with collision detection (CSMA/CD) network, each of which connects a large population of users. In the interconnected networks, the local users on the token ring send intra- or inter-network packets. The inter-network packets are transmitted to the CSMA/CD network via gateways and the FDDI network. In the meantime, the local users on the FDDI and CSMA/CD networks generate intra-network packets. Since the maximum packet sizes of those networks are different, packet fragmentation and reassembly are sometimes necessary. These functions are performed by gateways. The model focuses on the end-to-end delay between two end users on the token ring and CSMA/CD networks. Analytic models to calculate the delays for the FDDI network and the interconnected networks are presented in this paper, and the measurements from the models are compared with that from the simulation models to validate the analytic models.

CHI, Frank L. K., Professor, "New Cosmological Models in the Five-dimensional Space-Time-Mass Gravity Theory," *General Relativity and Gravitations*, 22, 12 (November 1990), 1347-1350.

A new class of vacuum solutions in the new five-dimensional space-time-mass gravity theory is found. These new cosmological models describe expanding universe without a big bang singularity, and the fifth dimension of these models shrinks as they expand.

GLINOS, Nikolaos, Assistant Professor, Bruce JOHNSON, Professor (Naval Systems Engineering), Nancy ANDERSON, Naval Architect (Hydromechanics Laboratory), co-authors, "Database Systems for Hullform Design," *Proceedings* of the Conference of the Society of Naval Architects and Marine Engineers, San Francisco, California, 1-2 November 1990, Vol. 17, pp. 1-25.

The conceptual design of a ship hullform is a complicated and time-consuming process. A hullform database containing geometry and performance data on a wide range of previous designs can shorten the design time during the conceptual design phase. The paper reviews several design support databases in existing systems for ship design and points out the need for a standardized ship hullform design database. Among the systems examined is the HDDS system for ship design, a combined effort by the United Kingdom and U.S. Navies. The paper also proposes a new standard relational database format for hullform design data, based on the International Towing Tank Committee Standard Symbols and Terminology list.

GLINOS, Nikolaos, Assistant Professor, "On the Design of a Database for Ship Hullform Data," Computer Science Technical Report SCI-TR-91-1, U.S. Naval Academy, Annapolis, Maryland, January 1991.

This technical report describes work done by the author and Dr. Bruce Johnson (Professor, Naval Systems Engineering) and Ms Nancy Anderson (Naval Architect, Hydromechanics Laboratory) for the design of a database to store hullform design data. The database design process is traced from the early stages to the final database version. It includes the interview questions, the functional hierarchy, and all the intermediate versions of the database. It also includes an overview of the ship design problem and addresses the need for an integrated ship design environment. Finally, a possible implementation of a standard format relational database for storing ship design data is given based on the International Towing Tank Committee Standard Symbols and Terminology list.

GLINOS, Nikolaos, Assistant Professor, Bruce JOHNSON, Professor (Naval Systems Engineering) and Nancy ANDERSON, Naval Architect, (Hydromechanics Laboratory), "Towards a Standard Relational Database for an Integrated Ship Hullform Design, Analysis, and Evaluation System," *Proceedings* of the Conference on Computer Applications in Design, Simulation and Analysis, International Society for Mini and Microcomputers, Las Vegas, Nevada, 19-21 March 1991, pp. 170-173.

An integrated ship hull form design system is proposed in order to shorten the design time during the early stages of ship hull form design. To make design data exchanges between the various organizations easier, a standard format relational database is proposed as the central module of the integrated system. The paper describes the format and the design of this database, which is based on the symbols and terminology list for ship hull form data, developed by the International Towing Tank Committee.

GLINOS, Nikolaos, Assistant Professor "Artificial Intelligence and Ship Design, Analysis, and Evaluation," *Proceedings* of the Conference on Artificial Intelligence and Simulation, Society for Computer Simulation, New Orleans, Louisiana, 1-5 April 1991, pp. 65-70.

This paper researches the potential use of artificial intelligence methods and techniques to provide support and guidance to the ship designer, in an integrated ship design environment. Several areas in which artificial intelligence (AI) could help, and where research should be focused, are given. In order to make the use of AI easier, it is proposed that the database of the integrated ship design system be an object-oriented one, rather than a flat record relational database. Object-oriented databases are discussed, as well as how they could be used in the ship design area.

HARRISON, Patrick R., Professor, co-author, "Towards Standards for the Validation of Expert Systems," *Expert Systems with Applications*, **2** (1991), 251-258.

The paper provides a basis for the standardization of the validation of knowledge-based systems (KBS). The place of validation within the development process is discussed, and a model is proposed. Knowledge-based system validation problems are decomposed using sequences of independent and dependent generic tasks. A model for validation of KBS causal processes as well as performance outcomes are presented. Practical applications to real systems are described.

HARRISON, Patrick R., Professor, "Lisp," *Standards and Review Manual for Certification in Knowledge Engineering*, ed. M. White and J. Goldsmith. Rockville, Maryland: Systemsware Corporation, 1990, pp. 163-180.

The chapter describes the concepts of interpretation and compilation in the Common Lisp language. It also describes the Common Lisp language and how to build procedural abstractions using Lisp. Advanced topics such as lexical control, recursion, structures, and the Common Lisp object system are discussed. The chapter also discusses the development and delivery of expert systems using Lisp-based environments.

HARRISON, Patrick R., Professor, co-author "Inferring Hemispherical Reflectance Using a Knowledge-Based System, *Proceedings* of the International Geoscience and Remote Sensing Symposium. University of Maryland, College Park, Maryland, Vol. 3, 1990, pp. 1759-1764.

A robust extraction technique for inferring physical and biological surface properties of vegetation using nadir and/or directional reflectance data from a satellite was developed using a knowledge-based system. The system was tested by inferring hemispherical reflectance using data similar to what HIRIS could collect for various targets. The system was also used to extract hemispherical reflectance from directional AVHRR data in a region of the Sahelian zone of Africa.

PARK, Eun K., Assistant Professor, "Quantitative Measurement of Performance Degradation in LANs," *Journal of Mini and Microcomputers*, **12**, 3 (1990), 85-91.

In addition to promptness, many local area network applications require robustness (fault tolerance) in order to avoid the often disastrous consequences of LAN system failures. The system's ability to perform functionally with some degradation while still maintaining an acceptable level of performance has become an important consideration and may be measured by both qualitative and quantitative analyses. In this paper, a general quantitative measure of the performance degradation of various LAN's is discussed. A new concept, a quantitative measure applicable to performance degradation, is introduced. Finally, example studies of the quantitative measure of the performance degradation following the failure of a component are presented.

PARK, Eun K., Assistant Professor, co-author, "Translating Petri Nets to Ada Programs," *Proceedings* the of Association for Computing Machinery Twenty-ninth Conference. Auburn University, Auburn, Alabama, 12 April 1991, pp. 248-253.

Petri nets are abstract and formal models. They have been used to develop concepts, theories, and tools to facilitate the representation, design, analysis, and simulation of concurrent systems. In this paper, a method for automatically translating a Petri net into an Ada program is presented. This translation makes a system designed by a Petri net executable. Executing these programs can aid in debugging of the design and determining the real time requirements of the system. The modeling of Petri nets in the Ada language can also enhance the understanding of concurrent programming and synchronization issues involved in large concurrent systems. Combining the Petri net concepts with the Ada programming language can help programmers to learn both the Ada tasking concepts and general concurrent programming concepts.

PARK, Eun K., Assistant Professor, co-author "Performance Simulation of a Token Ring: User's View," *Proceedings* of the IEEE Twenty-fourth Annual Simulation Symposium. New Orleans, Louisiana, 1-5 April 1991, pp. 312-317.

Most of the performance studies for local area networks (LAN's) have been based upon the average transmission time of a packet (or frame) as a performance criterion. Their models have been developed for the performance measure of the low-level physical and data link layers of LAN's. They predict the relative efficiency of different network topologies, transmission media, and access protocols. However, they often fail to measure an end-user's message transmission time. A realistic performance measure for end-users should attempt to measure the average transmission time of the entire user message.

In this study, the author concentrates on the performance of a token ring LAN system from a user's view. A simulator has been developed to measure quantitatively the elapsed time of an end-user's message.

Simulation results show that the performance of the network with the exhaustive service (ES) strategy is much better than that of the network which works with the non-exhaustive service (NES) strategy. Also, the measure based on user messages is compared with the conventional performance measure based on packets and shows differences in performance measurement.

PARK, Eun K., Assistant Professor, co-author, "A Simulation Study of a CSMA/CD with Connected Data Links," *Proceedings* of IEEE Twenty-fourth Annual Simulation Symposium. New Orleans, Louisiana, 1-5 Apr 1991, pp. 292-300.

Since local area networks (LAN's) have become a vital part of modern computing, a great deal of effort has been devoted to their design, standardization, and implementation. Most of this work has been based on a simple linear bus or ring topology (Ethernet, Token Bus, and Token Ring). However, the linear bus and ring topology networks have significant disadvantages in certain applications.

Recently, the researcher proposed a new hybrid architecture local area network, Hybrid-Meshnet. The Hybrid-Meshnet allows an insertion and/or deletion of data links into/from existing local area networks: Ethernet or Token Ring. The earlier works have concentrated on a token ring with connected data links. In this paper, another Hybrid-Meshnet network architecture, CSMA/CD with connected data links is investigated.

A simulation model is designed for the purpose of performance measure of the proposed network. Simulation results indicate that, even with a small increase in link cost by addition of direct data links, performance can be improved significantly over a pure Ethernet.

PARK, Eun K., Assistant Professor, "A Case Study in Object-Oriented Systems Analysis and Design," *Proceedings* of International Symposium on Computer Applications in Design, Simulation and Analysis. Las Vegas, Nevada, 19-21 March 1991, pp. 158-161.

Requirements analysis and design is a crucial phase in the life cycle of a software project. The most difficult part of constructing a software system is deciding exactly what to construct and how to construct it. One of the new alternative ways of programming is the idea of Object-Oriented programming. The basic idea behind the Object-Oriented approach is simple; looking at the world in terms of objects, as opposed to functional programming. Object-oriented programming encourages prototyping and reusability, and rewards the development of generic functions. Programs perform computations by passing messages between objects.

Traditional functional languages make use of a structured project life cycle. This structured life cycle is not equipped to analyze and design an Object-Oriented system accurately. This paper will describe alternative means to survey, analyze, and

design Object-Oriented systems. Related issues are also discussed. The deficiencies of the existing analysis and design processes are pointed out in relation to Object-Oriented systems. A case study of a specific problem is discussed in terms of the Object-Oriented analysis and design. Advantages and disadvantages are discussed, including prototyping and reusability issues.

PARK, Eun K., Assistant Professor, co-author, "A Pipeline Algorithm for Real-Time Robot Control," *Proceedings* of International Symposium on Computer Applications in Design, Simulation, and Analysis. Las Vegas, Nevada, 19-21 March 1991, pp. 124-127.

The computations required for real-time robot control are intensive. They are difficult to implement in real-time at high sampling rates due to nonlinearities and dynamic coupling. Reducing the computation time can be achieved by developing better computing algorithms and by designing a dedicated computer architecture. The proposed solution is a pipelined multiprocessor computer architecture using fast parallel computation algorithms. Multiple processors are utilized concurrently to perform pipelined parallel computations and to increase substantially processing speed and CPU utilization.

Concurrent performance is based on consideration of the sequential dependencies of the Newton-Euler equations, which are conducive to pipelining, and decomposition of the backward equations. The performance of the proposed algorithms is evaluated through simulation. Results show that the computational errors are relatively small and compare favorably to those obtained by other methods. The proposed computer architecture and the algorithms may be implemented with multiple low-cost microprocessors to achieve real-time robot control with high sampling rates.

PARK, Eun K., Assistant Professor, and Frederick A. SKOVE, Associate Professor, "An Approach to Ada Implementation of an Associative Memory," *Proceedings* of Ninth Annual National Conference on Ada Technology. Washington, DC, 4-7 March 1991, pp. 72-79.

A simplified memory management scheme to solve problems with content-addressable memory (CAM) and associative memory (AM) is presented. CAM uses a parallel search. Thus, search time is drastically reduced. AM searches in the same way, except that relational functions are used. One problem with these techniques is cost of hardware. This paper proposes a software simulation of AM hardware. This will greatly reduce costs, as well as provide a ready prototype upon which to test application software for AM. Ada's task construct was chosen for its powerful communication techniques between concurrent processes. Tasks immediately tell each other that the keyword has been matched to data in memory, and searching ceases. This process cuts the search time by an average of one half, compared to other concurrent constructs. Another problem addressed is that normally associated data cannot be accessed without first knowing the proper keyword for its parent element, resulting in the loss of access to some data. By allowing every memory cell to act as both an element and an attribute associated with another element, any information in memory can be accessed via a keyword match.

PARK, Eun K., Assistant Professor, and John J. SPEGELE, Major, USMC, "Adopting Ada as a Primary Undergraduate Programming Language," *Proceedings* of Ninth Annual National Conference on Ada Technology. Washington, DC, 4-7 March 1991, pp. 164-169.

Ada usage, as a general programming language in undergraduate institutions, has generally lagged industry demand for Ada-trained programmers and analysts. This paper discusses critical issues associated with adopting Ada as a primary programming language in undergraduate curriculums. Three specific issues, as they relate to Ada, are addressed: Language design and academic programming; compiler requirements for academia; and techniques for teaching programming to undergraduates.

PARK, Eun K., Assistant Professor, co-author, "An Extended Structure Chart: A New Tool for Expert System Design," *Proceedings* of Expert Systems: Theory and Applications. Long Beach, California, December 1990, pp. 19-22.

Expert systems analysts and designers are frequently faced with the task of developing and maintaining systems for the classification of large, incomplete, and highly dynamic data sets of which they have minimal personal knowledge. Acquiring the knowledge needed to power an expert system and structuring that knowledge into a usable form are major hindrances to expert system development. At present, no automatic methods exist for doing this, with the exception of some system-building aids capable of constructing rules from examples. Most likely it will be some time before these aids can even begin to replace the knowledge engineer. Therefore, presently, the only effective methodology to transfer the knowledge from the human experts to the systems analysts and designers is the interview process. This paper addresses the topic of better understanding of how knowledge is represented within the expert system in order to

provide a graphic tool to aid the system analysts and designers in the interviewing process. This new graphic tool takes the fundamental concepts of a structure chart and applies them to the decision-making processing required by the human expert and the expert system.

PARK, Eun K., Assistant Professor, co-author, "An Ada Interface for Massively Parallel Systems," *Proceedings* of IEEE Fourteenth International Computer Software and Applications Conference (COMPSAC). 30 October 1991, Chicago, Illinois, pp. 430-435.

The design of a set of Ada packages defining parallel data types is described. The parallel data types and operations defined on them are intended to provide natural Ada constructs for exploitation of the data parallel Connection Machine. Implementation concepts are described, and samples of Ada application code are shown. While the interface is intended for use with the Connection Machine, the basic concepts may apply to other SIMD machines, such as the MasPar MP-1 and DAP.

PARK, Eun K., Assistant Professor, co-author, "A Medium Access Control Protocol for a Load-Sharing Local Area Network," *Proceedings* of International Conference on Parallel and Distributed Computing and Systems. New York, New York, 12 October 1990, pp. 120-123.

Hybrid-Meshnet is a load-sharing local area network which has a dual channel structure, a token ring, and a mesh data channel. The token ring is a modification of ANSI/IEEE LAN Standard 802.5. The data channel is a collection of full-duplex data links (input segment and output segment). This paper addresses the design of a medium-access-control (MAC) protocol for Hybrid-Meshnet. Specifications for the MAC layer are presented, while the logical link control (LLC) layer described in ANSI/IEEE 802.2 remains the same, so that the network can be compatible with the other ANSI/IEEE standard LAN's. Also, a finite state machine (FSM) for data link channel interface is devised.

PHILLIPS, Andrew T., Assistant Professor, co-author, "Guaranteed Approximate Solution for Indefinite Quadratic Global Minimization," *Naval Research Logistics*, **37** (1990), 499-514.

The global minimization of large-scale indefinite quadratic problems over a bounded polyhedral set using a parallel branch and bound approach is considered. The objective function consists of both a nonlinear part (nonlinear variables) and a strictly linear part, which are coupled by the linear constraints. These large-scale problems are characterized by having the number of linear variables much greater than the number of nonlinear variables. A convex quadratic underestimating function to the indefinite quadratic objective function is easily constructed and minimized over the feasible domain to get both upper and lower bounds. It is shown that the algorithm guarantees that a solution is obtained to within any specified tolerance in a finite number of steps. Computational results are presented for problems, with the number of nonlinear variables varying from 15 to 125 and up to 400 linear variables. These results were obtained on a four processor CRAY 2 using both sequential and parallel implementations of the algorithm. The computation times using a four processor CRAY 2 ranged from less than one second to a maximum of 703 seconds, with a relative stopping tolerance of 0.001. The average (ten problems) parallel solution time for a problem with 125 nonlinear variables and 200 purely linear variables (the largest problem solved in terms of the number nonlinear variables) was approximately 35 seconds. The parallel implementation is very efficient, as shown by speedups greater than the number of processors in certain cases.

PHILLIPS, Andrew T., Assistant Professor, co-author, "A Parallel Algorithm for Partially Separable Non-convex Global Minimization: Linear Constraints, *Annals of Operations Research*, **15** (1990), 101-118.

The global minimization of large-scale, partially separable non-convex problems over a bounded polyhedral set using a parallel branch and bound approach is considered. The objective function consists of a separable concave part, an unseparated convex part, and a strictly linear part, which are all coupled by the linear constraints. These large-scale problems are characterized by having the number of linear variables much greater than the number of nonlinear variables. An important special class of problems which can be reduced to this form are the synomial global minimization problems. Such problems often arise in engineering design, and previous computational methods for such problems have been limited to the convex posynomial case. In the current work, a convex underestimating function to the objective function is easily constructed and minimized over the feasible domain to get both upper and lower bounds on the global minimum function value. At each minor iteration of the algorithm, the feasible domain is divided into subregions, and convex underestimating problems over each subregion are solved in parallel. Branch and bound techniques can then be used to eliminate parts of the feasible domain from consideration and to improve the upper and lower bounds. It is

shown that the algorithm guarantees that a solution is obtained to within any specified tolerance in a finite number of steps. Computational results obtained on the four processor CRAY 2, both sequentially and in parallel on all four processors, are also presented.

PHILLIPS, Andrew T., Assistant Professor, co-author, "A Global Optimization Approach for Solving the Maximum Clique Problem," *International Journal of Computer Mathematics*, 33 (1990), 209-216.

The problem of finding a maximum clique of an undirected graph is formulated and solved as a linearly constrained indefinite quadratic global optimization problem. Theoretical upper and lower bounds on the size k of the maximum clique are derived from the global optimization formulation, and a relationship between the set of distinct global maxima of the optimization problem and the set of distinct maximum cliques of the graph is discussed. In addition, some preliminary computational results are also presented.

SCHULZE, Kay G., Assistant Professor, co-author, "Comparing Three Numbers: The Effect of Number of Digits, Range, and Leading Zeros," *Bulletin of the Psychonomics Society*, **29**, 4 (1991), 361-364.

The literature abounds with results on the cognitive processes involved in determining the larger of two numbers. The present experiment varied range, number of digits, and leading zeros to determine whether some of the major results for comparing two numbers generalize to determining the largest of three numbers. The results showed consistencies as well as inconsistencies with two number comparison data. For example, the distance effect (Moyer and Landauer, 1967) held for the three-digit numbers but was not replicated for single-digit numbers. A two-stage cognitive process is suggested, with an encoding stage and a comparison stage. At the comparison stage, strategies may vary depending on the nature of the comparison that is to be made.

Presentations

AMSBURY, Wayne, Associate Professor, "A Study of Belief Networks," Office of Naval Research Meeting, U.S. Naval Academy, Annapolis, Maryland, 23 October 1990.

CHAE, Kijoon, Assistant Professor, "Performance Evaluation of FDDI Network and Interconnected Heterogeneous Networks," IEEE Fifteenth Conference on Local Computer Networks, Minneapolis, Minnesota , 30 September - 3 October 1990.

CHAE, Kijoon, Assistant Professor, "Performance Analysis of Prioritized Token Ring," IEEE Thirty-fourth Midwest Symposium on Circuits and Systems, Monterey, California, 14-17 May 1991.

GLINOS, Nikolaos, Assistant Professor, "Computer Algebra: An Overview," Applied Mathematics Seminar, U.S. Naval Academy, Annapolis, Maryland, 20 November 1990.

GLINOS, Nikolaos, Assistant Professor, "Computer Algebra: Grobner Bases," Applied Mathematics Seminar, U.S. Naval Academy, Annapolis, Maryland, 11 December 1990.

GLINOS, Nikolaos, Assistant Professor, "Symbolic Mathematical Computations - MACSYMA," Association for Computing Machinery (ACM), U.S. Naval Academy Student Chapter, Annapolis, Maryland, 24 February 1991.

GLINOS, Nikolaos, Assistant Professor, "Towards a Standard Relational Database for an Integrated Ship Design, Analysis, and Evaluation System," Conference on Computer Applications in Design, Simulation and Analysis, International Society for Mini and Microcomputers, Las Vegas, Nevada, 19-21 March 1991.

GLINOS, Nikolaos, Assistant Professor, "Artificial Intelligence and Ship Design, Analysis, and Evaluation," International Conference on Artificial Intelligence and Simulation, Society for Computer Simulation, New Orleans, Louisiana, 1-5 April 1991.

GLINOS, Nikolaos, Assistant Professor, Session Chair, "Modeling Issues in AI and Simulation," International Conference on Artificial Intelligence and Simulation, Society for Computer Simulation, New Orleans, Louisiana, 1-5 April 1991.

HARRISON, Patrick R., Professor, co-author, "Validation of Embedded Knowledge-Based Systems," Twenty-second Annual Pittsburgh Conference on Modeling and Simulation, University of Pittsburgh, Pittsburgh, Pennsylvania, 3 May 1991.

HARRISON, Patrick R., Professor, co-author, "Process Models of Knowledge-Based System Validation," Operations Research Society of America Meeting, Philadelphia, Pennsylvania, 29 October 1990.

HARRISON, Patrick R., Professor, co-author, "Validation of Expert Systems that Implement Simulations," Military Operations Research Society Mini-Symposium on Simulation, Albuquerque, New Mexico, 18 October 1990.

HARRISON, Patrick R., Professor, co-author, "An Integrated Prototyping and Validation Model for Knowledge-Based System Design," AAAI Workshop on the Validation, Verification, and Testing of Knowledge-Based Systems, Boston, Massachusetts, 29 July 1990.

HARRISON, Patrick R., Professor, "Evaluating and Validating Expert Systems," Panelist, IEEE Managing Expert System Programs and Projects Conference, Bethesda, Maryland, 12 September 1990.

PARK, Eun K., Assistant Professor, "Translating Petri Nets to Ada Programs," ACM Twenty-ninth Conference, Auburn University, Auburn, Alabama, 12 April 1991.

PARK, Eun K., Assistant Professor, "A Case Study in Object-Oriented Systems Analysis and Design," Symposium on Computer Applications in Design, Simulation and Analysis, Las Vegas, Nevada, 19-21 March 1991.

PARK, Eun K., Assistant Professor, "A Pipeline Algorithm for Real-Time Robot Control," Symposium of Computer Applications in Design, Simulation and Analysis, Las Vegas, Nevada, 19-21 March 1991.

PARK, Eun K., Assistant Professor, "An Approach to Ada Implementation of an Associative Memory," Ninth National Ada Technology Conference, Washington, DC, 4-7 March 1991.

PARK, Eun K. Assistant Professor, "An Extended Structure Chart: A New Tool for Expert System Analysis and Design," International Symposium on Expert Systems: Theory and Applications, Long Beach, California, 12-14 December 1990.

PARK, Eun K., Assistant Professor, "A Medium Access Control Protocol for A Load Sharing Local Area Network," International Conference on Parallel and Distributed Computing and Systems, New York, New York, 12 October 1990.

PARK, Eun K., Assistant Professor, "An Ada Interface for Massively Parallel Systems," IEEE Fourteenth International Computer Software and Applications Conference (COMPSAC), Chicago, Illinois, 30 October 1990.

PHILLIPS, Andrew T., Assistant Professor, "A Parallel Stochastic Method for Solving Linearly Constrained Concave Global Optimization Problems," TIMS/ORSA Joint National Meeting, Nashville, Tennessee, 13 May 1991.

PHILLIPS, Andrew T., Assistant Professor, "Sufficient Conditions for Fast Solution of Linearly Constrained Global Optimization Problems," Global Optimization II, Sopron, Hungary, 11 December 1990.

PHILLIPS, Andrew T., Assistant Professor, co-author, "A Global Optimization Formulation of the Fractional Programming Problem," International Federation of Operations Research Societies XII Conference, Athens, Greece, 15 June 1990.

SCHULZE, Kay G., Assistant Professor, and SPEGELE, John J., Major, USMC, "Advantages and Problems of a Computer-Rich Educational Environment," Fifth Annual Southeastern Small College Computing Conference, Nashville, Tennessee, 1-2 November 1991.

SPEGELE, John J., Major, USMC, "Establishing an Undergraduate Degree in Software Engineering: The Technical, Political, Licensing/Legal State and Federal Funding Issues". Eighth Annual Washington Ada Symposium/Sumna SIGAda Meeting, Washington, DC, 17-21 June, 1991.


C.B.GIBSON

DEPARTMENT OF

Mathematics

Professor James M. D'Archangelo
Chair

Mathematics provides a logical framework and a language indispensable to understanding the world in which we live. The following pages summarize the many contributions to this field of study made during the past year by the faculty and students of the Naval Academy. The results cited reveal the great scope and diversity of mathematics and offer glimpses of its intellectual beauty and appeal.

Seven midshipmen, participating either in the Honors Mathematics Major or in special research project courses, teamed up with dedicated faculty advisers to apply their mathematical skills to a variety of interesting problems. For example, Midshipmen Richard F. Neitzy and Deborah J. Smetana worked with Professor W. Charles Mylander and Lieutenant Commander Richard K. Phares to construct a mathematical model to analyze the speed requirements for the aircraft carrier of the twenty-first century. Midshipman David M. Ruth worked with Professor Mark D. Meyerson to discover some remarkable results about mathematical constructions in non-euclidean geometry.

This past academic year was also a very productive one for the faculty. Over forty research articles appeared in refereed journals published throughout the United States and abroad. The topics covered in these articles are as varied as mathematics itself. They range from the "applied" areas of submarine fleet detection, the buckling of rods, robot vision, and the fracturing of ice formations, to the "pure" areas of harmonic functions, C*-algebras, and number theory.

Over fifty research projects were conducted by members of the Mathematics Department with the support of a variety of sources such as the National Science Foundation, the Johns Hopkins University Applied Physics Laboratory, the David Taylor Research Center, the Naval Academy Research Council, the Naval Academy Instructional Development Advisory Committee, the NASA Goddard Space Flight Center and Robotics

Laboratory, the Ford Foundation, the Office of the Chief of Naval Research, the American Society for Engineering Education, and the Office of Naval Technology.

During the past year, department members presented the results of their work on eighty different occasions at professional mathematical meetings and colloquia throughout the United States and abroad. This activity, along with publication, enhances the academic stature of the Naval Academy and promotes the professional growth and reputation of those individuals involved. Through research activity, the faculty learn of and take part in the discovery of new mathematics. This new material and ideas can then be shared with midshipmen in advanced courses.

Sponsored Research

Vulnerability of Mission of U.S. SSBN Fleet to Missile Plume Detection

Researcher: Professor P. Peter Andre
Sponsor: Johns Hopkins University Applied Physics Laboratory

The present study examined whether the strategic mission of the U.S. SSBN fleet could be compromised by enemy detection of U.S. ICBM missile launch. The enemy forces might be able to detect the launch of the ICBM by its missile plume. The enemy attack boats might then be able to target our U.S. SSBN's and eliminate much of the SSBN fleet before the fleet could accomplish its strategic mission.

High detection and targeting abilities were assigned to the enemy fleet. The study then computed the probabilities that an enemy fleet could randomly find itself in a position to capitalize on these abilities.

Operator Algebras in Mathematical Physics

Researcher: Associate Professor B. Mitchell Baker
Sponsor: Naval Academy Research Council (OMN)

This work concerns problems in the representation theory of algebras of operators on a Hilbert space which are motivated by two topics in Mathematical Physics: Classical and Quantum Statistical Mechanics. In particular, information about the action of relevant symmetries (e.g. rotation groups) and the physically important extremal trace states was sought for a large class of approximately finite-dimensional algebras. This led to problems in random walk theory: the asymptotics of non-homogeneous random walks were studied. Problems of eventual positivity and unimodality were approached, and results were obtained for (1) a large class of algebras associated with actions of the circle group, and (2) a class arising from actions of the group SU(2). These results yielded computable characterizations of (a) extremal trace spaces and (b) associated group actions for the classes of algebras considered.

Self-Help Tutorials in Probability and Statistics

Researcher: Professor Michael W. Chamberlain
Sponsor: Naval Academy Instructional Development Advisory Committee

The primary goal of this project is to produce stand-alone computer lessons for midshipmen to use as supplements to course work in probability and statistics. The lessons cover basic notions of elementary probability theory. Each lesson is designed to emphasize a certain aspect of this theory and to give the student a better feeling for what randomness is, and how mathematics attempts to model nondeterministic phenomena. In particular, elementary simulations are used to show how well the theory predicts reality.

Recent work has been directed toward providing the user more opportunities for interactive experimentation. One program was developed that allows the user easily and quickly to simulate random "games." This means that solutions to fairly complicated problems can be approximated through repetition. Also theoretically derived answers can be checked for accuracy. Two tutorials were produced that cover the construction of confidence intervals and tests of hypotheses for the population mean. Here a split screen method was developed so that the user can move forward and backward through the lesson and see both explanations and graphics simultaneously.

On Adaptive Methods for Parabolic Equations Using Mixed Finite Element

Researcher: Assistant Professor Sonia M. F. Garcia
Sponsor: Naval Academy Research Council (ONR)

The aim of the work to be conducted is to improve significantly the state-of-art in the numerical computation of solutions of parabolic problems. This work proposes three objectives. The first objective is to study multilevel methods for solving linear and nonlinear parabolic equations using cell-centered schemes. The second is to improve the existing work in the mixed finite element method by incorporating moving grids for parabolic problems. And finally, the third objective is to investigate the implementation of the first two parts for parallel machines.

A Multisymplectic Approach to Classical Field Theory and the Calculus of Variations. Part II: Space + Time Decomposition

Researcher: Associate Professor Mark J. Gotay
Sponsors: National Science Foundation, Ford Foundation, and
Naval Academy Research Council (ONR)

In a previous paper the researcher laid the foundations of a covariant Hamiltonian framework for the calculus of variations in general. The purpose of the present work is to demonstrate, in the context of classical field theory, how this covariant Hamiltonian formalism may be space + time decomposed. It turns out that the resulting "instantaneous" Hamiltonian formalism is an infinite-dimensional version of Ostrogradskii's theory and leads to the standard symplectic formulation of the initial value problem. The salient features of the analysis are: *(1)* the instantaneous Hamiltonian formalism does not depend upon the choice of Lepagean equivalent; *(2)* the space + time decomposition can be performed either before or after the covariant Legendre transformation has been carried out, with equivalent results; *(3)* the instantaneous Hamiltonian can be recovered in a natural way from the multisymplectic structure inherent in the theory; and *(4)* the space + time split symplectic structure lives on the space of Cauchy data for the evolution equations, as opposed to the space of solutions thereof. This work has been completed and has been submitted to the *Journal of Differential Geometry and its Applications* for publication. Further research into the role of symmetries in the multisymplectic formalism is ongoing.

Momentum Maps and Classical Relativistic Fields

Researcher: Associate Professor Mark J. Gotay
Sponsors: National Science Foundation and Ford Foundation

In classical field theories the Euler-Lagrange equations typically split into hyperbolic evolution equations and elliptic constraint equations. This division is accompanied by a rich symplecto-geometric structure which, in most cases of physical interest, can be directly ascertained by analyzing the relevant gauge symmetries. The purpose of this project is to study the relations between gauge groups, momentum maps, and constraints.

The main theorem shows that the constraint set for such theories may be identified with the zero-level set of the momentum mapping associated with the gauge group. This result, along with a splitting of the fields into dynamic fields and nondynamic "atlas" fields which drive the gauge freedom of the system, enables one to case the dynamics into adjoint form on the symplectic space of dynamic fields and their conjugate momenta. This, in turn,

is very useful for discussing questions of linearization stability, gauge fixing, and the structure of the space of solutions of the evolution equations.

Several examples are also presented: Maxwell electrodynamics, Einstein gravity, parametrized particles, and string theories. This project, with the collaboration of J. A. Isenberg (Oregon), J. E. Marsden (Berkeley) and R. Montgomery (Santa Cruz), was begun in 1979 and is nearing completion. It will be published as a book by Mathematical Sciences Research Institute Publications (Springer-Verlag, tentatively 1992).

Quantization and Bosonic BRST Theory

Researcher: Associate Professor Mark J. Gotay
Sponsors: National Science Foundation and Ford Foundation

The researcher shows that BRST symmetry has a natural bosonic analogue in symplectic geometry. In fact, bosonic BRST theory arises as a purely symplectic construction, which can naturally be viewed as a specific instance of symplectic induction. In this context, both the BRST charge and the total ghost number appear as the "components" of a momentum map on an extended symplectic phase space. The researcher's approach to bosonic BRST theory is motivated by certain problems which arise in the quantization of constrained classical systems. The researcher shows that the usual Dirac quantization prescription is incorrect when the system has nonunimodular symmetries, and he demonstrates how bosonic BRST theory may be used to rectify this. As a byproduct the researcher also proves, under certain circumstances, that both the processes of induction and reduction commute with quantization. One portion of this work, carried out jointly with C. Duval (Marseille), J. Elhadad (Provence), J. Sniatycki (Calgary) and G. M. Tuynman (Lille), has been published in *Ann. Physics* (NY), 206, 1-26 (1991). Research continues on the cases when (1) the symmetry group does not act freely, (2) the momentum map is singular, and (3) one considers structure functions (as opposed to constants).

An Exterior Differential Systems Approach to the Cartan Form

Researcher: Associate Professor Mark J. Gotay
Sponsors: National Science Foundation, Ford Foundation, and
Naval Academy Research Council (ONR)

The notion of a "Lepagean equivalent" of a given variational problem is defined, and the basic properties of these objects are sketched. Using some ideas of Bryant, Dedecker, and Griffiths, the researcher shows that every constant rank variational problem has a canonical Lepagean equivalent and that, as a consequence, to every such variational problem there is assigned a canonical "generalized Cartan form." These observations rely crucially upon the exterior differential systems approach to the calculus of variations. Then the researcher proves that this generalized Cartan form is *universal* in the sense that every Cartan form for a classical variational problem can be obtained from it by pullback upon sectioning a certain bundle. These results lead to a simple new proof of the existence of Cartan forms for classical variational problems and explain in intrinsic terms why and to what extent classical Cartan forms are (typically) not uniquely determined by a Lagrangian. A paper has been accepted for publication in *Geometrie Symplectique et Physique Mathematique*, P. Donato et al., eds. (Birkhauser, Boston). In the future, research will concentrate on (1) equivariant means of constructing Cartan forms, and (2) the theory of bivariant Lepagean equivalents (in conjunction with P. Dedecker [Caracas]).

L_2-Cohomology and Intersection Homology of Algebraic Varieties

Researcher: Assistant Professor Caroline G. Grant
Sponsor: Naval Academy Research Council (ONR)

L_2-cohomology and intersection homology are known to be dual for a number of important types of algebraic varieties. It has been conjectured that they are dual for all algebraic varieties, provided that a suitable metric is used to compute the L_2-cohomology. Saper proved the conjecture for algebraic varieties with isolated singularities by constructing appropriate complete Kahler metrics on the nonsingular sets of the varieties. The researcher gives natural inductive constructions of three types of Kahler metrics on the nonsingular set of any algebraic variety X. The first metric reflects the algebraic structure of X but is not complete. The second is complete with Poincare-type growth near the singular locus. The third is complete, with growth intermediate between the first two, and generalizes Saper's metric on varieties with isolated singularities. This metric seems to be a good candidate for extending Saper's theorem to a larger class of singular varieties.

L_2-Cohomology of Poincare- and Saper-type Metrics

Researcher: Assistant Professor Caroline G. Grant
Sponsor: Naval Academy Research Council (ONR)

The researcher seeks to unify two different approaches to the study of L_2-cohomology and intersection cohomology of algebraic varieties. It has been conjectured that the two cohomology theories are always isomorphic, provided that a suitable metric is used to calculate the L_2-cohomology. Cheeger proved the isomorphism for varieties with conical singularities, using an induced, incomplete metric. Saper and Stern used complete metrics to prove the conjecture for arithmetic varieties and varieties with isolated singularities. The aim of the project is to investigate the relationship between the L_2-cohomologies of an induced incomplete metric such as Cheeger's, and various types of complete Kahler metric on the smooth part of a singular algebraic variety. In particular, the L_2-cohomologies of the three metrics constructed in the project described above will be compared with the L_2-cohomology of a metric induced by an embedding in projective space. The researcher has constructed a complete Kahler metric similar to that of Saper and Stern but with no restrictions on the type of singularities involved and conjectures that a metric of this type always has the same L_2-cohomology as an induced metric.

Classification of the Isometric Extensions of a Multidimensional Bernoulli Shift

Researcher: Assistant Professor Janet W. Kammeyer
Sponsor: National Science Foundation

A multidimensional Bernoulli shift is an independent process given by a commutative $\mathbf{Z}^n$ action on a Lebesque probability space. An isometric extension of this base process is a skew product of the Bernoulli shift with the action of G, some group of isometries on a compact metric space. What may such an extension look like? In particular, when is such an extension itself a Bernoulli process?

This researcher investigated the structure of these isometric extensions and proved that if such an extension is weakly mixing, then it must be a $\mathbf{Z}^n$ - Bernoulli shift. More to the point, any such extension may be classified, both up to isomorphism and up to factor isomorphism, according to the algebraic structure of the group of isometries G. These results extend to the isometric extensions of $\mathbf{R}^n$-Bernoulli flows and $\mathbf{Z}^n$-Bernoulli processes of

infinite entropy.

The method used in this investigation is known as a "nesting procedure." The method amounts to showing that certain distributions of names in the extension process are close in the d-metric, via successive d-matching. Those processes which permit such a "nesting procedure" to be carried out successfully are exactly those which are Bernoulli. These results have been submitted for publication.

Classification of the Isometric Extensions of Relatively Finitely Determined $\mathbf{Z}^d$-Actions

Researcher: Assistant Professor Janet W. Kammeyer
Sponsor: National Science Foundation

A commutative $\mathbf{Z}^d$-action defined on a Lebesque probability space (X,A,μ) is said to be finitely determined relative to a factor $H \subset A$ if H admits a Bernoulli complement in A. In other words, $H \vee B = A$ and $H \perp B$ where $B \subset A$ is Bernoulli. An isometric extension of this base process is a skew product of the Bernoulli shift with the actions of G, some group of isometries on a compact metric space. What may such an extension look like? In particular, when may such an extension itself be relatively finitely determined?

This researcher is investigating the structure of these compact extensions. One conjecture is that either such an extension is itself relatively finitely determined or, in the extension, the factor H admits no weakly mixing complement. This theorem has been proven (by this researcher) in the case where H is trivial, in which the base process is Bernoulli. This work is currently underway.

Physical Processes in Spacetimes with Mild Singularities

Researcher: Assistant Professor Deborah A. Konkowski
Sponsor: National Science Foundation

The researcher's purpose is to study the behavior of particles and fields in spacetimes which contain mild singularities. Theorems in general relativity predict singularities in large classes of spacetimes, but the nature of these singularities is mostly unknown. If mathematical tests prove a singularity is present in a spacetime, then it can be classified as one of three types, depending on its strength: quasiregular, nonscalar curvature, or scalar curvature. The first 2 types are mild.

The researcher is studying physical processes in spacetimes with quasiregular and nonscalar curvature singularities. In particular the researcher is looking at cosmic strong spacetimes and colliding plane wave spacetimes. Even though these have mild singularities they have unusual effects on particles and fields. Several papers have been published by the author on this and more are planned.

Applications of Algebraic Image Operators

Researcher: Professor Bao-Ting Lerner
Sponsor: National Aeronautics and Space Administration/
Goddard Space Flight Center

An innovative, efficient edge detection scheme has been developed utilizing algebraic structures. This edge detector combined with the Hough transform has provided a robust method for linear feature extraction. An accurate method for deriving gradient component information has been developed. A continuous single pixel wide edge, as well as inherently parallel global operations, are some of the advantages that the algebraic edge detector possesses over classical convolution-type edge detectors.

The algebraic operators are global operations which are easily reconfigured to operate on any size or shape region. This provides a natural platform from which to pursue dynamic scene analysis.

The Conjugacy Problem in Finitely Presented Extensions of Groups and The Higman Embedding Theorem

Researcher: Assistant Professor Jody M. Lockhart
Sponsor: Naval Academy Research Council (ONR)

It is known that a graph product of groups with solvable conjugacy problem may have unsolvable conjugacy problem. Restrictions on the edge groups and the embeddings of the edge groups into the vertex groups may force the conjugacy problem to be solvable. K. J. Horadam studied graph products with cyclic edge groups. She showed that if the edge groups are finite cyclic and if the images of the edge group generators in each vertex group are powers of a common central element that the graph product has solvable conjugacy problem. Horadam conjectured that the same result is true if the edge groups are all infinite cyclic.

One objective of this project was to prove Horadam's conjecture. This objective was met; it was shown that the graph product has solvable conjugacy problem if the images of the edge group generators in each vertex group G_v are powers of a common central element c where the group generated by c has solvable generalized word problem in G_v. The method used to prove this result is interesting. The group theoretic question was first reduced to a number theoretic question; then the number theoretic question was reduced to the word problem for commutative semigroups which is known to be solvable.

In addition to settling the question about graph products with infinite cyclic edge groups, Horadam's result about graph products with finite cyclic edge groups was generalized. It was shown that the assumptions about the images of the edge groups in the vertex groups are unnecessary; indeed, if D is a nonempty finite connected graph, if (G, D) is a graph of groups, if all vertex groups have solvable conjugacy problem, and if all edge groups are finite cyclic, then the graph product has solvable conjugacy problem.

Spectral Properties of Laplaceans on Non-Compact Manifolds

Researcher: Assistant Professor Robert B. Lockhart
Sponsor: Naval Academy Research Council (OMN)

Work on the spectral properties of Laplaceans on non-compact manifolds has been continued. If M is a manifold with finitely many ends, then outside a compact set, M is of the form $K \times \mathbf{R}^+$ where K is a compact manifold. If g is a Riemannian metric on M, let v(r) be the volume of Kx[1,r] and A(r) the area of $K \times \{r\}$.

Call an end dilating if supr $v(r)\int_r^\infty \frac{1}{A(t)}dt$ *is finite.*

Call an end contracting if supr $v(r)\int_1^r \frac{1}{A(t)}dt$ *is finite.*

It has been shown this year that if g is quasi-isometric to a warped product metric, then 0 is not in the essential spectrum of the Laplacean associated to g if and only if each end is either contracting or dilating.

Stability, Bifurcation, and Fracture in Ice Mechanics

Researcher: Associate Professor Reza Malek-Madani
Sponsor: Office of the Chief of Naval Research

This proposal concerns two sets of quasilinear partial differential equations that model flow of ice-ocean fluid in the Arctic region and the formation of wing cracks in ice. For the first set of equations the main points of concern are the existence of global weak solutions for the kind of nonlinearities that model ice deformation as a compressible visco-plastic material. Because the flow is two dimensional, recent results on quasilinear parabolic systems will be used to extract the existence theorem. Then, in order to resolve a question concerning the localization of the flow near coastal boundaries, steady-state solutions of the system will be studied in a circular domain. The solutions will be cast as minimizers of proper nonlinear functionals, and their stability as solutions of the full dynamical system will be established.

The second set of differential equations will model a block of ice under uniaxial compression. Ice will be modelled as an anisotropic thermally conducting material with a nonlinear constitutive law. Using the three-dimensional formulation of the problem, the formation of wing cracks as a primary-secondary bifurcation problem will be established. The stability of wing cracks as equilibrium solutions of the governing equations will be the final part of the proposal.

Representation of Solutions to Some Higher Order Elliptic Partial Differential Equations

Researcher: Professor Peter A. McCoy
Sponsor: Office of the Chief of Naval Research

The purpose of this research was to construct integral representations of solutions of higher order elliptic PDE's and to study their properties. A method was developed for characterizing the growth of entire function solutions to the Helmholtz equation in several variables. Solutions of infinite order and type were identified through coefficient and Bernstein approximation theorems.

An integral operator was developed expressing solutions of the heat equation in R^{4+1} as transforms of analytic functions in C^3. The inverse operator was constructed for the time independent case. Formulae for the iterates of the Laplacian are under development.

An Implementation of Buchberger's Algorithm over the Integers

Researchers: Associate Professor George Nakos and
Assistant Professor Nikolaos Glinos (Computer Science)
Sponsor: Naval Academy Research Council (ONR)

The researchers have implemented two versions of Professor Buchberger's algorithm on computing GROEBNER BASES over the integers by using *mathematica*. The current state of this project is as follows: the researchers are testing their programs against well known examples for speed and correctness. The cleaned up programs will be made available to faculty and midshipmen for free use.

On Expansions of Arbitrary Powers of Multivariate Formal Power Series

Researcher: Associate Professor George Nakos
Sponsor: Naval Academy Research Council (ONR)

In this relatively short note the researcher generalizes a formula known to computer scientists and combinatorial analysts as Miller's formula. If a is any real number, this formula computes the ath power of a formal power series by an extremely efficient on-line algorithm. Miller's result is extended to any multivariate formal power series.

Computer Algebra and Desuspensions of Real Stunted Projective Spaces

Researchers: Associate Professor George Nakos and
Assistant Professor Nikolaos Glinos (Computer Science)
Sponsor: Naval Academy Research Council (ONR)

Computer algebra techniques are used to answer affirmatively a conjecture raised by Bendersky-Davis up to degree 15. The previous contribution to this difficult problem is due to Wilson (degree 7). The algorithm used is quite complicated and slow, but the confirmation of this conjecture up to degree 15 has been established.

On Ideals Annihilating the Bottom Class of $BP_*(\bigwedge_{i=1}^{n} BZ/p^k)$

Researcher: Associate Professor George Nakos
Sponsor: Naval Academy Research Council (ONR)

One of the very difficult and interesting problems in Algebraic Topology these days is the computation of the bordism groups of finite groups. Experience has shown that computing just the annihilator ideals of the bottom classes of the corresponding classifying spaces sheds a lot of light in understanding these groups.

The researcher has discovered a class of ideals that are in general properly contained in the above mentioned annihilator ideals. Alas, things are a lot messier than the experts had hoped some time ago. On the positive side, one can do a lot more work to understand those ideals, thanks to this approach.

The Use of Computers in the Core Calculus Courses

Researchers: Professor Howard L. Penn and Associate Professor Craig K. Bailey
Sponsor: Naval Academy Instructional Development Advisory Committee

The purpose of the project is to investigate the use of computers in the teaching of calculus. There are a number of objectives in the use of computers in the teaching of calculus. First is to help to illustrate the concepts of calculus. A second objective is to stress the connection between the analytic and the graphical representation of functions and equations. Another objective is to place additional emphasis on the numerical topics in the course. Another objective is to be able to present more interesting and realistic applications of the study of calculus. Above all, the primary objective is to make the students think about the mathematics rather than merely parrot a procedure.

The Naval Academy has purchased a site licence for Microcalc, a well respected program available for calculus. The researchers have also produced with help from James L. Buchanan, two other programs, MPP and MPP3D, which are useful for the study of the subject. For the benefit of students, the researchers have produced a collection of computer assignments covering the three semesters of calculus. For the last several years, each enrolled midshipman has received a copy of the software for use in the calculus courses.

The programs and assignments are used by almost all of the instructors teaching calculus. The collection of computer assignments meet all of the goals outlined above, and most students are generally very receptive to their use. The researchers have received over 400 requests for copies of the programs and computer assignments from instructors at other universities, colleges, and high schools, including six other countries. MPP has been favorably reviewed in the *College Mathematics Journal*, and there will be a review of MPP3D in the same journal within a year. The programs have been described in a number of workshops throughout the country on software for the teaching of mathematics. Since the program is public domain, there is no way to determine the total numbers of faculty members and students who have used these programs.

This is an ongoing project. MPP has been used for several years. During the last year, a new program, MPP3D which plots surfaces in 3 space was written. Additionally, an HP Laser Jet driver was added to MPP. Still there is much more that needs doing. The class of surfaces in MPP should be expanded to include surfaces defined by revolving figures in the plane as they are covered in calculus I. The researchers wish to modify the surface plotter, so that it will be able to plot two surfaces on the same graph. They need to add the HP Laser Jet support to MPP3D and write a new Postscript driver for it. Additionally, they want to add modules to plot parametric space curves and vector fields in 3 dimension. They have had several requests for both of these modules. Documentation for MPP3D needs to be written, and the computer assignments need to be revised.

Patterns of Buckling for Flexible Cylindrical Structures under Loading with Applications to Robotics

Researcher: Associate Professor John F. Pierce
Sponsor: Naval Academy Research Council (ONR)

The project has two objectives. The first is to broaden work already underway which investigates how the pattern of equilibria for a nonlinearly elastic, isotropic, cylindrical rod under axial compression alters when additional loads are applied which break the axial symmetry of the system. The mathematical model for the rod is augmented so as to include deformations which distort the shape of the cross sections of the rod. The second objective is to apply the results developed to problems of controlling robots not rigidly attached to the earth. Such control problems arise in the interaction between the body and the hand of a robot in problems of grasping, pushing, and retrieval.

Spatial Extensions of Quasi-free Derivations

Researcher: Associate Professor Geoffrey L. Price
Sponsor: National Science Foundation

A linear operator δ defined on a uniformly dense *-subalgebra $D(\delta)$ of a C*-algebra B is called a *-derivation if it satisfies the Leibniz identity $\delta(x^{*}y) = (\delta x)^{*}y + x^{*}(\delta y)$, for all x and y in $D(\delta)$. The researchers say that δ is a generator of a C*-dynamical system if there is a strongly continuous semigroup $\{a_t: t \in \mathbf{R}^+\}$ of endomorphisms such that δ is the infinitesimal generator (loosely speaking, the derivative with respect to t) of $\{a_t\}$. An interesting problem from both the physics and mathematics points of view is to obtain conditions which suffice for a derivation to admit an extension which is a generator of a C*-dynamical system.

Quasi-free derivations on the CAR (canonical anticommutation relations) algebra form a class of *-derivations for which the extension problem is extremely interesting. Quasi-free derivations are associated in a non-trivial way with symmetric operators on Hilbert spaces. A longstanding conjecture of R. T. Powers holds that a quasi-free derivation δ_S associated with a symmetric operator S has a generator extension if and only if S has a self-adjoint extension, and that these generator extensions of δ_S are again quasi-free. Work in progress with Powers seems to indicate that the conjecture fails if one replaces the CAR algebra with $B(b)$, the weakly closed von Neumann algebra containing the CAR algebra.

A New Approach to Index Theory for Derivations

Researcher: Associate Professor Geoffrey L. Price
Sponsor: National Science Foundation

In recent work R. T. Powers obtained an index theory for semigroups of strongly continuous endomorphism $\{a_t: t \in \mathbf{R}^+\}$ on $B(b)$, the algebra of bounded operators on a Hilbert space b. The index takes the values $\{0,1,2,...\} \cup \{\infty\}$ and corresponds roughly to the number of times the identity representation of $B(b)$ occurs in a representation of $B(b)$ into the algebra of bounded operators on a certain inner product space. In the case where $\{a_t\}$ has a generator which is a quasi-free derivation δ_S the index agrees with deficiency index of the unbounded symmetric operator S.

In joint work with P. E. T. Jorgensen, the author has succeeded in obtaining a generalization of Powers' work which associates an index to derivations which are not necessarily generators. In the overlapping cases, the new index agrees with the old. However, the general case entails the use of an

indefinite inner product space, which leads to complications in trying to develop a representation theory. This work has been accepted for publication.

Recently Jorgensen, Powers, and Price have begun work in which a C^*-algebra is constructed which corresponds naturally with a skew-symmetric operator on a Hilbert space. Typically this algebra is isomorphic to several copies of the compact operators or the Wiener-Hopf algebra, and the multiplicity of this algebra appears to correspond with the deficiency indices of the operator.

Air Defense Penetration Study for the LRCSW

Researcher: Professor Thomas J. Sanders
Sponsor: The Johns Hopkins University Applied Physics Laboratory

The Long Range Conventional Standoff Weapon (LRCSW), which is a future generation cruise missile, was in the concept evaluation phase when this study was done. The purpose of this study was to examine LRCSW's vulnerability to airborne defenses as a part of a sophisticated and highly coordinated air defense system.

The methodology employed was to examine LRCSW survivability in a many-on-many context, utilizing the Petropavlovsk Scenario, developed for the LRCSW system concept evaluation studies (performed by selected contractors). The model ADSIM, Air Defense Simulation, developed by JHU/APL, was utilized for the study. Only airborne defenses and their ground-based support structures were examined.

Two-Dimensional Random Tour

Researcher: Assistant Professor Aaron I. Stucker
Sponsor: The Johns Hopkins University Applied Physics Laboratory

The researcher investigated the problem of tracking a target when only a relatively few data points are present. Standard statistical methods, such as goodness of fit, for associating data with a probability distribution are not valid because of the small number of data points available.

A stochastic process that has been suggested as a possible target motion model is the Random Tour Process, which assumes that the target tracks are piecewise linear. A study was begun to determine the probability that a track was generated by an object moving in a fashion consistent with a random tour.

Electromagnetic Signature Reduction

Researcher: Professor John C. Turner
Sponsor: David Taylor Research Center, Annapolis Laboratory

Work is continuing on this classified project. Additional trials were completed in Port Everglades in December 1990. The preliminary analysis of this data indicates good models. Additional data from other sources are yet to be included. Trials are scheduled for the summer and fall of 1991 to extend further the basis of the model.

Implementation and Applications of Level-Index Arithmetic

Researcher: Associate Professor Peter R. Turner
Sponsor: Naval Academy Research Council (ONR)

The proposal was to continue with the development of possible schemes for the eventual hardware implementation of LI arithmetic and the analysis of the algorithms used, while at the same time gaining more computational experience and evidence of the potential practical value of the system via applications using software implementations of the level-index, LI and symmetric level-index, SLI, and other proposed new computer arithmetic systems. This was a continuation of previous work on the level-index system. This system was originally developed by Clenshaw and Olver to overcome the difficulties created by overflow and underflow in programs for scientific computation.

Additionally, the system and its symmetric extension, SLI, have the virtue of using a consistent and appropriate measure of precision throughout the range of the real numbers. These two advantages are offset by the fact that arithmetic within the computer will be slowed down. However, the fact that the programmer or special purpose software designer would be freed from worries about potential overflow and therefore from the need to scale problems in advance of computation will in many cases more than balance this loss.

The principal objectives were to investigate further the implementation and application of LI and SLI arithmetic and the comparison of these with other proposed new computer arithmetics. Specifically, this has led to the publication of a paper in the *Proceedings* of the IEEE Symposium on Computer Arithmetic on the implementation and error analysis of extended arithmetic operations in SLI arithmetic. A related paper co-authored with D. W. Lozier of NIST was also submitted for publication.

The methods of investigation included mathematical analysis, the development and use of algorithms for various arithmetic systems, and their application to the evaluation of mathematical functions. This included a comparative study of the various schemes. The study also included research into recent hardware design developments and their possible use in eventual implementations of the level-index scheme. The other major area of activity concerns the use of parallel processors and the implications of the parallelism for the arithmetic system used.

The principal output of this research has been in the form of research papers and the development of ideas for further developments and publications. The new ideas include work on potentially fast, new (hardware) schemes for squaring numbers and for determining the signs of "double numbers." The work is still very much alive and is likely to be continuing for several more years. It is a major undertaking involving at least four principal active contributors.

A Teaching Package for Numerical Methods and Analysis

Researchers: Associate Professors Peter R. Turner and James L. Buchanan
Sponsor: Naval Academy Instructional Development Advisory Committee

There is at present no suitable published course material for the various numerical analysis courses (SM364, SM425, and SM426) which is appropriate for the Turbo PASCAL environment. The main aim of this work is to produce course materials--notes, numerical algorithm code and software, and graphics support. A secondary purpose is to identify those areas of numerical mathematics which are most appropriate for a practical treatment in introductory courses in scientific computation for presentation to other technical majors. This may well become a pressing need after the core courses review takes effect.

Over the last several years the methods of computer solution of the mathematical problems arising from modelling of physical situations have been steadily growing in importance. The range of problems which use scientific computation in their solution has grown along with the availability of computing power. However, the mathematical texts for the teaching of this material in undergraduate courses have remained firmly fixed in the use of FORTRAN as the primary programming language. The widespread--and, importantly, the local--use of Turbo PASCAL has been largely ignored thus far. The researchers seek to rectify this situation.

The development of good text, software, and support materials tailored to the needs of our students should be an influential step in attracting midshipmen to the area of scientific computing. The text material is being developed from the

material currently covered in the courses and the supplementary notes already used. The programs are written to take advantage of the new facilitiesoffered by Turbo PASCAL Version 5.5, such as the ability to pass functions into and through procedures. It is the lack of this ability which has meant that even the existing good software such as the Turbo PASCAL Numerical Methods Toolbox is of little assistance, since it does not allow large realistic problems requiring the use of more than one of these procedures to be solved. It is also the case that this Toolbox consists of "finished programs," and so its use does not give any real idea of the considerations which go into the development of scientific software.

The programs being developed include some similarly polished work but will also include sample programs to help the midshipmen in their understanding of the development and construction of such. The researchers also intend that the final versions will be sufficiently well-organized as to be used as procedures within more extensive programs. By the end of the two courses students should have a good understanding of the broad aspects of the subject, together with useful experience in building complex programs to solve real-life problems using the programs as significant building blocks.

Currently some 750 pages of text and several of the Turbo PASCAL units are available for use within math courses. They have been used as the primary text in SM425 and SM426 and as supplementary notes for SM364.

Periods and Subperiods of Matrices

Researcher: Associate Professor William P. Wardlaw
Sponsor: Naval Academy Research Council (ONR)

A square matrix A has period p and tail t if p is the smallest positive integer s and t is the smallest nonnegative integer k such that $A^{k+s} = A^k$, and A has subperiod q if there is a nonzero vector v such that q is the smallest positive integer r such that $A^r v = v$. A polynomial f(x) has exponent n if f(x) divides $x^n - 1$ but does not divide $x^k - 1$ for $0 < k < n$. Let A be a nonnilpotent matrix with minimum polynomial m(x). Then it is shown that A has period p and tail t if and only if $m(x) = x^t g(x)$ and g(x) has exponent p; that if A has period p, then p is also a subperiod, and every subperiod q of A divides p; and that A has subperiod q if and only if $\gcd(m(x), x^q - 1)$ has exponent q.

Matrix Representation of Finite Fields

Researcher: Associate Professor William P. Wardlaw
Sponsor: Naval Academy Research Council (ONR)

A method of representing the elements of a finite field F_q as the powers of a matrix A over its prime field F_p is presented. The researcher is in the process of writing an expository paper on these results.

Independent Research

New Results in Near Chromatic Polynomials

Researcher: Associate Professor Carol G. Crawford

This is an ongoing program of research concerned with almost proper line colorings and Near Chromatic Polynomials, reported by this researcher and Dr. Ruth Bari at the Second China-USA International Conference on Graph Theory, San Francisco, California. Let G be a simple (p,q)-graph with $q > 0$. A λ-coloring of the lines of G is almost proper if no three lines incident with the same vertex are assigned the same color. The Near-Chromatic Polynomial of G, denoted $N(G;x,y)$, is a polynomial that, for each integer $\lambda > 0$, counts the number of almost proper line colorings of G in at most λ colors. Current results of this project include an efficient reduction procedure and applications to experimental design problems.

Artificial Intelligence Applications for the Navy's 6.2 Technology Program

Researcher: Associate Professor Carol G. Crawford

The goal of this research project was to determine *state-of-the-art applications of artificial intelligence* suitable for the Navy's 6.2 logistics technology program. This project was sponsored by the American Society for Engineering Education/Navy Research Fellowship and the David Taylor Research Center, Carderock Laboratory. Special emphasis was given to expert systems and neural networks as applied to Fleet Logistics Readiness, Advanced Diagnostic Techniques, Advanced Test Equipment and Meterology, and Replenishment and Cost Analysis.

Multivariate Statistical Analysis

Researcher: Associate Professor Gary O. Fowler

Multivariate statistical analysis has become more accessible to undergraduates by way of computer programs, such as MATLAB, that specialize in matrix algebra. This research has focused on the problem of presenting the mathematical aspects to midshipmen. Generally, their core courses provide them with a minimal background for understanding multivariate statistics. A study of the historical development and a re-examination of the mathematical theory of multivariate statistics have provided the insight to produce an exposition at a level and in a context accessible to midshipmen. The result should be an ability by the midshipmen to understand analysis of multivariate data.

Numerical Stability Analysis of a Thermo-Visco-Plastic Bar

Researcher: Lieutenant Dennis R. Frazier, USN

This project is the continuation of work begun in the researcher's Master's thesis and more recently done in collaboration with Associate Professor Reza Malek-Madani and Associate Professor Thomas Mahar of the Naval Academy Mathematics Department on the numerical approximation of the spectra of differential operators. The differential operators are approximated by a discrete matrix

system of finite difference approximations to the derivatives. The Double Implicit Shifted QR Algorithm ("Double QR") is applied to the matrix to obtain the eigenvalues to the desired accuracy. Double QR is a powerful computational technique for these calculations, because complex eigenvalues can be computed without the need for complex arithmetic. Therefore, with sophisticated implementation, a personal computer can be used for calculations on large matrices which would otherwise require a mainframe or supercomputer.

The researcher has employed this method on self-adjoint operators from quantum mechanics with outstanding success. Recently, this technique has proven successful in approximating the eigenvalues of a non-self-adjoint system of partial differential equations modeling shear in a thermo-visco-elastic bar. The eigenvalues of this system determine the stability of equilibrium solutions. The results have compared very well with analytical results in those special cases where exact eigenvalues can be obtained.

The formation of shear bands in thermo-visco-elastic materials is currently of great interest in mechanical engineering. The stability analysis by numerical calculation enables comparison of the mathematical model with experimental results, which could contribute to the prediction of shear band formation in materials subjected to shear. This approach to more complicated mechnical models will also be investigated.

The Model Class of the Theory of Non-Abelian Free Groups

Researcher: Professor Anthony M. Gaglione

A. Tarski conjectured that the non-Abelian free groups satisfy precisely the same first-order sentences in a language appropriate for group theory, i.e., that they are elementarily equivalent. In this project, the Baunslag construct

$$K = (F * \bar{F}; u = \bar{u}),$$

i.e., a free product of F and $\bar{F}$ with amalgamation was studied. In particular, using methods of his own, the researcher was able to show that if F is a non-Abelian free group, then K, as above, where u is not a proper power in F, satisfies "many" of the sentences satisfied by every non-Abelian free group. G. Rosenberg showed that K is 3-free. This led the researcher to the following question which is still being investigated: "Is every finitely-generated non-Abelian 3-free group a model of the set of first-order sentences satisfied by every non-Abelian free group?"

Consecutive Points

Researcher: Professor Robert A. Herrmann

It is known that the classical concept of consecutive points is not properly modeled by standard mathematics. This researcher obtained previously a nonstandard characterization for consecutive points that parallels the classical concept. The question remained as to the existence of sets of such points. In this research, it has been shown that if for continuous

$$c:[a,b] \to R^{\underline{n}},\ n > 1,\ a < b,\ t' \in (a,b)$$

there is some fixed k, where $1 \leq k \leq n - 1$, such that the k-derivative, $c^{(k)}$, is continuous on (a,b), and $\{c^{(1)}(t'),...,c^{(k)}(t')\}$ is linearly independent in $R^{\underline{n}}$, then there exists a *-finite sequence of distinct internal sets $C_{\underline{m}}$, $m \in {}^*\underline{N}$ such that each $C_{\underline{m}} \subset \mu(t')$, and each $C_{\underline{m}}$ contains $(k + 1)$-consecutive points.

Ultralogics and More

Researcher: Professor Robert A. Herrmann

This is a special writing project to re-establish, improve upon, and extend all of the known results in the researcher's theories of ultralogics, developmental paradigms, ultracontinuity, ultrasmoothness, and the like. One of the more significant discoveries is the following: Let A be a nonempty set of atoms. Suppose that for nonempty sets X, Z; $A \notin X \cup Z$, $X \cap A = Z \cap A$, and there exists a bijection $\beta: X \to Z = \beta[X]$, where β is a set-theoretic bijection on sets and the identity on any atoms in $X \cap A$. Consider the sets $X_0 = X \cup A$, $Z_0 = Z \cup A$, and A and $\varnothing$ as the constants that denote a nonempty set of atoms and the empty set in our **ZFA** model. If X_0, Z_0 are 0-atomic, then the structures $<X_0, \epsilon, =>$ and $<Z_0, \epsilon, =>$ are isomorphic. Furtl.er, for each $n \geq 1$, if X_0, Z_0 are n-atomic, then the structures $<X_n, \epsilon, =, A, \varnothing>$ and $<Z_n, \epsilon, =, A, \varnothing>$ are isomorphic and the isomorphism is special.

Derivative Polynomials

Researcher: Associate Professor Michael E. Hoffman

The purpose of this research is to develop a theory of polynomials generated by repeated differentiation and apply it to interesting cases, particularly the tangent polynomials $P_n(x)$ defined by

$$\frac{d^n}{dx^n}(\tan x) = P_n(\tan x).$$

The results are that for any function $f(x)$ such that $f'(x) = P(f(x))$ for some polynomial function P, there is a sequence of polynomials $P_n(u)$ given by $f^{(n)}(x) = P_n(f(x))$. The author has found a formula for the generating function

$$F(u,t) = \sum_{n=0}^{\infty} P_n(u)\frac{t^n}{n!},$$

as well as one for the corresponding generating function for the "companion" polynomials $Q_n(u)$ defined by $g^{(n)}(x) = Q_n(f(x))f(x)$, where $g(x) = e^{\int f(x)dx}$. These generating functions can be related to the theory of symmetric functions.

In the case $f(x) = \tan x$, the generating functions satisfy an interesting functional equation. This case also leads, via various formulas for improper integrals, to identities relating values of the derivative polynomials for tangent to certain infinite series. In particular, the author is able to obtain a simple formula for Dirichlet L-series. The values of the Bernoulli and Euler polynomials at rational numbers can also be expressed in terms of the derivative polynomials. A paper discussing the results above will be submitted shortly. Research on the functional equation continues.

Cuspital Distributions

Researcher: Assistant Professor W. David Joyner

Research was conducted on cuspidal distributions associated to maximal parabolics and elliptic Cartans. Good progress was made. The researcher submitted a paper on supercuspidal distributions on certain unitary groups. A project was partially completed concerning the large sieve problem suggested by Secretary of the Navy Fellow, Larry Goldstein. Dr. Jim Fennell and the researcher also obtained some good bounds for large sieve inequalities over cyclotomic fields.

Restricted Orbit Equivalence for Actions of Discrete Amenable Groups

Researcher: Assistant Professor Janet W. Kammeyer

The central question in Ergodic Theory is to ask whether two dynamical systems are "the same." For example, suppose $(X,\mathcal{A},\mu)$ is a Lebesgue probability space. Let T be a measure preserving finite entropy ergodic **Z**-action on $(X,\mathcal{A},\mu)$. Two such systems are said to be orbit equivalent if there exists a bimeasurable, measure-preserving map ϕ between them which preserves the T-orbits, as sets. In 1959, H. Dye proved that any two ergodic **Z**-actions are "the same," in the sense that they are orbit equivalent.

If more restrictions are placed on this orbit equivalence ϕ , so that, for instance, the map ϕ must also preserve the order of the orbits, then any two ergodic **Z**-actions which are orbit equivalent in this restricted sense are said to be isomorphic. In 1970, D. Ornstein proved that any two Bernoulli (i.e., independent) **Z**-actions of equal entropy are "the same" in the sense that they are isomorphic.

These two notions of "sameness" may be thought of as two ends of a spectrum of restricted orbit equivalence, with orbit equivalence putting essentially no restriction on ϕ and isomorphism putting a quite rigid restriction on ϕ . In 1985, D. Rudolph published a general theory of restricted orbit equivalence for **Z**-actions. He defined the "size," m, of an orbit equivalence and defined what it meant for two **Z**-actions to be "the same" in the sense of being m-equivalent. He then proved a theorem which gave a characterization of those **Z**-actions which are m-equivalent.

This researcher is working jointly with D. Rudolph to extend the restricted orbit equivalence theory to G-actions, where G is some discrete amenable group, such as $\mathbf{Z}^d$.

Applications of Algebraic Image Operators

Researcher: Professor Bao-Ting Lerner

An innovative, efficient edge detection scheme has been developed utilizing algebraic structures. This edge detector, combined with the Hough transform, has provided a robust method for linear feature extraction. An accurate method for deriving gradient component information has been developed. A continuous single pixel wide edge, as well as inherently parallel global operations, are some of the advantages that the algebraic edge detector possesses over classical convolution-type edge detectors.

The algebraic operators are global operations which are easily reconfigured to operate on any size or shape region. This provides a natural platform from which to pursue dynamic scene analysis.

Linear Stability of a Thermo-Visco-Plastic Bar

Researchers: Associate Professor Thomas J. Mahar and Lieutenant Dennis R. Frazier, USN

A thermo-visco-plastic bar subject to a fixed end strain responds with a constant normal strain field. The linear stability of this displacement field is analyzed by solving the governing equations of linearized thermo-visco-plasticity. The standard procedure for solving such a system of partial differential equations consists of separating variables and studying the resulting eigenvalue problem. This procedure is shown to fail for a class of thermo-visco-plastic materials. The procedure fails because the resulting eigenvalue problem does not have a complete set of eigenfunctions for most thermal boundary conditions. Indeed, the non-self-adjoint elliptic operator for this problem does not have a spectral resolution of any type.

The stability analysis is carried out in three steps. First, the system of two partial differential equations is reduced to a single integro-partial differential equation for the temperature field. A transform is applied to this equation to derive an iterated renewal equation in the time variable for the spatial average of the temperature field. Laplace transforms are used to solve the renewal equation. Fourier inversion of the Laplace transform is complicated by the presence of a non-isolated singularity in the finite complex plane. This leads to an integral representation which cannot be reduced to a simple sum of residues. After the spatial

average of the temperature field is found, a non-homogeneous parabolic equation is solved to determine the temperature field. The displacement field is then determined from an integral representation.

A simple stability condition on the parameters of the problem follows from the analysis. Stability conditions for shear bands in plane and cylindrical geometry also follow immediately from the analysis.

The Foundations of Continuum Mechanics and Untypical Problems

Researcher: Associate Professor Reza Malek-Madani

The researcher, in cooperation with J. F. Pierce of the U.S. Naval Academy and Professor Clifford Truesdell of the Johns Hopkins University, proposes to investigate the formation and stability of singularities in systems of quasilinear elliptic and parabolic differential equations that govern the deformation of nonlinear viscous materials. Of particular interest are the effects of thermodynamical processes on the stability of singular and weak solutions of these equations. The governing equations stem from problems that originated in the mathematical formulation of the "shear band" problem in high-strength steel and problems that arise in the study of the wing cracks in ice mechanics.

Recent advances in the theory of nonlinear parabolic systems, the paper of Friedman and Necas specifically, have enabled the researcher to establish global existence of weak solutions for systems of the form

$$u_t = \frac{\partial}{\partial x}[f(u_x, u_{x1}, \theta)], \quad \theta_t = \theta_{xx} + f u_{x1},$$

that govern the simple shearing motion of a nonlinearly viscous material whose constitutive equation is given by f. In Maddocks and Malek-Madani it was shown how an existence theorem of this nature can be combined with a variational analysis of the equilibrium solutions of the above system of partial differential equations to establish the nonlinear and dynamic stability of the equilibria. It should be emphasized that among equilibria of the above system of equations are "shear band" solutions, namely solutions with a concentration of high velocity gradient in a small region of space. These solutions have been conjectured to be at the heart of failure, crack formation, and contact and separation of bodies. A very similar phenomenon is believed to be responsible in the formation of wing cracks in anisotropic ice under compressive loading.

Geometry

Researcher: Professor Mark D. Meyerson

The researcher studied the geometry of three-dimensional manifolds. In the spring, while on sabbatical, the researcher commuted weekly to Princeton to attend a course conducted by Professor William Thurston on the subject of geometric topology. One result of this study was the realization that manifolds can be given a geometric structure which aids in their classification.

Work was done with Midshipman 1/C David M. Ruth investigating the application of Euclidean construction techniques to Non-Euclidean geometry. In hyperbolic geometry it is natural to consider some tools not available in the Euclidean plane. In particular, a horocompass draws a "limiting curve" instead of a circle. The researchers showed that a straightedge and horocompass can construct any points that a straightedge and compass can construct.

Special Values of Zeta Functions of Higher Degree Forms

Researcher: Associate Professor Courtney Moen

The purpose of this project is to investigate the arithmetic and analytic properties of zeta functions attached to some forms of higher degree. This work is an outgrowth of some previous work of the researcher and M. Hoffman, concerning multiple harmonic series. In this project, the researchers specialize the variable exponents appearing in the multiple series and investigate the resulting function of a single complex variable. The goal is to study questions involving analytic continuation, function equations, and formulas for the special values of positive and negative integers.

Roles, Missions, and Threats Panel: Future CV Design Study

Researcher: Lieutenant Commander Richard Phares, USN

The researcher is serving as a member of the Roles, Missions, and Threats Panel of Future CV Design Study. The Center for Naval Analyses has been tasked by OP-55 to provide in the summer of 1991 a study describing what will be required of aircraft carriers in the future. The panel is one of several; others include the ship panel, (what the new carrier will look like) and the air panel, (what kind of aircraft will it carry) which will be collaborating this spring on the final report. To date the researcher has submitted seven point papers to the team leader, Dr. Peter Perla.

The Global Structure of Buckled States of Compressible Columns with Varying Cross Section

Researcher: Associate Professor John F. Pierce

Singularity theory and global bifurcation theory are used to determine the qualitative properties of non-bifurcating buckled states for a compressible, nonlinearly elastic rod whose cross sections change shape under deformation. The work complements the analysis of such buckled states for rods under the critical assumption that cross sections of the rod remain unchanged as the rod deforms. The work exploits recent advances in the description of the static equilibria of such rods using the theory of pseudo-rigid bodies. This work is being conducted with S. Antman.

Spontaneous and Induced Symmetry-Breaking Bifurcations in Pseudo-Rigid Bodies

Researcher: Associate Professor John F. Pierce

The theory of pseudo-rigid bodies describes the dynamic behavior of elastic bodies when the deformations are constrained to be homogeneous. Through a kinetic analog, the theory may be used to predict equilibrium configurations for non-linearly elastic rods whose cross sections alter shape under deformation. The theory is also described in the dynamic behavior of a particular type of mechanical structure which occurs frequently in robotics, known as a closed linkage.

The work studies what changes can occur to a family of equilibrating configurations for an unloaded, axially symmetric pseudo-rigid body both spontaneously and when the researcher applies perturbing loads which break the symmetry. The question is formulated as a problem of bifurcation on a group orbit to which the theory of singularities applies. The analysis indicates how alterations in the family of equilibrating configurations depend upon symmetries preserved or broken spontaneously, or by the perturbing load, and upon symmetries present in the response of the material comprising the body.

The Shapley Value of Resale Proof Trader

Researcher: Visiting Assistant Professor Thomas Quint

The researcher studied transferable utility games associated with resale-proof trades of information. These games are defined in Nakayama and Quintas, "Games and Economic Behavior."

Instead of the core, the researcher examines the Shapley Value Y of such games. The following points are made:

(1) Since these games are closely related to simple games, the Shapley Value is a good measure of "power" for the players in the game.

(2) The Shapley Value Y lies in the core if there is exactly one resale-proof set.

(3) A simple expression for Y exists in the case of a symmetric game (i.e., where payoffs only depend on the size of the set of non-inventors in a coalition).

(4) Easy to use bounds are derived for Y in the general (non-symmetric) case. In particular, if player 1 is the inventor, the researchers prove $Y_1 \geq Y_i$ for all i .

The research was supported by the American Society for Engineering Education/Office of Naval Technology Postdoctoral Fellowship Program and done in collaboration with L. Quintas.

Necessary and Sufficient Conditions for Balancedness in Partitioning Games

Researcher: Visiting Assistant Professor Thomas Quint

The researcher considers the class of partitioning games, which includes the bridge game, assignment game, consecutive game, and m-sided assignment game. These are games in which the set of essential coalitions, instead of being restricted to "one of each type" pairs (as in the assignment game) can be any set π. He then proves, using the theory of linear programming, that the core exists if a certain "partitioning linear program" (PLP) solves integrally. Furthermore, if the core does exist, the set of core payoff vectors for the player is precisely the set of dual solutions to the PLP. In the case of the assignment game, the PLP reduces to the "assignment linear program" (which always solves integrally), so the main result of Shapley and Shubik's "assignment game" paper (*International Journal of Game Theory*, 1972) is generalized. The documentation of this research has been accepted for publication in *Mathematical Social Science*. This project was supported by the American Society for Engineering Education/Office of Naval Technology Postdoctoral Fellowship Program.

Lattices and Two-Sided Matching Markets

Researcher: Visiting Assistant Professor Thomas Quint

The purpose of this research is to see if in some sense the set of core matchings in the 2-sided matching model of Demarge-Gale (*Econometica*, 1985) is a lattice. This would be natural because in the ordinal preference TSMM of Gale-Shapley, (*American Mathematical Monthly*, 1962), the set of core matchings is a lattice (and hence the agents on one side of the market have incentive to cooperate.

To do this, the researcher reasoned as follows: first, since core matchings define regions (in Euclidean space) of possible core payoffs, one must first devise a partial ordering over the set of possible regions. The researcher can show that all such regions are sublattices of $\mathbf{R}^n$, and thus the researcher can use the relation $\leq$ defined in Topkis (*Operations Research*, 1978) as a partial ordering. The researcher obtained the following result:

Thus: If (a) The set of possible core payoffs U_μ for players on one side of the market under any core matching μ is connected, and (b) A certain "nondegeneracy condition" holds, then the set of core matchings is a lattice under the partial ordering $\leq$ defined by $\mu^1 \leq \mu^2 \Rightarrow U_{\mu 1} \leq U_{\mu 2}$.

Finally, the researcher generalizes the above to the case where the sets U_μ may not be connected, by introducing the concept of semimatchings, which essentially are "matching-connected region of payoffs" pairs. Then, in the general case (where still the non-degeneracy condition is assumed), the set of core semimatchings is a lattice under $\leq$.

A Second Order Perturbation Solution of the Main Problem in Artificial Satellite Theory

Researcher: Lieutenant Christopher P. Sagovac, USN

The goal of this research was to extend the methods developed by Danielson, Snider, and Sagovac in the paper "Satellite Motion Around an Oblate Planet: A Perturbation Solution for All Orbital Parameters Part II -- Orbits for All Inclinations," AIAA-90-2885, *Proceedings* of the AAS/AIAA Astrodynamics Conference, held in Portland, Oregon, August 1990. Those methods were successful in developing a singularity-free first order solution to the main problem in artificial satellite theory. An open question after the development of the theory was whether the methods could successfully be extended to second order.

Extensive use was made of the symbolic manipulation program Mathematica, available on the Mathematics Department Local Area Network. Special programming techniques were developed and used which simplified the tedious algebraic computations. These programming techniques and programs (in Mathematica) are not problem-specific and reside on the net ork for all to use. For instance, an initialization file, init.m, is introduced which fixes several "bugs" in Mathematica and introduces several useful functions which were not included with Mathematica. Further, the trigonometric simplification package Trigonometry.m was found to be in error and was rewritten by Dr. Andre Deprit of the National Institute of Science and Technology, Gaithersburg, Maryland. Computations performed in mid-January revealed that a singularity exists to second order in the general solution to the main problem when using the aforementioned theory. In carefully weighing the other advantages/disadvantages of the theory, it was determined that the theory did not meet the necessary criteria to make it preferable to other, more established theories used to solve the main problem in artificial satellite theory.

Work on the theory has been suspended due to the singularities encountered to second order. Alternative approaches, developed by other researchers, are presently being pursued.

Navy Astrodynamics Working Group

Researcher: Lieutenant Christopher P. Sagovac, USN

The Navy Astrodynamics Working Group was commissioned to study compatibility and standardization issues as they apply to space surveillance activities concerning the Navy and other government agencies which exchange element sets/software.

Multiplex Method of Linear Programming

Researcher: Associate Professor Carvel S. Wolfe

The researcher has developed a program that is ten times faster than the Standard Simplex Method; i.e., it uses 1/10 (or often fewer) iterations than the Simplex Method.

Integer Programming

Researcher: Associate Professor Carvel S. Wolfe

The researcher is developing Integer Programming by the cutting plane methods. Various scheduling cases prove to be much easier (faster) by cutting planes than by Branch and Bound.

Research Course Projects

Contour and Surface Fitting

Researcher: Midshipman 1/C Matthew D. Heck, USN
Adviser: Associate Professor Peter R. Turner

The task of fitting appropriate contours to multidimensional data has been studied extensively and has led to many different approaches which have varying degrees of appropriateness for different situations. One of the principal methods is based on the use of piecewise polynomial interpolation, in which the researchers seek polynomials of minimum degree which agree with all the data in each subdomain.

An alternative which was explored for the situation where the function is given in closed form is to use an "equation-solver" to locate points on contours. It became clear, however, that even for reasonably simple functions, piecewise quadratic interpolation functions with a carefully chosen grid would be more efficient. The remainder of this study was restricted to bivariate piecewise polynomials on a rectangular grid of data points. In particular, programs were developed for plotting contours of piecewise bilinear and biquadratic interpolants. These are the fundamental functions of the two variable finite element methods on rectangular meshes.

A computer program to generate these contour plots was developed which allows the function and/or data as input with the mesh points and contour values either specified by the user or placed uniformly throughout the domain and a specified range.

The techniques and programs studied here will be further developed for possible inclusion in the numerical analysis teaching package being developed for the U.S. Naval Academy by Associate Professors Peter R. Turner and James L. Buchanan.

Modelling of Electromagnetic Data

Researcher: Midshipman 1/C Kevin S. Mooney, USN
Adviser: Professor John C. Turner

This project develops models for electromagnetic data, with the objective of predicting the moment from onboard data. The data are on North-South headings only, so additional data are used to validate the model for other headings.

Singularities in Spiess Target Motion Analysis

Researcher: Midshipman 2/C Frederic E. Nauck, USN
Adviser: Visiting Research Professor Daniel H. Wagner

The problem addressed is finding range, course, and speed of a constant-velocity target using four bearings. In the Spiess method of doing this, the observer takes three bearings while on a constant-velocity leg, turns to a new course at the same speed, takes a fourth bearing, and intersects that bearing line with the bearing that would have occurred (predictable from the first three bearings) if the observer had not changed course. The intersection is the target position. From two positions and times, one obtains course and speed.

A difficulty is that the two bearings may coincide, which is a "singularity," and no unique intersection exists. Also, if the angle of intersection is small, then the position estimation is very sensitive to bearing errors.

A method was developed to compute the set of pairs of second-leg course and fourth bearing time which result in a singularity, given knowledge of target speed. The reason target speed suffices is that the first three bearings and times determine the direction of the target motion *relative* to the observer. Since target speed is not known, a tactical decision aid was developed to compute and graph the singularity curve(s) (there may be two, one, or zero) for each of four representative speeds spanning the possible target speeds. Application of this aid shows that for target speeds above the observer speed, a sector of second-leg courses is identified for which singularity-avoidance is assured. For target speeds lower than observe speed, reliance must be placed on avoidance of certain fourth bearing times.

Speed Requirements for the Aircraft Carrier of the Twenty-First Century: A Mathematical Model

Researchers: Midshipmen 1/C Richard F. Neitzey and Deborah J. Smetana, USN
Advisers: Professor W. Charles Mylander and
Lieutenant Commander Richard K. Phares, USN

In designing the next generation of aircraft carriers, cost restraints and issues of survivability and mission effectiveness must be balanced. A reduction in the power plant from that in the current Nimitz class thirty-knot carrier type to a smaller power plant propelling a new class of carriers at twenty knots will provide a reduction in cost but at the loss of mobility.

This project assessed the impact of the loss of mobility of a carrier in a strike against well defended land bases. A model was developed and implemented in a spreadsheet using the spreadsheet program SuperCal4. It calculates the results of attacks by a land-based force (Red) against a carrier task force (Blue), and Blue attacks against Red. It is assumed that attacks by the opposing forces cannot occur simultaneously. Particular attention is paid to how Red should use long-range surveillance aircraft to locate the approaching Blue Task Force. Thus an attack built around a slower aircraft carrier is much more vulnerable to long-range detection and attack by Red. The project reports present the spreadsheet model and the measure of effectiveness chosen to compare the thirty-knot carrier against the twenty-knot carrier. The model was used to examine several different scenarios, including scenarios with an initial Red surprise attack, ones with an initial Red attack without surprise, and ones with an initial Blue cruise missiles attack. The 30-knot carrier is shown to have a significant advantage over a 20-knot carrier, due to its ability to get in close enough to deliver an effective attack while not suffering as much a reduction of capabilities due to prolonged exposure to long range Red attacks.

Geometric Construction in Euclidean and Non-Euclidean Planes

Researcher: Midshipman 1/C David M. Ruth, USN
Adviser: Professor Mark D. Meyerson

The study of geometry and geometrical constructions has fascinated mathematicians for centuries. This paper begins by laying a foundation for geometry, providing an axiom system as ground rules accompanied by geometrical definitions. The focus is then directed to constructions in two different geometries: Euclidean and hyperbolic. The fundamentals of the ancient and famous game of constructions are discussed, and references to the familiar Euclidean plane and proofs of the equivalence of certain tools are offered. Next, the topic of hyperbolic geometry is addressed. Included are several definitions of and discussions of concepts associated with this less-familiar geometry. Finally, the stage is set to discuss the rules and tools associated with constructions in the hyperbolic plane. Examples of such constructions are offered, and then the main result of this study is presented: proof that any construction in hyperbolic geometry that may be done using straightedge and compass may be performed alternatively with straightedge and horocompass. The constructions performed in the hyperbolic plane are independent results (unless otherwise indicated), but these same results very likely may be found in Russian publications not available in translation.

Comparative Testing in Single-Leg Target Motion Analysis

Researcher: Midshipman 2/C Vincent C. Vertin, USN
Adviser: Visiting Research Professor Daniel H. Wagner

Two PC programs had been previously developed to find target, range, course, and speed from bearings observed while the target and the observer move at constant velocity. These are called Naval Academy Target Motion Analysis (NATMA) and Track Bundle Target Motion Analysis (TBTMA). The project goal was to compare the accuracy of these methods.

Both methods use Bayesian inference, based on user-entered prior distributions of course, speed, and, in the case of TBTMA, range, and on observed bearings. Both initially infer a distribution of target velocity from the velocity prior and the bearing observed at detection. Both use Monte Carlo simulation in different ways. NATMA simulates errors for each of three observed bearings, computes direction of relative motion, infers distributions of velocity and range and, by Monte Carlo, averages these distributions over a normal distribution of bearing errors. TBTMA generates sample target tracks and a distribution over same and updates the track probabilities for each bearing observation.

Before the testing, revisions to TBTMA were undertaken. The range prior was changed from the Weibull to the lognormal form of distribution. The track generation was changed from uniform to random sampling of the priors. The most challenging aspect of the latter was linearization of the bivariate velocity distribution followed by inversion of the resulting cumulative distribution function.

The main accuracy criterion for testing was that range should be estimated within 20% of actual range. Combinations of initial bearing and target course were chosen on the basis of having a significant probability of occurring, according to the initial-bearing update. A single prior for speed was used; the course prior was uniform over 360^{o} or various 180^{c} sectors.

NATMA tests showed generally good accuracy, given bearing differences at least five times the assumed standard deviation of bearing error. The revised TBTMA program compared unfavorably with NATMA and, surprisingly, with the original TBTMA. In a few comparisons between the latter and NATMA, neither had a clear advantage over the other.

Publications

ANDRE, P. Peter, Professor, "Vulnerability of the Strategic Mission of U.S. SSBN Fleet to Detection of Missile Plume," Applied Physics Laboratory, Johns Hopkins University Report, August 1990.

The report addresses the probability that a randomly arrayed enemy fleet could compromise the strategic mission of the U.S. SSBN fleet by detection of the SSBN's ICBM missile launch.

BUCHANAN, James L., and Howard L. PENN, Professors, "MPP and MDEP, Software for Calculus and Differential Equations," *Proceedings* of the 1990 American Society for Engineering Education Annual Conference, pp. 36-38.

MPP is a collection of eight modules used for the teaching of calculus. The program runs on IBM PC and compatibles with at least 512K memory and a graphics board. The program is menu-driven and extremely easy to use. It makes excellent use of color computer graphics. MDEP is a program designed for the teaching of differential equations. The requirements are the same as MPP. Some of the program's strong points are its ability to draw easily phase plane portraits, tangent fields, and numerical solutions to differential equations. The program also easily handles series solutions. These programs may be obtained from the authors for just the cost of the media.

BUCHANAN, James L., and Howard L. PENN, Professors, and Thomas J. MAHAR, Associate Professor, "The Geometric Interpretation of Differential Equations," *Visualization in Teaching and Learning Mathematics*. Eds. Walter Zimmermann and Steve Cunningham, MAA Notes, Volume 19 (1991), 139-147.

There are many examples of ways that Geometric Interpretation can aid the understanding of the solution to differential equations. In this paper the authors present a few such examples. These include the study of the solution to the vibrating spring problem, resonance in an electric circuit with a square wave forcing function, and the study of the orbital mechanics of the three body problem.

CRAWFORD, Carol G., Associate Professor, co-author, "New Results in Near Chromatic Polynomials," *Proceedings* of Second International Conference on Graph Theory and Computing, Springer-Verlag, June 1991, pp. 31-42.

This paper extends results published in earlier papers by the author and R. Bari. In particular, this paper presents an efficient reduction algorithm for the calculation of Near Chromatic Polynomials, together with applications to experimental design.

CRAWFORD, Carol G., Associate Professor, "Artificial Intelligence Applications for 6.2 Navy Logistics Technology," David Taylor Research Center Technical Report, December 1990.

This report is the result of research funded by a 1990 Navy/American Society for Engineering Education Research Fellowship. The author explores expert systems and neural networks with specific applications to logistics technology.

D'ARCHANGELO, James M., Professor, co-author, "Resonant Acoustic Scattering from Elastic Spheroids," *Journal D'Acoustique*, 3, (September 1990), 201-212.

The resonances of submerged solid prolate elastic spheroids excited by axially incident sound have been visualized by a T-matrix calculation of the far-field backscattering amplitude (form function), obtained as a function of frequency. A "tangent sphere model" is used to predict the resonance frequencies from the phase matching of circumnavigating surface waves of both Rayleigh and Whispering-Gallery type, leading to good agreement with the T-matrix results for tungsten carbide, steel, and aluminum spheroids of aspect ratios between 1.5 and 2.

GAGLIONE, Anthony M., Professor, co-editor, *Combinatorial Group Theory-Proceedings* of the AMS Special Session in Combinatorial Group Theory-Infinite Groups, Rhode Island: American Mathematical Society, 1990.

This volume contains the papers in final form of a special session of the American Mathematical Society on Combinatorial Group Theory held at the University of Maryland in April 1988. This session was organized by A. Gaglione, B. Fine, and C. X. Tang. Each paper was carefully refereed. The papers contained in this volume represent a mix of pure research and expository articles. It is hoped that the papers have sufficient details so that they are accessible to the non-specialist. It is also the intent of this volume to convey a sense of direction of the field.

GAGLIONE, Anthony M., Professor, co-author, "$\gamma_{n+1}(F)$ and $F/\gamma_{n+1}(F)$ Revisited," *Combinatorial Group Theory* (October 1990), 35-41.

Let F be a free group of finite rank $r \geq 2$, i.e., $F = \langle c_1, c_2, \ldots, c_r \rangle$. For $x,y \in F$ the commutator $[x,y] = x^{-1}y^{-1}xy$. The lower central series of F is the sequence of subgroups $F_1 = \gamma_1(F)$, then having defined $\gamma_n(F)$, $\gamma_{n+1}(F)$ is the group generated by all commutators $[x,y]$ such that $x \in \gamma_n(F)$ and $y \in F$. In this paper, a matrix representation of $F/\gamma_{n+1}(F)$ is established. Also a finite presentation for $F/\gamma_{n+1}(F)$ is obtained. Both of these results do not appear in the current literature.

GAGLIONE, Anthony M., Professor, co-author, "The Commutator Collection Process," *Combinatorial Group Theory*, (October 1990), 43-59.

P. Hall's collection process has been described in his classical paper and later in textbooks on group theory. In this paper, a careful and precise implementation of the collection process is described in full detail. This paper also establishes properties of the collection process which the authors have found essential for their work on the lower central factors of special free products. However, these properties do not appear in the literature.

GAGLIONE, Anthony M., Professor, co-author, "Problem 11.19," *Kourovka Notebook*, (1990), 100-101.

Is the n-th term of the lower central series of an absolutely free group the normal closure of the set of basic commutators (in some fixed free generators) of weight exactly n ? (It is known to be true for $n \leq 5$.)

GAGLIONE, Anthony M., Professor, co-author, "Problem 11.20," *Kourovka Notebook*, (1990), 101.

Suppose the researchers have $[a,b] = [c,d]$ in an absolutely free group, where a, b, $[a,b]$ are basic commutators (in some fixed free generators). If c and d are arbitrary (proper) commutators, does it follow that $a = c$ and $b = d$?

GOTAY, Mark J., Associate Professor, co-author, "A Symplectic Analogue of the Mostow-Palais Theorem," *Symplectic Geometry, Groupoids and Integrable Systems*. M.S.R.I. Publication 20, New York (1991), pp. 173-182.

The researchers show that given a Hamiltonian action of a compact and connected Lie group G on a symplectic manifold (M,ω) of finite type, there exists a linear symplectic action of G on some $\mathbf{R}^{2n}$ equipped with its standard symplectic structure such that (M,ω,G) can be realized as a reduction of this $\mathbf{R}^{2n}$ with the induced action of G .

GOTAY, Mark J., Associate Professor, co-author, "Nonunimodularity and the Quantization of the Pseudo-Rigid Body," *Hamiltonian Systems, Transformation Groups and Spectral Transform Methods*. Montreal: Publication CRM, 1990, pp. 149-160.

The researchers discuss the pseudo-rigid body as an example of a classical system with nonunimodular gauge symmetries. They show that the standard Dirac quantization prescription must be modified for such systems, and illustrate how this can be accomplished by means of "unimodularization."

GOTAY, Mark J., Associate Professor, "A Multisymplectic Approach to Classical Field Theory and the Calculus of Variations. I. Covariant Hamiltonian Formalism," *Mechanics, Analysis and Geometry: 200 Years After Lagrange*. ed. M. Francaviglia, North Holland, Amsterdam: 1991, pp. 203-235.

Several recent results on the Hamiltonian formalism in the calculus of variations are presented. In particular, the researcher proposes a new candidate for the covariant phase space and shows that it carries a canonical multisymplectic structure. Corresponding covariant Legendre transformations are constructed; while not necessarily unique, the class of all such is completely characterized. A suitable notion of regularity is also defined. These results constitute the foundation of a truly Hamiltonian framework for the calculus of variations in general, and enable the researcher to deal directly with higher order Lagrangians as well as multiple integrals in much the same way as one treats ordinary mechanics. The key ingredient in this work is a generalization of Kijowski and Szczyrba's notion of "multiphase space."

GOTAY, Mark J., Associate Professor, co-author, "Quantization and Bosonic BRST Theory," *Annals of Physics*, **206**, (1991), 1-26.

The researchers show that BRST symmetry has a natural bosonic analogue in symplectic geometry. In fact, bosonic BRST theory arises as a purely symplectic construction, which can naturally be viewed as a specific instance of symplectic induction. In this context, both the BRST charge and the total ghost number appear as the "components" of a momentum map on an extended symplectic phase space. This approach to bosonic BRST theory is motivated by certain problems which arise in the quantization of constrained classical systems. The researchers show that the usual Dirac quantization prescription is incorrect when the system has

nonunimodular symmetries and demonstrate how bosonic BRST theory may be used to rectify this. As a byproduct the researchers also prove, under certain circumstances, that both the processes of induction and reduction commute with quantization.

HERRMANN, Robert A., Professor, "Consecutive Points and Nonstandard Analysis," *Mathematica Japonica*, 2 (1991), 1-6.

In this paper it is shown that some type of nonstandard analysis appears necessary in order to investigate rigorously the intuitive concept of consecutive points as it is described within classical differential geometry.

KIDWELL, Mark E., Professor, co-author, "Dichromatic Link Invariants," *Transactions* of the American Mathematical Society, Vol. 321, 1990, pp. 197-229. MR 90m:57007.

The researchers investigated the skein theory of oriented dichromatic links in S^3. They defined a new chromatic skein invariant for a special class of dichromatic links. This invariant generalizes both the two-variable Alexander polynomial and the twisted Alexander polynomial. Alternatively, one may view this new invariant as an invariant of oriented monochromatic links in $S^1 \times D^2$, and as such it is the exact analog of the twisted Alexander polynomial. They discussed basic properties of this new invariant and applications to link interchangeability. For the full class of dichromatic links they show that there does not exist a chromatic skein invariant which is a mutual extension of both the two-variable Alexander polynomial and the twisted Alexander polynomial.

KONKOWSKI, Deborah A., Assistant Professor, co-author, "Stability of the Quasiregular Singularities in Bell-Szekeres Spacetime," *Physical Review D*, 43 (1991), 609-611.

The behavior of geodesics and minimally coupled scalar waves on the Bell-Szekeres spacetime is used to probe the nature of the quasiregular singularities present. Components of the stress-energy tensor in a parallel propagated ortho-normal frame diverge as does a stress-energy scalar at the singularities. It is argued that this divergence makes the singularities unstable, converting them to a scalar curvature singularity.

LERNER, Bao T., Professor, co-author, "Applications of Algebraic Image Operators to Robot Vision," *Ergonomics of Hybrid Automated Systems II*, ed. W. Karwowski and M. Rahimi, August 1990, pp. 819-824.

An innovative, efficient edge detection scheme has been developed utilizing algebraic structures. This edge detector combined with the Hough transform has provided a robust method for linear feature extraction. An accurate method for deriving gradient component information has been developed. A continuous single pixel wide edge as well as inherently parallel global operations are some of the advantages that the algebraic edge detector possesses over classical convolution-type edge detectors.

The algebraic operators are global operations which are easily reconfigured to operate on any size or shape region. This provides a natural platform from which to pursue dynamic scene analysis.

MCCOY, Peter A., Professor, "Representation of Harmonic Functions in R^4," *Journal of Mathematical Analysis and Applications*, **154**, 1 (1991), 43-54.

Reciprocal integrals are constructed so that {H, h} constitutes a dual transform pair where H is a harmonic function in $\mathbf{R}^4$ and h is the associated analytic function in $\mathbf{C}^3$. Necessary and sufficient conditions for the harmonic continuation to encounter singularities are linked to properties of the analytic continuation and conversely. Thus, Szego's theorem regarding zonal harmonic series and analytic functions in $\mathbf{C}^1$ has a function theoretic extension to several variables.

MCCOY, Peter A., Professor, "Optimal Approximation and Growth of Solutions to a Class of Elliptic Partial Differential Equations," *Journal of Mathematical Analysis and Applications*, **154**, 1, (1991), 203-211.

Function theoretic methods derive Bernstein type theorems for a class of second order elliptic partial differential equations to determine the disk of regularity and growth of solutions at the boundary.

MEYERSON, Mark D., Professor, "USNA: Blocks and Harmonic Series," *Mathematica Militaris*, **2** (Fall 1990), 5.

This paper is a description of some visual aids used in calculus. Blocks are used to emphasize the divergence of the harmonic series, and string is used to illustrate the dot product of vectors in space.

MEYERSON, Mark D., Professor, "A Brief History of USNA's Mathematics Department," *Mathematica Militaris*, **2** (Spring 1991), 6-7.

This paper contains a summary of the changes in the mathematics curriculum at the U.S. Naval Academy since its founding. A summary of the courses and texts at about ten-year intervals is also provided.

MICHAEL, T. S., Assistant Professor, "The Structure Matrix and a Generalization of Ryser's Maximum Term Rank Formula," *Linear Algebra Applications*, **145** (1991), 21-31.

The author shows that the famous Ford-Fulkerson Theorem that relates structure matrices to a certain class of combinatorial objects remains valid under somewhat weaker hypotheses than those given by Ford and Fulkerson. This enables the author to give a streamlined proof of Ryser's maximum term rank formula. In fact, with the author's generalized result, he can provide a simpler proof of a result that extends Ryser's original formula.

MOEN, Courtney, Associate Professor, "Infinite Series with Binomial Coefficients," *Mathematics Magazine*, **64**, 1 (February 1991), 53-55.

This short note shows that some recently-studied infinite series involving the central binomial coefficient in the denominator can be evaluated by using the standard identity relating the gamma function and the beta function. It also shows that certain double series with binomial coefficients in the denominator are very easy to evaluate and have sums which can be expressed in terms of special values of the Riemann zeta function.

MYLANDER, W. Charles, Professor, co-author, *Optimization for Profit*. New York: Haworth Press, 1991.

The unique feature of this textbook on linear programming is its emphasis on techniques for building and working with linear programming models. Models are structured using activity analysis. This approach is a natural extension of the way decision makers approach problems. It includes a large number of examples of the use of linear programming models in industry and agriculture. The book complements software the author has developed for use in building and solving linear programs.

PENN, Howard L., Professor, and Craig K. BAILEY, Associate Professor, "The USNA Calculus Initiative," *Priming the Pump, the Calculus Reform*, ed. Thomas Tucker, Mathematical Association of America Notes, Volume 17, 1990 pp. 278-279.

The U. S. Naval Academy has been involved for several years in a project to introduce the use of computers into the teaching of calculus. Every student at the Academy has an MS Dos computer. Each faculty member in the Mathematics Department has a computer, and every classroom is equipped with a computer and an overhead projection device. The software used is MPP, a public domain program available from the author. The goals of the program are several. First, the authors wish to stress the concepts of calculus. A second goal is to make connections among the analytic and graphical representations of equations and functions. Another goal is to stress the numerical aspects of calculus. Additional emphasis is also placed on other interesting and meaningful applications.

PRICE, Geoffrey L., Associate Professor, co-author, "Continuous Spatial Semigroups of *-endomorphisms of $B(b)$," *Transactions* of the American Mathematical Society, **321**, 1991, pp. 347-361.

Robert Powers recently obtained a numerical invariant for one-parameter semigroups of endomorphisms of the algebra of bounded operators on a Hilbert space, $B(b)$. Subsequently, William B. Arveson has introduced another index for endomorphisms of $B(b)$. Despite the fact that these invariants were obtained quite differently, each has been demonstrated to give the same value as the other in verifiable instances. In the joint paper above, the authors were able to show, via a delicate analysis of some problems in unbounded operator theory, that the indices actually are the same.

PRICE, Geoffrey L., Associate Professor, "The C^*-Algebras Generated by Pairs of Semigroups of Isometries Satisfying Certain Commutation Relations," *Pacific Journal of Mathematics*, **146** (1990) 315-330.

One of the tools needed to verify that the Arveson and Powers indices coincide is the structure theory of a pair of semigroups of isometries in $B(b)$, $V = \{U^t : t \in \mathbf{R}^+\}$ and $B = \{V_t : t \in \mathbf{R}^+\}$ which satisfy the

Weyl commutation relations $U^*V = \exp(\lambda t)I$. In this paper the author initiates an investigation into the structure of the operator algebras generated by all isometries U_t, V_t with t ranging over a semigroup γ contained in **R**. Price determines, among other results, that this C^*-algebra is simple if and only if γ is dense in $\mathbf{R}^+$. This result draws together the theory developed by R. G. Douglas on the structure of C^*-algebras generated by a single semigroup of isometries, with the highly non-commutative theory of J. Cuntz on the structure of algebras generated by a pair of isometries satisfying the condition $uu^* + vv^* = I$.

SAGOVAC, Christopher P., Lieutenant, USN, co-author, "Satellite Motion Around an Oblate Planet: A Perturbation Solution for All Orbital Parameters Part II - Orbits for all Inclinations," AIAA-90-2885, *Proceedings* of the AAS/AIAA Astrodynamics Conference, Portland, Oregon, August 1990.

The search for a universal solution of the equations of motion for a satellite orbiting an oblate planet is a subject that has merited great interest because of its theoretical and practical implications. Here, a complete higher order perturbation solution for the orbit, including the effects of the J2 terms in the planet's potential and free of singularities for all parameters, is displayed. The simple formulas provide a fast method of accurately predicting satellite orbits for many revolutions.

SANDERS, Thomas J., Professor, co-author, "An Airborne Defense Penetration Study for the Long Range Conventional Standoff Weapon (LRCSW) (U), JHU/APL Document #NWA-90-054, September 1990, SECRET NOFORN-WNINTEL.

This technical report contains the results of an airborne defense penetration study for the LRCSW during the summer of 1990. At that time, the LRCSW project was in the concept evaluation phase. The purpose of the study was to examine LRCSW's vulnerability to airborne defenses as part of a sophisticated and highly coordinated air defense system.

The methodology employed was to examine LRCSW survivability in a many-on-many context, utilizing the Petropavlovsk Scenario, developed for the LRCSW system concept evaluation studies (performed by selected contractors). The model ADSIM, Air Defense Simulation, developed by JHU/APL, was utilized for the study. Only airborne defenses and their ground-based support structure were examined.

TURNER, Peter R., Associate Professor, *Guide to Numerical Analysis*, (U.S. Edition). Boca Raton, Florida: CRC Press, 1990.

This textbook covers in a straightforward and readable way the problems, methods, and mathematical background required by most introdu ctory courses in the subject. Full and rigorous mathematical justifications of the numerical methods are supplied where these are accessible to students at this level, but where these would require an advanced knowledge of linear algebra or analysis, a less formal approach is adopted. The author takes care to explain fully all the necessary algebraic manipulation, and to provide plenty of examples and exercises to illustrate when and how each method can be applied.

TURNER, Peter R., Associate Professor, "Will the 'Real' Real Arithmetic Please Stand Up?" *Notices of the American Mathematical Society*, **38**, (April 1991), 298-303.

In this article, properties of the number systems used by computers are discussed and contrasted with those of the pure mathematicians' real number system. The development of computer arithmetic from the early days of fixed point arithmetic through the transition to floating-point and beyond is described briefly. The reader is then introduced to the symmetric level index system, and the possible transition to its use is discussed. The properties of this system which set it apart from the floating-point system--a smooth representation function and closure, in particular--are highlighted in support of the article's main thesis that perhaps this is the "real" real arithmetic of the future.

TURNER, Peter R., Associate Professor, "Implementation and Analysis of Extended SLI Operations," *IEEE Symposium on Computer Arithmetic*, Grenoble, France, June 1991, pp. 118-126.

This paper is concerned with extended arithmetic operations, such as forming scalar products, in symmetric level-index, SLI, arithmetic. Schemes for the implementation of such algorithms are described and analysed both in terms of comparative timings for these operations and their floating-point counterparts, and in terms of the control of errors in the computation. It is shown that with sufficient parallelism available in the SLI processor, the computation can be as fast as for floating-point operations. Also, the researcher sees that the SLI operation can be modified to produce just a single rounding error from extended operations very economically.

WARDLAW, William P., Associate Professor, Problem **1349**, *Mathematics Magazine*, **63** (1990), 189.

Let K be a field, n a positive integer, and $\mathbf{I}$ the nxn identity matrix. Give necessary and sufficient conditions on n and K such that for every nxn matrix $\mathbf{A}$ over $\mathbf{K}$ there is an element a in K such that $\mathbf{A} + a\mathbf{I}$ is invertible.

WARDLAW, William P., Associate Professor, Problem **437**, *College Mathematics Journal*, **21** (1990), 423.

For each polynomial f with integer coefficients, define the real number

$$a(f) = 0.a^1a^2a^3\ldots$$

whose kth digit a^k is determined by the relations

$$0 \leq a^k \leq 9 \quad \text{and} \quad a^k = f(k) \pmod{10}.$$

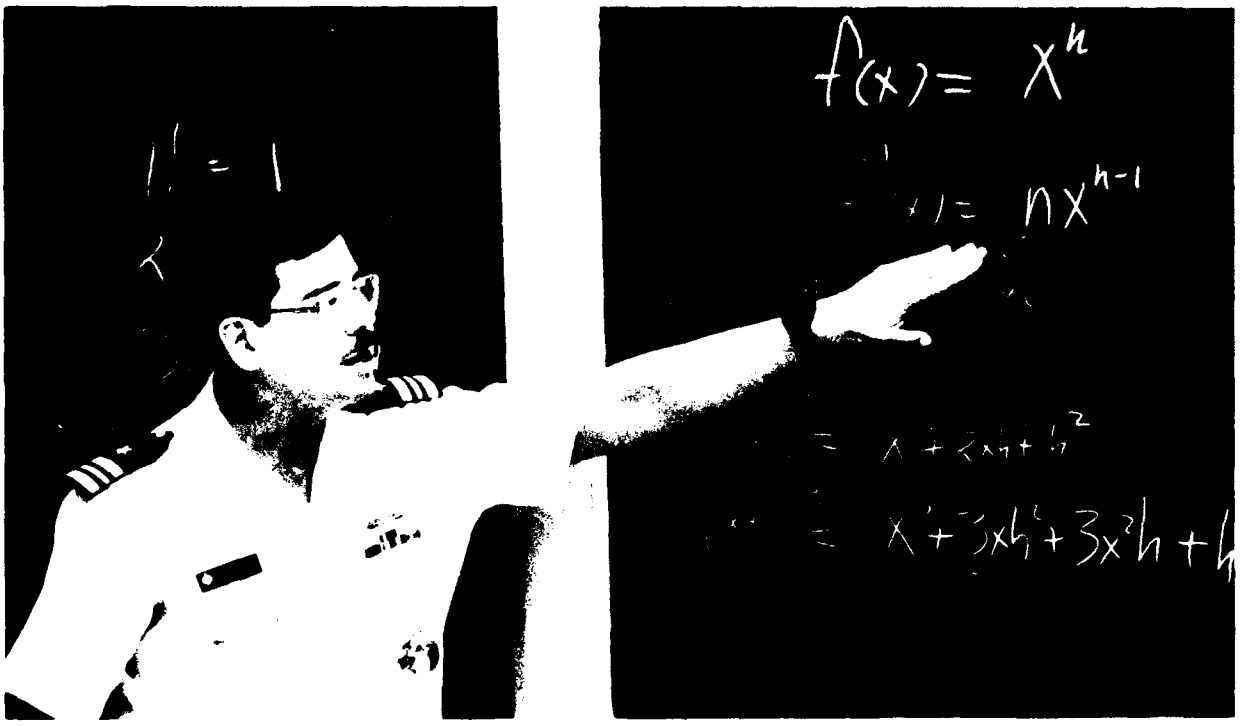
Let

$$A = \{a(f): f \in \mathbf{Z}[x]\}$$

be the set of all such numbers. Find the cardinality of A and characterize its elements.

WARDLAW, William P., Associate Professor, Problem **441**, *College Mathematics Journal*, **22** (1991), 70.

Let K be a field, n a positive integer, and J the $n \times n$ matrix with every entry equal to 1. Show that for each $n \times n$ matrix A over K, exactly one of the following conditions holds: $A + aJ$ is singular for (1) exactly one element a in K; (2) no element a in K; or (3) every element a in K.



Presentations

ANDRE, P. Peter, Professor, "Vulnerability of the Strategic Mission of US SSBN Fleet to Detection of Missile Plume," Annual Planning Meeting of Submarine Tactics Development Program, Applied Physics Laboratory, Johns Hopkins University, Laurel, Maryland, 4 February 1991.

BAILEY, Craig K., Associate Professor, "Tiling the Plane," Washington and Lee University Faculty Student Colloquium, Lexington, Virginia, 12 October 1990.

BAKER, B. Mitchell, Associate Professor, "Polynomials, Random Walks, and K_o-theory," Boston University, Boston, Massachusetts, 5 December 1990.

BUCHANAN, James L., Professor, co-author, "Software for Teaching Calculus and Differential Equations," Annual Meeting of the American Society for Engineering Education, Toronto, Canada, 24-25 June 1990.

BUCHANAN, James L., Professor, co-author, "Software for Teaching Calculus and Differential Equations," Loyola College Mathematics Department Seminar, Baltimore, Maryland, 3 December 1990.

CRAWFORD, Carol G., Associate Professor, "AI Applications for Naval Logistics Technology," David Taylor Institute, David Taylor Research Center, Carderock, Maryland, 2 August 1990.

CRAWFORD, Carol G., Associate Professor, "Math Anxiety Revisited," 1991 National Conference on Problem Solving Across the Curriculum, SUNY at New Paltz, New York, 13 June 1991.

DAVIS, Frederic I., Professor, "Mathematica in the Classroom," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, March 1991.

GOTAY, Mark J., Associate Professor, "The Cartan Form in the Calculus of Variations," Workshop on Differential Geometry and Hamiltonian Systems, Toledo, Ohio, 8 July 1990.

GOTAY, Mark J., Associate Professor, "Quantization and Bosonic BRST Theory," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 14 September 1990.

GOTAY, Mark J., Associate Professor, "The Pseudo-Rigid Body, Quantization, and Bosonic BRST Theory," University of North Carolina, Chapel Hill, North Carolina, 26 November 1990.

GOTAY, Mark J., Associate Professor, "Symplectic Geometry and Bosonic BRST Theory," North Carolina State University, Raleigh, North Carolina, 28 March 1991.

GOTAY, Mark J., Associate Professor, "Some Applications of Symplectic Induction," Colloquium, Universitat Hamburg, Hamburg, Germany, 26 April 1991.

GRANT, Caroline G., Assistant Professor, "Metrics for Singular Algebraic Varieties," Mathematics Department Seminar, University of Toronto, Toronto, Canada, 28 September 1990.

GRANT, Caroline G., Assistant Professor, "Kahler Geometry and Algebraic Manifolds," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 3 April 1991.

HERRMANN, Robert A., Professor, "The Necessity for Nonstandard Analysis," Maryland, District of Columbia, Virginia Section of the Mathematical Association of America Fall Meeting, Towson State University, Towson, Maryland, 17 November 1990.

HERRMANN, Robert A., Professor, "The Necessity for Nonstandard Analysis," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 20 February 1991.

HOFFMAN, Michael E., Associate Professor, "Derivative Polynomials," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 27 March 1991.

KAMMEYER, Janet W., Assistant Professor, "A Classification of the Isometric Extensions of a Multidimensional Bernoulli Shift," American Mathematical Society Special Session in Ergodic Theory, Amherst, Massachusetts, 20 October 1990.

KAMMEYER, Janet W., Assistant Professor, "Classifying the Isometric Extensions of a Multidimensional Bernoulli Shift," Workshop on Orbit Equivalence and Nonsingular Transformations, Chapel Hill, North Carolina, 2 March 1991.

KAMMEYER, Janet W., Assistant Professor, "An Introduction to Restricted Orbit Equivalence of Z^2-actions," Tufts University Ergodic Theory Seminar, Boston, Massachusetts, 15 March 1991.

KAPLAN, Harold M., Professor, "Looking in all Directions Simultaneously," Mid-Atlantic Region Probability and Statistics Day, The George Washington University, Washington, DC, 20 October 1990.

KIDWELL, Mark E., Associate Professor, "From Vector Calculus to de Rham Cohomology," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 17 October 1990.

KONKOWSKI, Deborah A., Assistant Professor, "Singularities in Colliding Plane-Wave Spacetimes," Gravitation '90, Banff, Canada, August 1990.

KONKOWSKI, Deborah A., Assistant Professor, "Singularities in Bell-Szekeres Spacetime," Spring Meeting, American Physical Society, Washington, DC, 22-25 April 1991.

KONKOWSKI, Deborah A., Assistant Professor, "Singularities in Colliding Plane-Wave Spacetimes," Fourth Canadian Conference on General Relativity and Gravitation," Winnipeg, Canada, 15-20 May 1991.

LERNER, Bao T., Professor, "Applications of Algebraic Image Operators to Robot Vision," Second International Conference on Human Aspects of Advanced Manufacturing and Hybrid Automation, Honolulu, Hawaii, 9 August 1990.

MALEK-MADANI, Reza, Associate Professor, "Shear Localization in Thermo-Visco-Elasticity," Mathematics Department Colloquium, North Carolina State University, Raleigh, North Carolina, 1 April 1991.

MALEK-MADANI, Reza, Associate Professor, "Stability and Localization in Thermo-elasticity," Partial Differential Equation Seminar, University of Maryland, College Park, Maryland, 2 May 1991.

MARUSZEWSKI, Richard F., Associate Professor, "Introduction to the Mathematics Department Computer Systems," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 17 September 1990.

MARUSZEWSKI, Richard F., Associate Professor, "Disk Operating Systems," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 15 October 1990.

MARUSZEWSKI, Richard F., Associate Professor, "QUATTRO and Applications of Spreadsheets," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 29 October 1990.

MARUSZEWSKI, Richard F., Associate Professor, "Introduction to the Use of the Math Department Network," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 28 January 1991.

MCCOY, Peter A., Professor, "Function Theoretic Analysis of Solutions to a Class of Elliptic Partial Differential Equations," International Congress of Mathematicians, Kyoto, Japan, 27 August 1990.

MCCOY, Peter A., Professor, "Representing Solutions to Some Higher Order Elliptic PDE's," Office of Naval Research Review, U.S. Naval Academy, Annapolis, Maryland, 17 October 1990.

MCCOY, Peter A., Professor, "The Heat Equation in R^{n+1} (n = 3,4)," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 21 November 1990.

MCCOY, Peter A., Professor, "Parabolic Equations in Several Variables," American Mathematical Society Annual Meeting, San Francisco, California, 17 January 1991.

MCCOY, Peter A., Professor, "Approximating Solutions to the Helmholtz Equation with Infinite Order Growth," Mathematics Department Applied Mathematics Seminar, Annapolis, Maryland, 16 April 1991.

MICHAEL, T. S., Assistant Professor, "The Decomposition of the Complete Graph into Three, Isomorphic Strongly Regular Graphs," Twenty-Second Southeastern International Conference on Combinatorics, Graph Theory, and Computing, Baton Rouge, Louisiana 11-15 February 1991.

NAKOS, George, Associate Professor, "On Ideals Annihilating the Bottom Class of $BP_*(\lambda\ BZ/p^k)$," Annual Meeting of the American Mathematical Society, San Francisco, California, 17 January 1991.

NAKOS, George, Associate Professor, "Grobner Bases," Mathematics Department Applied Mathematics Seminar, U.S. Naval Academy, Annapolis, Maryland, 4 December 1990.

PENN, Howard L., Professor, and Janet KAMMEYER, Assistant Professor, "MPP Software for the Learning of Calculus," U.S. Naval Academy High School Science and Engineering Seminar, Annapolis, Maryland, 12 June 1990.

PENN, Howard L., and James L. BUCHANAN, Professors, "MPP and MDEP, Software for the Teaching of Calculus and Differential Equations, Minicourse, American Society for Engineering Education Annual Meeting, Toronto, Canada, 24-25 June 1990.

PENN, Howard L., Professor, "Demonstration of MPP and MDEP," Poster Session, American Society for Engineering Education, Toronto, Canada, 27 June 1990.

PENN, Howard L., and James L. BUCHANAN, Professors, "Software for the Teaching of Calculus and Differential Equations," Loyola College Mathematics Department Seminar, Baltimore, Maryland, 3 December 1990.

PENN, Howard L., Professor, and Aaron I. STUCKER, Assistant Professor, "The USNA Calculus Initiative," Poster Session, AMS-MAA Joint Winter Meeting, San Francisco, California, 12 January 1991.

PENN, Howard L., Professor, "Using the Computer as an Aid to the Teaching of Calculus," Trenton State University Mathematics Department Seminar, Trenton, New Jersey, 6 February 1991.

PIERCE, John F., Associate Professor, co-author, "The Global Structure of Buckled States for Compressible Columns," Annual Meeting, Society for Industrial and Applied Mathematicians (SIAM), Chicago, Illinois, 19 July 1990.

PIERCE, John F., Associate Professor, "The Patterns of Buckling for Compressible Rods," Conference on Theoretical Mechanics, Rutgers University, New Brunswick, New Jersey, 26 August 1990.

PIERCE, John F., Associate Professor, "Singularity Theory, Pseudo-Rigid Bodies, and Symmetry-Breaking Loads," Department of Mathematics Colloquium, George Washington University, Washington, DC, 31 October 1990.

PIERCE, John F., Associate Professor, "The Energy-Momentum Method and Relative Equilibria for Pseudo-Rigid Bodies," Seminar on Symplectic Geometry and Mechanics, Department of Mechanical Engineering, U.S. Naval Academy, Annapolis, Maryland, 23 and 30 March 1991.

PRICE, Geoffrey L., Associate Professor, "A Core Result for Unbounded Operators," Canadian Operator Theory Symposium, Montreal, Quebec, Canada, 29 May 1991.

QUINT, Thomas, Visiting Assistant Professor, "Cores of Assignment Games," International Conference on Game Theory," Stony Brook, New York, 10-14 July 1990.

QUINT, Thomas, Visiting Assistant Professor, "Introduction to Two-Sided Matching Games," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 19 September 1990.

QUINT, Thomas, Visiting Assistant Professor, "Introduction to Two-Sided Matching Games," Western Maryland College Mathematics Colloquium, Westminister, Maryland, October 1990.

QUINT, Thomas, Visiting Assistant Professor, "Lattice and Two-Sided Matching Games," Department of Operations Research Colloquium, Cornell University, Ithaca, New York, 19 November 1990.

SAGOVAC, Christopher P., Lieutenant, USN, "Satellite Motion Around an Oblate Earth: A Perturbation Solution for All Orbital Parameters Part II - Orbits for All Inclinations," AIAA/AAS Astrodynamics Conference, Portland, Oregon, 8 August 1990.

STUCKER, Aaron I., Assistant Professor, "Adventures in Topology," Benjamin Banneker Black Honors Mathematics Society, U.S. Naval Academy, Annapolis, Maryland, 10 November 1990.

STUCKER, Aaron I., Assistant Professor, co-author, "The USNA Calculus Initiative," Poster Session, Annual Mathematics Meetings, San Francisco, California, 18 January 1991.

STUCKER, Aaron I., Assistant Professor, "Alternatives to the Lecture Method-Group Problems," Annual Mathematics Meetings, San Francisco, California, 19 January 1991.

STUCKER, Aaron I., Assistant Professor, "Alternatives to the Lecture Method-Group Problems," National Science Foundation Conference on Mathematics Education, New Mexico State University, Las Cruces, New Mexico, 2 March 1991.

STUCKER, Aaron I., Assistant Professor, "Tiling A Soccer Ball," Benjamin Banneker Black Honors Mathematics Society, U.S. Naval Academy, Annapolis, Maryland, 23 March 1991.

TURNER, Peter R., Associate Professor, co-author, "Supercomputers Need Super Arithmetic," SIAM National Meeting, Chicago, Illinois, 18 July 1990.

TURNER, Peter R., Associate Professor, "Supercomputers Need Super Arithmetic," Mathematics Department Research Seminar, University of Lancaster, Lancaster, England, 27 November 1990.

TURNER, Peter R., Associate Professor, "Implementation and Analysis of Extended SLI Operations," ARITH 10, the Tenth IEEE Symposium on Computer Arithmetic, Grenoble, France, 26-28 June 1991.

TURNER, Peter R., Associate Professor, Chairman and Organizer, Minisymposium on "SLI Arithmetic: An Alternative to Floating-point," International Conference on Industrial and Applied Mathematics ICIAM 91, Washington, DC, 10 July 1991.

TURNER, Peter R., Associate Professor, co-author, "SLI Arithmetic 2: Implementation," ICIAM 91, Washington, DC, 9 July 1991.

TURNER, Peter R., Associate Professor, and James L BUCHANAN, Professor, co-authors, "SLI Arithmetic 3: Impact on Numerical Algorithm," ICIAM 91, Washington, DC, 9 July 1991.

TURNER, Peter R., Associate Professor, co-author, "SLI Arithmetic 4: Software Engineering Aspects," ICIAM 91, Washington, DC, 9 July 1991.

WAGNER, Daniel H., Visiting Professor, "Bayesian Single-Leg Target Motion Analysis," Military Operations Research Society Symposium, Keflavik, Iceland, 30 June 1990.

WARDLAW, William P., Associate Professor, "Elementary Cryptography," Mathematics Department Applied Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 25 September 1990.

WARDLAW, William P., Associate Professor, "Two Modern Cryptosystems," Mathematics Department Applied Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 2 October 1990.

WARDLAW, William P., Associate Professor, "The RSA Public Key Cryptosystem," Mathematics Department Applied Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 15 October 1990.

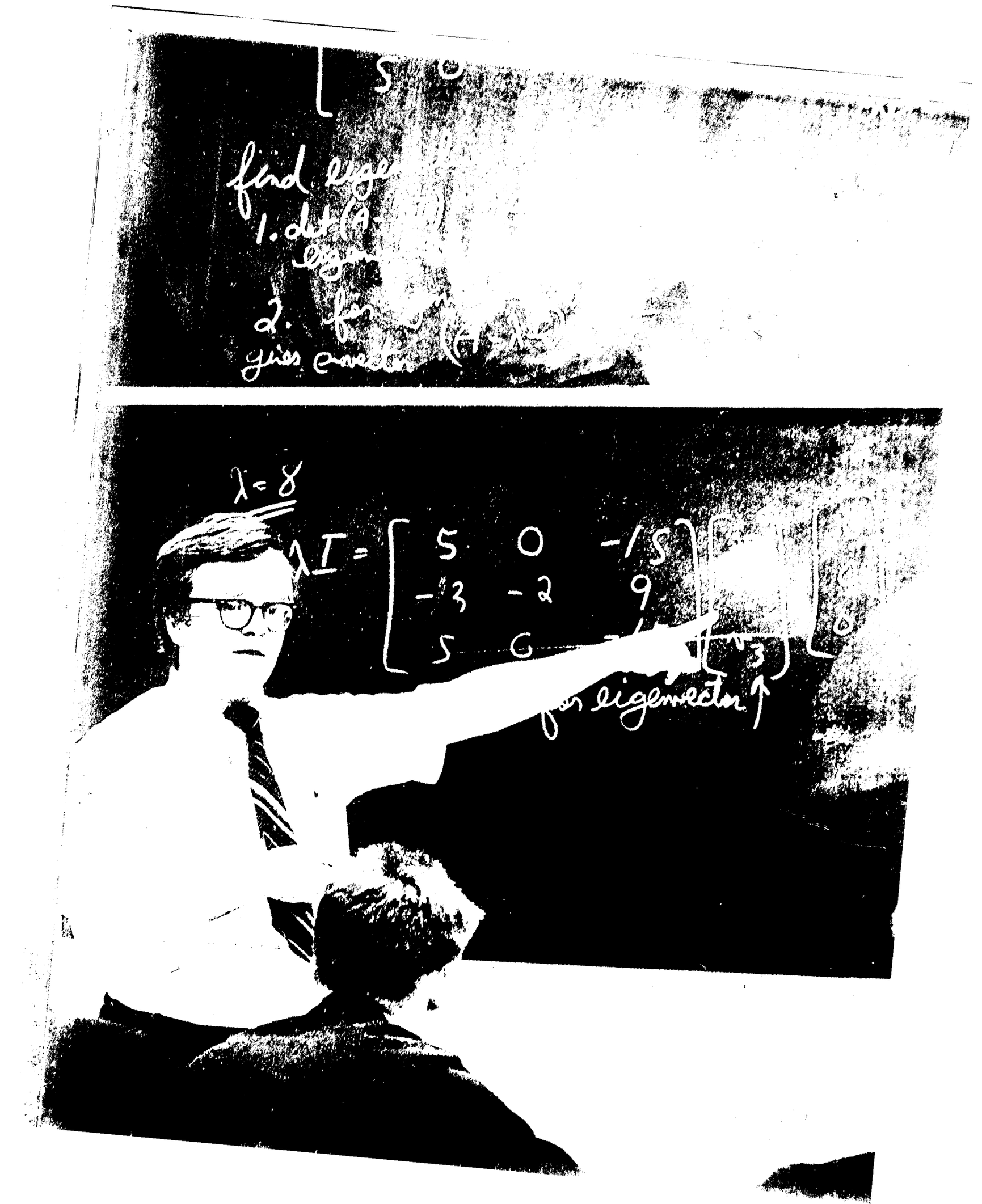
WARDLAW, William P., Associate Professor, "The RSA Public Key Cryptosystem," American University, Washington, DC, 6 November 1990.

WARDLAW, William P., Associate Professor, "Matrix Representation of Finite Fields," MD-DC-VA Section of the Mathematical Association of America Fall Meeting, Towson State University, Towson, Maryland, 17 November 1990.

WARDLAW, William P., Associate Professor, "Periods and Subperiods of Matrices," Annual Meeting of the American Mathematical Society, San Francisco, California, 17 January 1991.

WARDLAW, William P., Associate Professor, "Matrix Representation of Finite Fields," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 6 March 1991.

WARDLAW, William P., Associate Professor, "Pegjump Games," Thomas Jefferson High School of Science and Technology Annual Mathematics Day Program, Fairfax County, Virginia, 17 April 1991.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DEPARTMENT OF

Oceanography

Commander Michael P. Cavanaugh, USN
Chair

During the 1990-1991 academic year, the faculty of the Oceanography Department conducted sponsored and independent research in a broad range of oceanographic and atmospheric areas.

This research provided opportunities for the faculty to keep abreast of current work, and it served as the basis for qualified midshipmen to undertake related research projects. Fourteen midshipmen conducted research and then presented the results of their work, either by publishing results or making presentations, several at major scientific conferences.

The department's oceanographic vessel, YP-686, again conducted research on the Chesapeake Bay, including the third major summer data collection effort. It included in situ data collection coordinated with remotely-sensed data collection by laser-equipped aircraft and satellite sensors.

Funding sources included the Commander, Naval Oceanography Command, David Taylor Research Center, the U.S. Geological Survey, and the Office of Naval Research. Cooperative research included work with the National Environmental Satellite Data and Information Service (NESDIS) of the National Oceanic and Atmospheric Administration, the National Science Foundation, the National Aeronautics and Space Administration, the Johns Hopkins University Applied Physics Laboratory, and the University of Delaware.

Specific areas of research activity within the department included Arctic acoustics, environmental pollution, geological mapping, analysis of satellite imagery using numerical methods, satellite analysis of various oceanic phenomena, Gulf Stream forecasting, upwelling, and explosive cyclogensis. The physical properties of the Chesapeake Bay were studied, including its optical properties, sedimentation, temperature, dissolved oxygen, salinity, pH, and aquatic life.

A variety of meteorological and oceanographic phenomena was studied using the department's Digital Image Processing System (DIPS). This Hewlett-Packard UNIX-based system enabled faculty and midshipmen to process and study Landsat (U.S. Earth Resources Satellite), SPOT (Systeme Probatorire d'Observation de la Terre), AVHRR (Advanced Very High Resolution Radiometer), and CZCS (Coastal Zone Color Scanner) satellite imagery.

The department's new Remote Sensing Laboratory was completed this year. It expands on the image processing capability our DIPS provides. It includes a VAX 3200 system with two workstations, and software from the University of Miami's Rosensteil School for Marine and Atmospheric Sciences. The new system processes AVHRR and CZCS satellite data. Future networking into the Space Physics Analysis Network (SPAN) is anticipated during fiscal year 1991 to permit links to over 15 universities and U.S. government agencies across the country. It is a major focus of the department's cooperative research initiative in remote sensing, a Center for Excellence in Oceanic Remote Sensing (CEORS, pronounced "Sea Oars").

Sponsored Research

Estimation of Precipitable Water from Advanced Very High Resolution Radiometer Split Window Radiances

Researchers: Visiting Professor Arnold Gruber and
Ensign Bradley S. Tidwell, USN
Sponsor: Naval Oceanography Command

In an attempt to calculate monthly mean precipitable water on spatial scales of about 300 km by 300 km from satellite radiances, two different models that utilize the 10.8 μm snf yhr 11.8 μm windows (split window) of advanced very high resolution radiometer were studied. One uses the difference in brightness temperature in a linear model (Dalu, 1986) and the other uses the ratio of the variances of the two channels (Jedlovic, 1990) as input to a model to calculate the precipitable water.

The models were tested with advanced very high resolution radiometer data collected by the National Oceanographic and Atmospheric Administration from their normalized difference vegation index (NDVI) database (Tarpley, 1991). Monthly mean split window data on a 21 x 21 target grid collected from a site near Manhattan, Kansas, for the period May 1985 through June 1986 were analyzed and compared to radiosonde calculations of precipitable water. The researchers found the model proposed by Jedolvic to be inappropriate for their needs. Jedolvic's model is best suited for small targets (30 km by 30 km), where the main variations are in surface temperature, with little or no variation in atmospheric moisture. Dalu's model however, gave excellent results when compared to radiosonde values of precipitable water. The root mean square difference was 0.31 cm, and the mean difference was .06 cm of precipitable water for an annual mean of 2.10 cm.

The researchers plan to test this model further, using target areas that exhibit a wide range of precipitable water, e.g., semi-arid to moist tropical.

The Hydrographic Structure of the Strait of Gibraltar

Researcher: Visiting Researcher Thomas H. Kinder
Sponsor: Office of Naval Research

The Mediterranean Sea loses nearly 1 m/year through net evaporation. The balance of salt and fresh water is maintained by a vigorous mean flow through the narrow (about 10 km) and shallow (about 300 m depth) Strait of Gibraltar. The high evaporation rate induces both a mean sea surface difference (barotropic pressure gradient) and mean salinity difference (baroclinic density gradient) along the strait, so fresh Atlantic water inflows to the Mediterranean at shallow depths, and saltier Mediterranean water outflows beneath. When tidal forcing is added to these climatological factors, the flow within the strait becomes critical with respect to the internal Froude number (i.e., flows exceed the speed of long internal waves). The resulting hydraulic phenomena (manifest as large amplitude lee waves and propagating internal soliton packets) interact with the regional climatology to control the (mostly) two layer flow through the Strait.

During 1985-1986, an intensive international field experiment was conducted within the Strait of Gibraltar. The major focus was on the time-dependent two-layer control within the strait. Secondary objectives included the influence of the strait on the water mass properties of the adjacent ocean, and the influence on the mesoscale (i.e., flows where the earth's rotation is important - roughly 10-100 km in the horizontal) flows in nearby Gulf of Cadiz (eastern North Atlantic Ocean) and Western Alboran Sea (western Mediterranean Sea).

This research has two objectives, both using field data obtained in large experiments. First, what are the dynamics of the Strait of Gibraltar flow? Answering this question involves the application of stratified (two-layer) hydraulic control theory (developed by others). Second, what are the dynamics of the Alboran Sea gyre? Answering this question involves the application of numerical circulation models (developed by others).

USNA-NOARL West Midshipmen Research Project

Researcher: Lieutenant Commander Gary M. Mineart, USN
Sponsor: Naval Oceanographic and Atmospheric Research Laboratory, Atmospheric Directorate

Selected advanced very high resolution radiometer (AVHRR) satellite scenes over ocean surfaces in the Persian Gulf and Arabian Sea (from the data set held by NOARL West) will be used as input to the SATVIS aerosol optical depth and meteorological range estimation model. Scene selection will be based on parameters necessary for effective use of the model and synoptic/mesoscale features of interest. SATVIS output will be compared with available in-situ data. A correlation between satellite-derived and surface-derived meteorological ranges will be attempted. Finally, the performance of SATVIS in the Persian Gulf and Arabian Sea as compared to previous studies in the Mediterranean will be assessed.

An Examination of Synoptic Weather Data Collected During the ERICA Field Project (Winter 1988-89)

Researcher: Associate Professor David R. Smith
Sponsor: Naval Academy Research Council (ONR)

This project will investigate the meteorological phenomenon called explosive cyclogenesis - rapid intensification of low pressure systems that form along frontal systems in middle latitudes. This phenomenon generally occurs several times (approximately ten) each winter offshore of continents, especially where there are warm ocean currents such as the Gulf Stream. Such storms are responsible for strong winds and heavy precipitation along the coast, and violent waves at sea. Unfortunately, this phenomenon occurs in areas where there is a lack of adequate meteorological observations. A major field project called the Experiment on Rapidly Intensifying Cyclones over the Atlantic (ERICA) was conducted during the Winter of 1988-1989 to study this phenomenon. This project proposes to analyze data sets collected during the ERICA Field Project.

This study proposes to examine surface weather analyses and satellite imagery to identify signatures preceding intense cyclone development. The purpose is to determine synoptic scale features in the meteorological data fields that can assist weather forecasters in the prediction of explosive cyclogensis. Identification of such features can provide meteorologists the ability to provide Naval planners with adequate lead time to avoid the adverse weather conditions associated with such storms.

(As part of their SO496 research projects during the spring semester, Midshipmen 1/C Keith Lehnhardt and Paul Bowen performed some analysis of vertical soundings of thermodynamic variables in the vicinity of explosively developing cyclones during ERICA Intensive Operational Periods 4 and 5 respectively. Their findings were incorporated into the researcher's work during the summer intersessional period.)

Independent Research

Northeast North Pacific Spring Current Patterns

Researcher: Professor John W. Foerster

A time series study of the eastern North Pacific Ocean waters adjacent to the Pacific Northwest of North America concentrates on the springtime period. Between March and May pre-dominant wind patterns over the North Pacific Ocean change, as the North Pacific High Pressure Center (Hawaiian High) begins its annual intensification. As the high pressure center expands with seasonal heating, the winds shift to a northwesterly flow. A subsequent change occurs in the flow patterns of the North Pacific Current and the developing California Current. Using the advanced very high resolution radiometer (AVHRR) aboard the polar orbiter allows a study of these changes. The result of analyzing 53 images over 7 years from 1983 through 1989 is a noticeable and distinct shift in surface temperature patterns during the spring period. Comparing this information to ship-gathered information, buoy data, and meteorological conditions allows a demonstration of the time and space of this shift and a method to predict the change. Support for this project was provided by the Office of Naval Research through the Johns Hopkins University Applied Physics Laboratory.

Optical Remote Sensing Techniques Applied to a Study of Gray Whale Hydrodynamics

Researcher: Professor John W. Foerster

The gray whale (Eschrichtius robutus) is a large marine mammal. It migrates annually from caving grounds in Mexico to the feeding grounds of the Bering Sea, a distance of 18,000 kilometers. To be an efficient swimmer, the gray whale must overcome the energy consumptive influence of turbulence. The researcher studied the efficiency of the animals' swimming hydrodynamics using computerized remote sensing techniques and an expert system. The hypothesis tested was that gray whales swimming at migration speeds (1-3m/sec) achieve laminar flow. As a whale nears the surface to breathe, wakes are created and bubbles entrained. This change is measurable in digitized photographs by studying the picture element (pixel) values. Also, expelled air and purged mud from the feeding process were used as simulated dye tracers. Laminar flow was the finding. The study continues to explore power output and propulsive efficiency. It was supported by the Office of Naval Research through The Johns Hopkins University Applied Physics Laboratory.

Microcomputer Applications of Digital Data Sets

Researcher: Assistant Professor Peter L. Guth

A computer program to manipulate digital elevation models continues to be expanded to use other data, most recently TIGER line data from the Census Bureau and the new Exclusive Economic Zone bathymetric data from the National Ocean Survey. It also will take live satellite positions from a Global Positioning Satellite and display the location on a map on the computer screen, an application currently in use on YP686. The program will merge satellite and elevation data, draping the satellite image over a block diagram from the elevation model. The program will now "fly through" the terrain model with a rapidly displayed series of images. Papers on the program were presented to the Geological Society of America National meeting and the Eighth Thematic Conference on Geologic Remote Sensing.

An Investigation of Explosive Cyclogenesis along the East Coast of the United States: A Case Study of the Veterans' Day Storm (11 November 1987)

Researchers: Ensign Russell S. McCormack, USN, and
Associate Professor David R. Smith

The primary objective of this project is to investigate explosive cyclogenesis along the east coast of the United States. Explosive cyclogenesis is the rapid development (at the rate of 24 mb/24 hours or more) and intensification of the circulation associated with a low pressure system. This is a somewhat frequent (5-10 times per year) event that occurs over the Gulfstream ocean current off Cape Hatteras, North Carolina, that brings strong winds and heavy precipitation (often in the form of snow or freezing rain) to the Atlantic seaboard.

In this investigation, the researchers examined both conventional meteorological information and remotely- sensed data to determine possible signatures in the data fields preceding the rapid development of these storms at sea. Identification of such features would greatly enhance the ability of operational forecasters to predict these hazardous meteorological phenomena, the most important weather producers for the east coast and just offshore.

Ensign McComack presented his results at the Fourteenth Annual Meeting of the National Weather Association. A manuscript presented to the American Meteorological Society was awarded third prize for the Father James B. Macelwane Undergraduate Research Award in January 1991.

Global, Regional, and Zonal Time Series of Satellites SST's

Researcher: Visiting Professor Alan E. Strong

A monthly time-series of advanced very high resolution radiometer (AVHRR) derived multi-channel sea surface temperatures (MCSST) has been compared with ship and buoy SST data during the 1982-1989 period. Results have been converted to annual means to reduce serial dependencies between months. Data separated both into regional and latitudinal time-series show favorable agreement between the satellite and conventional SST's in most areas. Comparisons with results from the NOAA/GFDL coupled atmospheric/ocean model indicate that certain changes that might be expected to accompany published global warming scenarios may be beginning in some ocean areas. For example, during the past decade, the southern hemisphere "ocean" has been warming at a slightly slower rate (o.03C/yr) than is seen over the northern hemisphere "ocean" (0.04C/yr). The researcher's time-series shows that displaying warming tendencies, rather than cooling: The Indian Ocean (-0.05C/yr), the high latitude southern ocean (-0.08C/yr); and the equatorial oceanic belt (-0.06C/yr).

Although most regional and zonal trends seen in the satellite MCSST time-series are also present in the conventional SST data during this same period, the ship and buoy data increases are not quite as great. Interesting seasonal differences have been noted in certain areas that possibly can be attributed to ship contamination, procedures as these 12-month cycles are absent in the satellite-derived SST's.

Ecosystem Dynamics of Long Island Coastal Embayments: A SUPE Study

Researcher: Assistant Professor Mario E. C. Vieira

Great South Bay, New York, is a shallow unstratified productive estuary (SUPE) typical of the coastal lagoons dominating the eastern United States coastline. The study evaluates the interrelationship of hydrodynamics and trophodynamics on the nature of these SUPE ecosystems, using Great South Bay as a model. The influence of freshwater inputs and coastal water intrusions on residence time of water in the Bay will be elucidated. The impact of hydrology and flushing gradients on salinity and nutrient supplies and consequent changes to primary productivity and the nature of the primary producers (phytoplankton versus seagrass) will also be addressed. A dynamical model will be developed to analyze, in conjunction with an existing hydrodynamic model, the interactions between the physical and biological factors affecting ecosystem organization.

Long Island Sound Study

Researcher: Assistant Professor Mario E. C. Vieira

This project consists of compiling current meter and hydrographic data sets collected in 1988 for the Long Island Sound Study by researchers from the Marine Sciences Research Center of State University of New York. This effort is a part of the National Estuary Program conducted by the U.S. Environmental Protection Agency. The Long Island Sound Study was conceived to protect and improve the health of the sound's resources and the water quality upon which they rely. It is the most extensive and comprehensive effort ever undertaken to collect and analyze data in the sound.

The circulation and physical structure of the sound's waters are fundamental aspects of the investigation. A database is being prepared, consisting of edited and reduced current, salinity, and temperature time series data. These measurements are now being analyzed with the purpose of revealing the three-dimensional distribution of the residual field of motion and mass throughout the sound.

Research Course Projects

Remote Sensing of Antarctic Sea Ice

Researcher: Midshipman 2/C Andrew S. Lomax, USN
Adviser: Assistant Professor Peter L. Guth

Work is currently in progress to determine the interannual variability of sea-ice extent around the continent of Antarctica from 1973 to the present, using satellite-derived data. Several sources are used, including ESMR on Nimbus 5, the SMMR on Nimbus 7, and the SSM/I on the DMSP satellite. Several algorithms exist to convert the raw brightness temperature data to sea-ice concentration, and efforts have been made to quantify the effects of these different algorithms on the estimate of sea-ice extent. Particular attention has been paid to the DMSP data during the period July 1987 to March 1989. Sequential color-coded images of this data set are displayed on a PC to give a quasi-continuous display of sea-ice concentration after conversion of the brightness temperature data using the algorithm developed by Cavalieri *et al.* This sequence clearly shows the differences in rates of ablation and growth inherent in Antarctic sea-ice and the absence of the previously-observed Weddell Sea polynya.

An Examination of Sea-Surface Temperature Influence on Tropical Storms over the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea

Researcher: Midshipman 1/C Caren M. Ritter, USN
Advisers: Associate Professor David R. Smith and
Visiting Professor Alan E. Strong

This investigation examines hurricane data during the 1982-1989 tropical storm seasons over the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea. Development and movement of tropical storms over the areas and periods of interest are correlated with sea-surface temperature (SST) patterns (mean and anomaly values) over the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea. SST information is obtained using advanced very high resolution radiometer data from the NOAA-9 and -11 meteorological satellites.

Pearson product correlation coefficients are computed to determine the relationship between tropical storm intensity (in terms of minimum sea level pressures and surface winds) and SST values. Analysis of the data suggests that some recent storms (e.g., Hurricanes Gilbert and Hugo) exceeded maximum intensity predicted by earlier studies (Miller, 1958; Merrill 1988) relating tropical storms development to sea-surface temperature patterns. This lends credence to a theoretical prediction by Gray (1990) that the upcoming decade will produce more violent tropical storms than observed during the early 1980's. This study also suggests the important role that remotely-sensed sea-surface temperature data can play in the prediction of tropical storm development and movement. The results were presented at a seminar at the National Environmental Satellite Data Information Service and at the American Geophysical Union Annual Spring Meeting. It is anticipated that a manuscript will be submitted to the American Meteorological Society for the Father James Macelwane Undergraduate Research Award and to a journal of either the American Meteorological Society or The Oceanographic Society for publication.

A Numerical Model of the Chesapeake Bay as a Classroom Tool

Researcher: Midshipman 1/C Jonathan C. Ciccone, USN
Adviser: Assistant Professor Mario E. C. Vieira

A numerical model of coastal circulation has been adapted to the northern Chesapeake Bay, constituting a teaching tool to be utilized in connection with a course in estuarine physics at the U.S. Naval Academy.

MECCA (Model for Estuarine and Coastal Circulation Assessment) is a three-dimensional, time-dependent, finite difference numerical model capable of simulating the tidal, wind, and density driven circulation in shallow waters (Hess, 1989). In this application the model was run with a grid size of 5.5 km and driven with actual Annapolis data (tide, salinity, wind) and river inflows. The outputs from a week-long model run were compared with in-situ measurements; the results encourage further refinement of the grid and eventual coverage of the whole bay.

Publications

FOERSTER, John W., Professor, "Northeast North Pacific Spring Current Patterns," *North American Polar Orbiter Users Group*, 2 (May 1991), 234-247.

A time series study of the eastern North Pacific Ocean waters adjacent to the Pacific Northwest of North America concentrates on the springtime period. Between March and May predominant wind patterns over the North Pacific Ocean change, as the North Pacific High Pressure Center (Hawaiian High) begins its annual intensification. As the high pressure center expands with seasonal heating, the winds shift to a northwesterly flow. A subsequent change occurs in the flow patterns of the North Pacific Current and the developing California Current. Using the advanced very high resolution radiometer (AVHRR) aboard the polar orbiter allows a study of these changes. The result of analyzing 53 images over 7 years from 1983 through 1989 is a noticeable and distinct shift in surface temperature patterns during the spring period. Comparing this information to ship-gathered information, buoy data, and meteorological conditions allows a demonstration of the time and space of this shift and a method to predict the change.

FOERSTER, John W., Professor, "Columbia River Spring Plume Distribution as a Function of Current Changes in the Northeast North Pacific Ocean," EOS, (April 1991), 163.

The hypothesis for this study is that the seasonal shift of the Columbia River plume corresponds to the change in ocean current patterns. A combination of a satellite image time series analysis and oceanographic measurements off the Columbia River comprise this study. Actual measurements, historical data, and satellite imagery show the Columbia River plume moves when the spring current patterns in the Northeastern North Pacific Ocean change. Major current patterns in the winter are intrusive as the Davidson Current flows north. In April, the early spring layered pattern appears, as the winds and water mass transport shift with the expanding Hawaiian High Pressure Center. The Davidson Current diminishes and the Hawaiian High continues to expand as April closes. Finally, by May, the current patterns cant at an angle to the coast. During May and into the summer period, the river plume shifts from flowing north along the coast (March) to offshore (April). In May, the river plume flows south along the coast and out over the shelf. Therefore, during this major run-off period, the river plume shifts as a function of current movement, water mass transport, and coriolis deflection.

GUTH, Peter L., Assistant Professor, "1990, Superposed Mesozoic and Cenozoic Deformation, Indian Springs Quadrangle," *Basin and Range extensional tectonics near the latitude of Las Vegas*, ed: B. Werniche. Geological Society of America Memoir. 176, pp. 237-249.

Northwestern Clark County contains Tertiary extensional faults of the Sheep Range detachment that overprint the Mesozoic Sevier thrust belt. Three thrust faults occur, from west to east the Spotted Range, Pintwater, and Gass Peak thrusts. The Spotted Range and Pintwater thrusts were minor imbrications in the thrust belt, and have been excised by Tertiary extension. The Gass Peak thrust emplaced a major structural plate interpreted to have overridden a large ramp in the basal decollement of the Sevier belt, where the thrusts climb from the base of the Eocambrian clastic wedge to the middle Cambrian Bonanza King Formation.

Tertiary extension involved normal faults, steep at the surface but inferred to flatten into a deeper detachment, strike-slip faults that bound extensional blocks, and syntectonic sedimentary basins. The Spotted Range and Pintwater thrusts were largely excised by normal faults. The Dog Bone Lake fault is interpreted to have reactivated the basal thrust ramp, and other faults of the Sheep Range detachment may have reactivated the upper decollment in the Bonaza King Formation. Extensional faults are predominantly down to the west, and rotate bedding significantly in the eastern part of the region but much less to the west where the extensional allochthon was thicker and surficial extension less.

GUTH, Peter L., Assistant Professor, "Combining Imagery and Digital Elevation Models on a Personal Computer," *Proceedings* of the Eighth Thematics Conference on Geologic Remote Sensing, Vol. 2, (1991), pp. 921-929.

Personal computers possess graphics capabilities, disk storage capacity, and processing speed to combine satellite imagery with gridded digital elevation models. MICRODEM performs these functions on an MS-DOS microcomputer with VGA graphics. By running standard hardware used for word processing and spreadsheet manipulation, MICRODEM makes image manipulation possible for students and all professionals. MICRODEM displays satellite data including SPOT, Landsat, and advanced very high resolution radiometer (AVHRR), or aerial photographs scanned with a simple scanner. The program performs standard image analysis functions, including trained classification. Using digital elevation models (or other gridded data like gravity or magnetic), MICRODEM displays color maps of elevations, slope, aspect, or reflectance, draws contour maps, and displays three dimensional views. After registering the satellite image to the elevation model, MICRODEM can overlay elevation contours or a UTM grid on the image, drape the image onto a three-dimensional block diagram, or use the satellite image for point location for lavation model manipulation.

GUTH, Peter L., Assistant Professor, "Manipulating Large Gridded Data on a Personal Computer," *Federal Digital Cartography Newsletter* (1990) 12-14.

This paper describes the uses of the MICRODEM computer program for manipulating digital elevation models and other gridded data sets. The program deals with raster data sets and can function as a geographic information system. A sample of output from the program shows nuclear karst from Yucca Flat, Nevada.

KINDER, Thomas H., Visiting Professor, co-author, "The Aspiration of Deep Waters Through Straits," *The Physical Oceanography of Straits*, ed., L. Pratt, Kluwer, 295-319.

As suggested by Strommel nearly 20 years ago, deep waters in isolated basins may be sucked upward by strong shallow flows ("Bernoulli effect"). This simple and appealing idea, based on two-layer hydraulic flow, apparently works in the Gibralter-Mediterranean system, in spite of complicating factors (e.g., vigorous tidal stirring, strong lateral variability). Aspiration of deep waters probably occurs at many sills and ridges that isolate deep basins, at least episodically, and may control residence times for the deep waters.

KINDER, Thomas H., Visiting Professor, co-author, "The Atlantic Inflow in the Western Mediterranean," *Journal of Physical Oceanography*, **20** (2), 242-263.

Using the first long-term (112 days) current measurements in the region, a complete kinematical description of the Alboran Sea gyre was obtained. This recurring feature, formed by the Atlantic inflow jet, often fills the entire western Alboran Sea, from Spain to Morocco. Two interesting results were (1) a persistent inflow oscillation with a 9-day period (which does not match know Strait of Gibralter periodicities), and (2) a rapid (about 1 day) disappearance of the gyre for a duration of about 10 days.

KINDER, Thomas H., Visiting Professor, co-author, "Generation and Kinematics of the Internal Tide in the Strait of Gibralter," *The Physical Oceanography of Straits*, ed., L. Pratt, Kluwer, pp. 477-491.

The barotropic tide causes strong flows within the Strait of Gibralter which contribute to the high internal Froude number. The resulting internal motions, with much of the variance at tidal frequencies, cause a large perturbation in the density structure throughout the Strait. This paper describes the evolution of the internal tide in the Strait using all data from the 1985-1986 experiment.

KINDER, Thomas H., Visiting Professor, co-author, "Recent Progress in Strait Dynamics," Reviews of Geophysics, Supplement: 617-631 (U.S. National Report to International Union of Geodesy and Geophysics, 1987-1990).

During the last decade or so, there has been renewed interest in the dynamics of flows through straits. Much of the new understanding has resulted from the extension of hydraulic control theory to encompass counter flow, stratification, complex boundaries (e.g., critical sections in depth and width at separate locations). The most definitive field experiment to date, the Gibralter Experiment, is used to illustrate this new understanding.

SMITH, David R., Associate Professor, co-author, "Establishment of the American Meteorological Society's Atmospheric Education Resource Agents (AERA) Program," *Bulletin of the American Meteorological Society*, **72**, 5 (May 1991), 612-615.

This article describes the Atmospheric Education Resource Agents (AERA) Program established by the American Meteorological Society. AERA's are specially designated master science teachers who have completed an educational program in the atmospheric sciences and who are incorporating weather-related topics into their science curricula. These teachers serve as resource agents for AMS, providing a vital link between the Education Office of the American Meteorological Society and teachers across the country who are teaching weather topics.

Forty-eight teachers representing 29 different states attended the First Annual Workshop for Atmospheric Education Resources. These attendees were oriented on their roles as AERA's and were familiarized with the activities of the American Meteorological Society. They also heard a variety of prominent speakers describe current research activities on "hot-topics" in the atmospheric sciences.

The article also describes future plans for the AERA program, including plan training sessions for current and future participants in the program.

SMITH, David R., Associate Professor, co-author, "Atmospheric Science Education Program for Teachers at Purdue University: A Model Program for Science Teachers," *The Earth Scientist*, **8**, 4 (April 1991), 10-12.

The Atmospheric Sciences Education Program (ASEP) was established at Purdue University in April 1986. Its primary objective was to enhance the quality of weather studies for pre-college science curricula by: (1) improving the background knowledge of science teachers in atmospheric sciences through summer workshops; (2) developing educational materials in atmospheric sciences for elementary, middle, and high school science programs; and (3) providing a continuing partnership between Purdue University and Indiana school systems for supporting the development of weather studies at the pre-college level.

This presentation describes the accomplishments of the Atmospheric Sciences Education Program over the past three years. These include: (1) workshops conducted for teachers during the summers of 1987 (for grades 5-9) and 1988 (for grades 7-12); (2) educational materials developed to assist teachers after they have returned to their respective school programs; (3) school visitations by ASEP staff members to evaluate the incorporation of atmospheric sciences into the science curriculum of participating schools and continuing correspondence with teachers to provide ongoing support in curriculum development; (4) activities by the teachers (in-service training, conference presentations, extracurricular activities, etc,) to continue the educational process throughout their school districts; and (5) activities of ASEP staff to inform the Atmospheric Sciences community about the need and importance of developing pre-college programs in the Atmospheric Sciences.

Suggestions on how this program might be used as a model for other disciplines to promote science education are also discussed.

SMITH, David R. Associate Professor, co-author, "Weather Measurements Around Your School: Variability of Temperature and Humidity," *The Science Teacher*, **58**, 1 (January 1991), 40-43.

This paper describes a micrometeorological experiment conducted by teachers participating in the Atmospheric Science Education Program at Purdue University (July 1989). Thirty observers were stationed in a network on and around the Purdue University campus. They measured temperature and humidity at each of the locations in 15-minute intervals over a one-hour period. Upon completion of the measurements, the observers performed an analysis of the data to determine the variability of these environmental parameters. Major findings include: (1) a distinct variability of temperature due to terrain, paving surfaces, buildings, trees, etc., and (2) variability in humidity due to the inverse correlation of temperature and relative moisture content, as well as local sources of liquid water and water vapor. Suggestions for conducting such a field experiment in a school situation are also provided.

SMITH, David R., Associate Professor, co-author, "Guide to Establishing School and Popular Educational Activities," *Bulletin of the American Meteorological Society*, **71**, 12 (December 1990), 1760-1766.

This article provides guidance for promoting school and popular meteorological and oceanographic educational activities for individual members and local chapters of the American Meteorological Society. This "Guide" suggests a variety of activities (e.g., science fairs, mentorship programs, career day participation, speakers' bureaus, etc.) and appropriate procedures for establishing and maintaining effective contact with both schools and

the popular media. The intent is to inform the entire membership of the American Meteorological Society with effective ways of promoting one of the most important tasks of the society--educating the general public about the disciplines of meteorology and oceanography.

SMITH, David R. Associate Professor, and Gary L. STRINGER, Lieutenant Commander, USN, "METLAB - A Computer-based Meteorological Laboratory for the United States Naval Academy." Preprints of the Seventh International Conference on Interactive Information and Processing Systems in Meteorology, Oceanography, and Hydrography, American Meteorological Society, Boston, Massachussetts, pp. 462-467.

The Oceanography Department at the United States Naval Academy has just completed installation of Phase I of its computerized meteorological laboratory (METLAB). The system includes seven Hewlett-Packard HP-370 computers and software developed by RMS Technologies, Inc. The purpose of this system is to provide a computerized environment appropriate for meteorological instruction at the undergraduate level. METLAB is designed to ingest a variety of meteorological products, serve such products to workstations in the laboratory, and provide interactive capabilities for weather data analysis, interpretation, and prediction. This paper describes the current system configuration and how it is being integrated into an undergraduate synoptic meteorology class. Meteorological data streams utilized in the system are discussed, as well as graphical products available at the student workstations. Further, a discussion of future plans for expansion is included.

Presentations

BAKER, L. Gene, Lieutenant Commander, USN, and Murray S. KORMAN, Associate Professor, (Physics) "Underwater Acoustics at the U.S. Naval Academy," Acoustical Society of America, San Diego, California, 26-30 November 1990.

BAKER, L. Gene, Lieutenant Commander, USN, Russell J. COOLMAN, and Gilbert C. NIEDENTHAL, Midshipmen 1/C, USN "A Student Monitoring Program for the Chesapeake Bay," Chesapeake Research Federation, Baltimore, Maryland, December 1990.

FOERSTER, John W., Professor, "Northwest North Pacific Spring Current Patterns," Polar Orbiter User Group, Washington, DC, 1 June 1990.

FOERSTER, John W., Professor, "Acoustic Analysis of Spring Oceanic Zooplankton," Western Society of Naturalists, Monterey, California, 29 December 1990.

FOERSTER, John W., Professor, "Gray Whale Hydrodynamics," Office of Naval Research Conference, Annapolis, Maryland, 15 October 1990.

FOERSTER, John W., Professor, "Gray Whale Hydrodynamics," American Association for the Advancement of Science, Washington, DC, 5 February 1991.

FOERSTER, John W., Professor, "Columbia River Plume," American Geophysical Union, Baltimore, Maryland, 30 May 1991.

GRUBER, Arnold, Visiting Professor, "Radiation Budget and Longwave Cloud Forcing Anomalies from NOAA Operational Data" Press World Meteorological Organization, World Climate Research Program, 12-14 November 1990.

GUTH, Peter L., Assistant Professor, "Teaching Plate Tectonics and Marine Geophysics to Introductory Students with a Microcomputer," Geological Society of America National Meeting, Dallas, Texas, 30 October 1990.

GUTH, Peter L., Assistant Professor, "Combining Imagery and Digital Elevation Models on a Personal Computer," Eighth Thematic Conference on Geologic Remote Sensing, Denver, Colorado, 1 May 1991.

KINDER, Thomas H., Visiting Professor, "Hydraulic Control in the Strait of Gibraltar." Third International Colloquium of the Fixed Link between Europe and Africa, Merrakech, Morocco.

KINDER, Thomas, H., Visiting Professor, "Two Layer Hydraulic Control in the Strait of Gibralter." International Council for the Exploration of the Mediterranean Sea, Perpignam, France.

LOMAX, Andrew S., Midshipman 1/C, USN, Peter L. GUTH, Assistant Professor, and Robin G. WILLIAMS, Visiting Professor, "Investigation of Antarctic Sea-Ice Extent by Means of Passive Microwave Remote Sensing," American Geophysical Union Spring Meeting, Baltimore, Maryland, 29 May 1991.

SMITH, David R., Associate Professor, Caren M. RITTER, Midshipman, 1/C USN, and Alan E. STRONG, Visiting Professor, "An Examination of Sea-Surface Temperature Influence on Tropical Storm over the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea", 1991 Annual Spring Meeting of the American Geophysical Union, Baltimore, Maryland, 29 May 1991.

SMITH, David R., Associate Professor, "Project Atmosphere: K-12 Educational Initiatives of the American Meteorological Society", National Earth Science Teachers Association Meeting, Thirty-ninth National Convention of the National Science Teachers Association, Houston, Texas, 30 March 1991.

SMITH, David R., Associate Professor, "American Meteorological Society's K-12 Educational Initiatives," National Research Council, Committee on Meteorological Analysis, Prediction, and Research, Washington, DC, 21 March 1991.

SMITH, David R., Associate Professor, Gary L. STRINGER, Commander, USN, "METLAB - A Computer-Based Meteorological Laboratory for the United States Naval Academy," Seventh International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, American Meteorological Society, New Orleans, Louisiana, 14-18 January 1991.

SMITH, David R., Associate Professor, "American Meteorological Society's Resources for the Atmospheric Education Resource Agents (AERA)" and "Roles and Expectations for Atmospheric Education Resource Agents (AERA)," First Workshop for Atmospheric Education Resource Agents, American Meteorological Society, New Orleans, Louisiana, 12-13 January 1991.

SMITH, David R., Associate Professor, "Using Meteorology to Stimulate Interest in the Science Classroom," Annual Mini-Convention of Elementary and Secondary Educators of the Archdiocese of Baltimore, Baltimore, Maryland, 19 November 1991.

SMITH, David R., Associate Professor, and Russell S. MCCORMACK, Ensign, USN, "The Veterans' Day Storm of 1987: A Case Study of Explosive Cyclogenesis Along the East Coast," Fourteenth Annual Meeting of the National Weather Association, New Carrollton, Maryland, 18 October 1990.

STRONG, Alan E., Visiting Professor, "1990 Global Regional, and Zonal Sea Surface Temperature Signals from Satellite and In-situ Observations during the 1980's," 1990 Marine Technology Society, Washington, DC, 26-28 September 1990.

STRONG, Alan E., Visiting Professor, "1991 Large-scale Satellite Observed Sea Surface Temperature's during the 1980's as Compared with Conventional Sea Surface Temperature's," Second Symposium on Global Change Studies, American Meteorological Society Annual Meeting, New Orleans, Louisiana, 14-18 January 1991.

STRONG, Alan E., Visiting Professor and Richard C. MCCORMACK, Ensign, USN, "1991 Coral Bleaching and Sea Surface Temperatures," Oceanography Society Second Annual Conference, St. Petersburg, Florida, 24-28 March 1991.

VIEIRA, Mario E. C., Assistant Professor, "A Numerical Model of the Chesapeake Bay as a Classroom Tool," Spring Meeting of the American Geophysical Union, Baltimore, Maryland, 29 May 1991.

VIEIRA, Mario E. C., Assistant Professor, "The Role of Environmental Changes in an Unusual Coastal Plankton Bloom," Symposium on Hydrobiological Variability in the Ices Area, 1980-1989, Mariehamn, Finland, 5 June 1991.

DEPARTMENT OF

Physics

Professor Robert N. Shelby
Chair

The 1990-1991 academic year has been another year of active and productive involvement of Physics Department faculty and students in a broad range of research efforts. As detailed in the abstracts that follow, the range of topics includes studies of planetary magnetic fields, galactic astronomy, atomic physics, nuclear physics, archeological research, condensed matter physics, non-linear optics, optics and lasers, submarine magnetics, non-linear acoustics and acoustical signatures. Hard work has resulted in major system improvements that have greatly enhanced experimental research capabilities in the optics, atomic physics, condensed matter, and nuclear physics laboratories. These efforts, together with work in laboratory development, computer interfacing, and software development for use in student and research laboratories, have served to maintain the vitality of the educational program in the department.

The long established history of strong midshipmen involvement in departmental research was continued with three Trident Scholar Projects and nine independent student research projects having been successfully completed during the year. Two highlights of the student research have included a project done at the Naval Observatory by a student of Associate Professor Elise Albert and papers given at a national Acoustical Society meeting by students of Associate Professor Murray Korman. In addition, the future looks bright with three physics students having been selected as Trident Scholars for the next year.

Visiting Researchers in the department this year were Dr. Christopher Coughlin, an Office of Naval Technology Post Doctoral Fellow working with Drs. Fontanella and Wintersgill in condensed matter research, and Dr. Charles Bell, who came from the Naval Surface Warfare Center, White Oak Laboratory, as a participant in the Naval Scientist Training and Exchange Program (NSTEP).

Funding support for Physics Department research has come from departmental funds, the Naval Academy Research Council, and the USNA Instructional Development Advisory Committee; from the Naval Research Laboratory, the National Science Foundation, the David Taylor Research Center, DuPont de Nemours, Company, and the American Society for Engineering Education.

Sponsored Research

Projectile K-Auger Electron Spectroscopy in Fast Ion-Atom Collisions

Researcher: Assistant Professor John M. Anthony
Sponsor: Naval Academy Research Council (ONR)

In these experiments, the energy and intensity of K-Auger electrons emitted by projectile ions are measured following collisions with atomic or molecular gas targets. Due to kinematic broadening effects, Auger lines arising from the decay of the projectile electron cloud can lead to a severe degradation of resolution; an electron spectrometer designed to minimize these effects was used. The HRPES, or high energy resolution projectile electron spectrometer, which was designed and built by the atomic collisions group at the University of North Carolina at Chapel Hill, was used in experiments performed at the Oak Ridge National Laboratory. Also, a high resolution, zero degree observation angle tandem electron spectrometer was used for experiments conducted during the summer of 1990 at Kansas State University's MacDonald Laboratory.

The experiments so far have concentrated on measuring transition energies and production cross-sections for doubly ionized (4-electron) carbon ions in the 3 to 20 Mev energy range. Some data were also taken for 2-electron carbon ions as well. Work during the summer of 1989 and through the 1989-1990 academic year was performed at the Oak Ridge National Laboratory EN tandem Van de Graff accelerator facility. A great deal of advice and technical support was given by the ORNL atomic collision group. In the summer of 1990 the researcher accepted an invitation by the atomic collision group headed by Professor Pat Richard at Kansas State University using their new 0κ spectrometer.

So far, measurements have been made of the $1s^2 2s2p\ ^3P$ metastable fraction in the incident 4-electron (or Be like) carbon beam over a 3 to 15 MeV energy range. Work is also in progress to compare measured Auger production cross-sections, for certain transitions, to theoretical calculations for excitation by the electron-electron anti-screening interaction.

Also, a computer program has been written and is now being tested for modeling the lens effect of the radial deceleration field used in the ORNL experiments. Plans for the summer of 1991 include final data analysis and preparation for publication.

Computer Simulation of Second Stokes Scattering in Transient Raman Scattering

Researcher: Professor Gerald P. Calame
Sponsor: Naval Research Laboratory, Code 6540

The response of Raman-scattering media to transient laser pulses is of continuing interest for several practical applications. Recent interest has been generated in the study of the generation of the second-Stokes beam under transient conditions. A computer program, written last year in order to model the process, suffered from an inadequate number of points in the spatial mesh, and did not simulate realistically the buildup of the first and second Stokes beams from original photon noise. The program has been rewritten in order to remove these difficulties. Although the program runs perfectly on the NATS system, the program as modified for the NRL CRAY has a bug in it, which has so far prevented its use on that system. The effort to debug the program continues.

Hydrogen Profiling Using Elastic Recoil Detection

Researcher: Associate Professor F. David Correll
Sponsor: Naval Research Laboratory, Code 4671

Work supported by this program during FY90 proceeded in two phases: a survey of ion-beam analysis (IBA) techniques used for depth-profiling hydrogen in solids, and the development of apparatus for hydrogen profiling by the elastic recoil detection (ERD) technique at the USNA tandem accelerator laboratory.

The goal of the first phase was to become familiar with the IBA techniques commonly used for measuring depth profiles of hydrogen isotopes in solids. A literature search was performed, seeking recent references describing the ERD technique. Based on that literature search, a bibliography was prepared and a talk on hydrogen profiling was presented to the Diamond Film group at NRL on 1 August 1990.

The goal of the second phase of the work was to design, fabricate, and install apparatus for hydrogen profiling by the ERD technique at the USNA tandem accelerator laboratory. New detector holders were designed and constructed; a rotating sample holder was designed and built; and installation of a new data-acquisition system employing a VAXstation 3500 and a CAMAC front-end was begun.

The first phase of the work is essentially complete: IBA techniques for profiling hydrogen have been reviewed and a reasonably complete set of references has been assembled. The second phase is continuing: most of the apparatus needed to perform ERD measurements at USNA has been built, installed, and tested.

Magnetospheric Physics

Researcher: Associate Professor Irene M. Engle
Sponsor: Naval Academy Research Council (OMN)

The researcher continues intermittent work on several projects:

(1) Modeling, from first principles, a representation of the Jovian magnetosphere during a semi-inflated state, as observed during the Voyager II flyby. Two papers based on this work are now in press; a third abstract on work in progress was presented at the May 1991 meeting of American Geophysical Union in Baltimore.

(2) A new look at the Mercury magnetospheric field, in response to a recently published review on Mercury which contains some conclusions which are not supported by this investigator's experience. The researcher is currently seeking a publication source for the completed manuscript. Meanwhile, an investigator interested in obtaining time dependent configuration modeling for analysis of some more recently observed photoionization of heavy ions near the disc of Mercury has contacted the researcher.

Other projects include:

(3) modeling, from first principles, as in project 1, or by scaling from a function set, as in project 4, self-consistent, three-dimensional global magnetospheres of Uranus and Neptune;

(4) adapting alternate sets of orthogonal functions for three-dimensional representation of magnetospheres for earth and other planets with intrinsic planetary magnetic fields; and

(5) the relation of observed temporal variations of magnetospheric configurations to the proximate causes and consequential phenomena; investigations of the mechanisms for transport of particles, momenta, and energy related to the aforesaid phenomena. These projects were also supported by the I. M. Engle Foundation.

Mathematical Modeling of Magnetic Sources

Researcher: Associate Professor William E. Fasnacht
Sponsor: David Taylor Research Center, Code 2751

The first part of the work led to the confidential report listed below. Written in response to a request to "tell us how you do it," this is a study of the relations and interactions among magnetometer type, data set, and source parameters. Essentially, it is a summary of some years of modeling experience, written to help others avoid some rather subtle pitfalls inherent in the process.

A continuing portion of the work is the design of a new sensor array for use at deperming slips, which will again be classified.

Tribomechanical Properties of SiC Implanted with Energetic Si Ions

Researcher: Assistant Professor James R. Huddle
Sponsor: Naval Research Laboratory, Code 4671

Three polished samples of a-SiC (Kyocera SC201) were each bombarded with silicon ions of energy 6 MeV, 4 MeV, 2 MeV, 1 MeV, and 0.36 MeV to produce a rather uniform damage profile from the surface to a depth of 2 μm. The total dose for the first sample was calculated to be the critical dose for complete amorphization. The second sample was bombarded to a total dose 4 times the calculated critical dose, and the third was bombarded to a total dose one fourth the calculated critical dose. A fourth polished sample was not bombarded. Measurements of surface microhardness, fracture toughness, surface roughness, and of friction and wear properties at the interface between the SiC surfaces and the surface of a steel ball show dramatic differences as a function of Si ion dose.

This work was presented at the 1990 Fall Meeting of the Materials Research Society and was published in the MRS Extended Abstracts.

Characterization and Tribology of Carbonaceous Films Formed by the Ion Beam Assisted Deposition of Silicone Fluids

Researcher: Assistant Professor James R. Huddle
Sponsor: Naval Research Laboratory, Code 4671

Hioki et al. have reported that carbonaceous films formed by the vapor deposition of silicone fluids and simultaneous ion beam irradiation have low friction (μ = 0.05) in high humidity ambient atmospheres. The researcher describes the experimental procedures to produce these films at rates exceeding 10 A/sec. These films have C:Si:O ratios similar to the silicone fluid. Film compositions are measured with Rutherford Backscattering and Elastic Recoil Scattering. Chemical information is obtained with infrared spectroscopy. Friction and load carrying properties are measured in dry and moist air. The mechanisms by which low friction coefficients are achieved and maintained, including the formation of transfer films, are examined.

This work was presented at the 1991 Meeting of the International Conference on Metallurgical Coatings and Thin Films, ICMCTF-1991.

Experiments on the Nonlinear Scattering of Crossed Focused Beams in the Presence of Turbulence

Researcher: Associate Professor Murray S. Korman
Sponsor: Naval Academy Research Council (ONR)

An experimental study, involving the nonlinear interaction of mutually perpendicular crossed ultrasonic beams overlapping (at a common focal point) and interacting in the presence of turbulence leads to measurements of the farfield radiated sum frequency pressure. Earlier experimental results [M.S. Korman, S.C. Rife, "Nonlinear Sound Scattering of Crossed Focused Beams in the Presence of Turbulence," Proc. Intl. Cong. Acoust., Belgrade, Yugoslavia, 1989, Vol. 1, pp. 291-294.] measured the profile of the radiated sum frequency pressure by scanning the overlap region across the width of turbulence produced by a submerged circular water jet ($Re = 8.5x10^4$). In scanning, the receiver transducer moves fixed relative to the senders (of primary frequencies $f_1 = 2.05MHz$ and $f_2 = 1.95MHz$). Pressure scans compare well with known values of the radial turbulent rms velocity profile, $u_r(r)$. This work is extended to include measurements of the profiles of frequency broadening, skewness, and kurtosis that are obtained from the frequency spectrum of the nonlinearly scattered sum frequency wave. Angular measurements of Doppler shift and spectral broadening are used to predict the mean flow speed and rms turbulent velocity on the jet axis.

Magnetic Modeling

Researcher: Professor Frank L. Miller
Sponsor: David Taylor Research Center, Annapolis,Laboratory

This is a classified project involving investigating various methods of modeling different sources of magnetic fields.

Optical Mixing in Photorefractive Materials

Researcher: Assistant Professor Steven R. Montgomery
Sponsor: Naval Academy Research Council (ONR)

The tungsten bronze crystals barium strontium potassium sodium niobate (BSKNN) and strontium barium niobate (SBN) are called photorefractive, because their indices of refraction can be changed by light at very low power levels. The refractive index change can be modelled as a grating when two or more beams interfere within a crystal and, in fact, a single beam scattered by imperfections in a crystal produces random gratings that scatter the incident radiation out of the beam. This scattered light is called beam fanning. Producing nonrandom gratings is possible by illuminating a crystal with laser beams whose directions, wavelengths, and polarizations are carefully controlled. The gratings have potential applications in information storage, real time optical processing of images, and as phase conjugating mirrors that can be used to descramble images and very accurately target high power laser beams.

The purpose of this project was to study the gratings formed in BSKNN when the input light consisted of collinear laser beams whose wavelength and polarizations could be independently controlled. This study was prompted by the observation, during the course of previous work with SBN and BSKNN, that the beam fan could be made to take the form of rings rather than the nearly random scattering usually seen in single beam fanning. Similar rings, in a different material, are displayed in the October 1990 issue of *The Scientific American* to analyze the rings. The argon ion laser beam in Michelson B-10, consisting of five different wavelengths, was separated into two beams, which could be independently controlled to produce two monochromatic beams with independent polarizations. The two beams were then combined into one and allowed to enter the crystal. The ring properties were then studied as a function of

wavelength, incident angle, and polarization. A theoretical model initially proposed by colleagues at the Army's Center for Night Vision and Electro-Optics to explain these effects was developed into a computer program by this investigator using the software package Mathematica on a Macintosh. The core of the program involves determining the intersection between spherical and ellipsoidal shells that do not have a common origin. These intersection curves are then mathematically projected onto a plane for comparison to the observed rings.

Sonar Pattern Recognition Using Neural Networks

Researcher: Associate Professor Eugene P. Mosca
Sponsor: Naval Research Laboratory, Code 6527

This is an investigation into the feasibilty of using neural network technology for sonar pattern recognition applications. The Neutral Works simulation of ART I is used to detect novelty events in various background underwater acoustic environments. As part of a preprocessing stage the power spectral density of time series data is truncated in order to create a "grey scale." The arousal of the network constitutes the detection of a novelty.

Update Physics Lab Software

Researcher: Professor David A. Nordling
Sponsor: Naval Academy Instructional Development Advisory Committee

Since 1983 the Physics Department has incorporated microcomputers into the Physics laboratories. In 1989-1990 a major upgrade was effected by incorporating expanded memory and speed-up of the CPU. In 1989 most of the existing software had been converted to incorporate these changes. During this past year the three remaining pieces of software were converted and a new one was added to the software package.

Since the hardware used in the Physics Laboratory Workstations has been in use for nearly 10 years, it is planned to replace the microcomputer portion of the workstations. A microcomputer has been selected and during this past year work began in the development of some of the necessary software for this new microcomputer.

Studies of Low-Light Level Raman Amplifiers

Researcher: Professor Lawrence L. Tankersley
Sponsor: Naval Research Laboratory, Code 6540

All the studies proposed are in support of an ongoing effort at the Naval Research Laboratory in Code 6540. Under this proposal, the current study of Raman amplification will be continued and extended. Work is planned for the following areas: (1) Low-light level amplification and imaging; (2) Quantum fluctuations and Raman amplifier noise; (3) Interactions of noise and signal fields in amplifiers; (4) Amplifier dynamic effects - spatial and spectral gain narrowing; and (5) Potential biological applications of low-light imaging.

Optical Properties of High Temperature Superconductors

Researcher: Professor Donald J. Treacy
Sponsor: Naval Research Laboratory, Code 6871

The main purpose of the work is to develop a far-infrared laser capable of measuring the absorption coefficient of high-temperature superconductors. The reason for these measurements is to determine the energy gap of some high-temperature superconductors to test various models which have been advanced to explain their properties.

Most of the work was done on developing the optical system to be used with a 50-watt carbon dioxide pump laser. This work is almost complete. Additional work was done on transport phenomena in high-temperature superconductors. The thrust of the transport work is to develop a model of optically-induced changes in the resistivity. This information will be used to distinguish between bolometric and other mechanisms of response in these materials. The potential applications for other (non-bolometric) forms of response include optical memories.

Complete Resonance Parameter Sets for Fundamental Symmetry Experiments

Researcher: Assistant Professor Jeffrey R. Vanhoy
Sponsor: National Science Foundation

To extract accurate parity or time-reversal violating matrix elements from experimental data requires complete knowledge of the resonance parameters. This includes the spin and parity of the neutron resonances, along with the partial width amplitudes. A complete set of resonance parameters was not known for any of the nuclei under consideration for experiments. Neutron capture angular distributions for ^{113}Cd and ^{117}Sn have recently been measured at Dubna, USSR, but the Dubna groups have repeatedly had a difficult time finding a consistent set of resonance parameters. At the request of E.I. Sharapov, the researcher has looked into this problem. Using the formalism developed in previous work by others, it is found that a consistent set of parameters can indeed be found.

Neutron-Proton Particle-Hole Structure of Collective Levels in 48Ca

Researcher: Assistant Professor Jeffrey R. Vanhoy
Sponsor: National Science Foundation

Calcium-48 (n,n') and (n,n'g) experiments were performed at the University of Kentucky Nuclear Structure Laboratory over the last few years. The deformation parameters derived from these two neutron scattering experiments have been compared to those obtained from proton, alpha, and electron scattering experiments to gain information on the neutron-proton structure of quadrupole and octupole-type excitations. It is found that the wave-functions for the 2_1+ and 3_2- are strongly neutron dominant, while the 3_2- has approximately equal neutron-proton p-h structure. The proton strength in the 3_1- is much larger than existing RPA/TDA shell model calculations predict. This work was done in collaboration with Sally F. Hicks (University of Dallas), M. T. McEllistrem, and S. W. Yates (both of the University of Kentucky).

Collective Excitations and Fast E1 Strength in Cerium-140

Researcher: Assistant Professor Jeffrey R. Vanhoy
Sponsor: National Science Foundation

The structures of the N=82 nuclei are interesting because they provide a basis for understanding the effects seen in neighboring nuclei as neutron-pairs are added and taken away. A few "fast" E1 transitions may have been observed in ^{140}Ce. These intense transitions could imply the existence of collective quadrupole-octupole deformations, the breakup of the inert ^{132}Sn core used for calculations in this region, or that "fast" transitions can be considered the norm in this mass region.

Gamma-ray excitation functions have been measured for incident neutron energies from E_n=2.0 to 4.4 MeV in 0.1 MeV steps. These excitation functions allow the placement of new levels and provide high precision angle-integrated inelastic neutron scattering cross-sections not easily obtainable from (n,n') experiments. Gamma-ray angular distributions and Doppler shifted g-ray energies have been measured at E_n = 2.0, 3.0, and 4.4 MeV. Analysis of the 2.0 and 3.0 data is complete, and analysis of the 4.4 MeV data is continuing. To date χ 30 new levels have been identified. Transition rates are determined for most of these states. Luckily, many ground state transitions are observed--this will provide much nuclear structure information for comparison to the single-step reactions (e,e'), (a,a'), (p,p'), and (n,n'). Comparision of INS cross-sections with those at the National Nuclear Data Center indicate that the existing evaluated inelastic cross-sections in the NNDC/ENDF compilation are confused with contributions from scattering to nearby excited levels. The complementary (n,n') scattering study has just begun at the University of Kentucky by Pei-hua Zhang. This work was done in collaboration with Sally F. Hicks, C. R. Bennett, E. A. Meier (University of Dallas), and M. T. McEllistrem (University of Kentucky).

Electrical Properties of Polymers

Researchers: Associate Professor Mary C. Wintersgill and
Professor John J. Fontanella
Sponsor: Du Pont de Nemours, Company

The audio frequency dielectric constant and loss have been measured over the temperature range 5.5-300K for various types of polymers, including amorphous teflon, EVOH, polypropylene, polyethylene, nylon, and PMMA. The EVOH and nylon samples were measured both "dry" and "wet," and the differences were characterized. Several new relaxations were observed, and the activation parameters for each were determined.

Electrical Properties of Beta and Beta" Aluminas

Researcher: Associate Professor Mary C. Wintersgill
Sponsor: Naval Academy Research Council (ONR)

Beta and beta" aluminas have a number of interesting properties, many of which arise principally because of the ability of these materials to incorporate a very large variety of ions into their structure. For example beta" alumina doped with neodymium has a fluorescence lifetime substantially larger than that of neodymium in YAG, a standard laser host material. In addition, many ions show fast ion motion in these solids, raising the possibility of their use as solid state battery electrolytes or as semi-permeable membrane materials. Many of the impurities introduced into these materials exist as defects having dipole moments, making them amenable to investigation by electrical relaxation techniques. An extensive program of investigation of the defect structures and their physical properties has been initiated. Preliminary results reveal very low temperature relaxations characteristic of quantum mechanical tunnelling, as well as higher temperature relaxations probably associated with a phase transition.

High Pressure and Low Temperature Electrical Properties of Beta and Beta" Alumina

Researchers: Associate Professor Mary C. Wintersgill and
Assistant Professor Joseph F. Lomax (Chemistry)
Sponsor: National Science Foundation

Beta and beta" aluminas have a number of interesting properties, many of which arise principally because of the ability of these materials to incorporate a very large variety of ions into their structure. Preliminary data indicate that a number of these materials exhibit electrical relaxations at very low temperatures, with the characteristics of quantum tunnelling behavior. The most likely explanation of this type of effect involves protons associated with impurity ions, as both types of material show substantial absorption of water. Very low temperature studies, using a dilution refrigerator, will help in the investigation of these defects. High pressure studies are intended to provide information concerning the dilation effects associated with dipolar reorientation. This study is part of an extensive program of investigation of the defect structures and physical properties of beta and beta" alumina.

Defects in Oxide Materials

Researcher: Midshipman 1/C Anthony J. Kotarski, USN
Advisers: Associate Professor Mary C. Wintersgill and
Assistant Professor Joseph F. Lomax (Chemistry)
Sponsor: Trident Scholar Program

The primary goal of the project was to investigate defects in oxide materials, principally calcium carbonate (calcite). Naturally occurring calcite was used, including samples from Mexico, Southern Africa, and Montana. A number of defects were detected using electrical relaxation techniques, and the composition and physical characteristics of the samples were investigated using a variety of supplementary techniques. Structures were postulated for a number of the defects on the basis of these results. In addition, some work was carried out to investigate the properties of vanadyl phosphate, which is an important catalytic material.

Development of Ion-Beam Analysis Techniques for Archeological Research

Researcher: Midshipman 1/C William D. Kulp III, USN
Advisers: Associate Professor F. David Correll
and Assistant Professor James R. Huddle
Sponsor: Trident Scholar Program

Particle-induced X-ray emission (PIXE) has been investigated as a technique for studying prehistoric stone tools collected from sites in southern Maryland by archeologists at the Maryland Historical Trust. Experimental apparatus, including a sample positioner, X-ray detector, X-ray filters, and electronics have been designed, assembled, or optimized for the project. Data analysis software has been obtained, installed, and modified as needed. The elemental compositions of fifty-one rhyolite tools have been measured using in-air PIXE, and the data have been subjected to a statistical analysis to reveal similarities between the compositions of different tools. The results of this analysis have been interpreted in terms of several models for prehistoric trade.

Acquired Polarization Effects in Parity Non-Conservation Experiments with Polarized Targets

Researcher: Midshipman 1/C Paul A. Larson, USN
Adviser: Assistant Professor Jeffrey R. Vanhoy
Sponsor: Trident Scholar Program

One interesting class of fundamental symmetry violation tests involves the measurement of low energy neutron transmission through a thick target as projectile/target spin orientations are changed. As the neutron beam propagates through a target, certain components are preferentially absorbed by nuclear resonances. This induces regenerative effects in thick targets, known as the acquired polarization effect, which complicate the interpretation of transmission measurements. This study extends the work of Postma et al. to include parity mixing in the neutron resonances. The researcher focuses on the role that nuclear resonance spectroscopy plays in beam modification. From this focus three basic results were derived. First, with known resonance parameters for spin 1/2 targets ^{57}Fe, ^{103}Rh, ^{111}Cd, ^{113}Cd, ^{117}Sn, and ^{203}Tl, and spin 7/2 target ^{139}La, the relative sizes of the various terms are determined, including the values of the cross-sections, transmission percentages, the size of the transmission effect, and the percentage of the transmission effect caused by acquired polarization. For the case of ^{113}Cd, acquired polarization accounts for 40% of the transmission effect, and for ^{117}Sn it is nearly 100%. Therefore the relative size of the acquired polarization term is very sensitive to the nuclear spectroscopy, and knowledge of resonance parameters is extremely important for accurate analysis. This had not been realized before this investigation. Second, the effect of imperfect target polarization reversal on the value of the transmission effect is determined in the case of ^{113}Cd. It is found that target orientation inefficiencies as small as 3% will mimic a parity violation. Third, the effect of the depolarization term on the relative size of the acquired polarization is explored, also for the case of ^{113}Cd. In this case as the depolarization increases, the transmission effect actually gets larger. This is in contrast to what one would normally expect.

Independent Research

Interstellar Gas in the Galactic Halo

Researcher: Associate Professor C. Elise Albert

Work is continuing on a major analysis of neutral interstellar clouds in the lower galactic halo. In collaboration with Dr. D.C. Morton, Director, Herzberg Institute of Astrophysics and Dr. J.C. Blades, Space Telescope Science Institute, high resolution observations of absorption lines of CaII and TiII formed along the lines of sight toward more than 60 high latitude halo stars have been obtained with the 3.6 meter Canada France Hawaii Telescope. Complementry spectra of neutral hydrogen emission were obtained with the 140-foot telescope of the National Radio Astronomy Observatory. Material above the galactic plane increases significantly in both amount and absorption velocity range out to, but not beyond, a distance of 500-1000 parsecs. Twenty-three good cases of individual high latitude CaII clouds have been identified, including several examples of clouds well outside the galactic plane. These halo clouds show considerable spatial structure and appear to be significantly less depleted than typical disk clouds.

Acoustic Scattering from a Ribbed Structure

Researcher: Professor Donald W. Brill

A comparison was made of two different methods which can be used to model the monostatic scattering of sound waves from ribbed cylindrical bodies immersed in fluids. The cylinders are of finite length with flat end caps and a coaxial set of reinforcing ribs. The two methods used were the Kirchhoff method and Keller's geometrical theory of diffraction (GTD). The cylinder and its end caps were assumed soft, while the ribs were assumed rigid. Each theory was applied both alone and in various combinations to this soft cylinder and rigid rib set. In each case plots were made of the sonar target strength (TS) as a function of the aspect angle (θ) away from the axis of the cylinder for two different incident wave frequencies. In each case the TS for this entire structure was made up of the superposition of the contributions from both the soft cylinder and the rigid ribs. An additional case was the Kirchhoff calculation for a soft-ended cylinder with alternating bands of rigid and soft composition. In all cases the numerical evaluations produced a lobe structure which resembles that of a diffraction grating. There are other more complex and difficult ways to model this problem which could include the elastic properties of the structure. The present study seeks to render the ribbed cylinder's more salient features by considering a much simplified mode of analysis. This project was supported by the American Society for Engineering Education.

Distortion Repair and the Automatic Digitizing Processor

Researcher: Associate Professor John P. Ertel

Current state-of-the-art digitizing tablets fall into two basic categories, depending on whether they sense position ultrasonically or through inductive coupling. The final intrinsic resolution of these devices, after interpolation, typically varies from about 0.05 to about 0.005 of an inch, depending on the model and price range. While any of these devices can be a tremendous aid in obtaining numerical information from a 2-D (dimensional) source, they all suffer from three distinct problems which are not likely to be either cured or alleviated by any redesign. These problems are: (1) difficulty in alignment of the 2-D article to be digitized to the "natural axes" of the tablet; (2) possible, if not probable, astigmatic distortions of the source article due to photographic or xerographic reproduction; and (3) possible nonorthogonality of the coordinate axes of the source article.

A two-step method has been developed to address these problems through software processing of the output of the digitizer in which fiduciary marks, chosen by the operator, are digitized. This information is sufficient to calculate up to quadratic tensor corrections to adjust for astigmatism and lack of internal orthogonality. Additionally, a coordinate rotation is effected yielding proper x-y data pairs for the digitized object. A third step is added to scale the output within the x and y ranges specified by the operator.

The software for the above transformations has been written in PASCAL, FORTRAN, and BASIC and may be easily translated to any other high level language. Pseudo macro versions of this software recently have been developed to allow a similar translation into the typical assembler. Handlers for several digitizer/micro-computer configurations have also been developed.

A Study of Robust Numerical Integration

Researchers: Associate Professor John P. Ertel and
Assistant Professor Patricia E. Burt (Electrical Engineering)

A suite of techniques has been developed providing for the "intelligent integration" of a function which is immune to most of the pathologies limiting the resolution of typical numerical methods. By avoiding the pitfalls of "blind integration" (which is insensitive to the slope and therefore nonadaptive to the curvature of the problem at hand and the intrinsic inefficiencies of "fixed Riemann cell width"), these procedures form a shell under which any of the standard methods for approximating area, Trapezoidal Rule, Simpson's Rule, Gaussian Quadrature, etc. may be more reliably used. While not intrinsically fast, this process nevertheless provides for a potential improvement in the speed with which a numerical integral may be obtained and yields consistently robust results.

Computer Automated Data Acquisition and Analysis System for the New Tandem Accelerator Laboratory

Researchers: Assistant Professors James R. Huddle and Jeffrey R. Vanhoy,
and Professor F. David Correll

The USNA Physics Department took delivery of components for a Computer Automated Measurement And Control (CAMAC) based data acquisition and analysis system in August 1990. The components include a micro-VAX workstation, a microprogrammable branch driver (MBD), and CAMAC Standard instrumentation modules. The CAMAC instrumentation has been interfaced to the micro-VAX via the MBD, and the data acquisition software XSYS has been implemented on the VAX. The system is in the de-bugging stage.

Upgrade of the USNA Tandem Accelerator Laboratory

Researchers: Assistant Professors James R. Huddle and Jeffrey R. Vanhoy,
and Professor F. David Correll

Upgrades to the Naval Academy Tandem Accelerator Laboratory have been developing under a long-range plan since 1989. Procurement documents have been prepared for an upgrade to the ion source/injector system, for an auxiliary beamline system, for a high-vacuum ion beam analysis system, and for a low energy photon spectrometer. The ion source/injector system has been removed and returned to the manufacturer for upgrading. Delivery of the upgraded ion source/injector is expected in July 1991. The auxiliary beamline and high-vacuum ion beam analysis systems are under contract negotiation. The low-energy photon spectrometer should be delivered in August 1991.

New Laboratory Experiments for SP324-425

Researchers: Assistant Professors James R. Huddle and Jeffrey R. Vanhoy,
and Professors F. David Correll and Donald R. Treacy

A package of spectroscopy experiments for the Physics of the Atom sequence of courses for physics majors (SP324-425) is under development. The package will include experiments performed in the visible, infrared, and x-ray regions of the electromagnetic spectrum. Experiments in the visible region include experiments using research quality high-resolution Czerny-Turner scanning spectrometers in which the normal and anomalous Zeeman effect is investigated and in which the mass of the deuteron is measured. X-ray experiments include x-ray diffractometry to investigate crystal structure and an experiment using proton-induced x-ray emission (PIXE) to investigate Mosley's Law. The PIXE experiment is performed in the Naval Academy Tandem Accelerator Laboratory. Fourier-Transform Infrared (FTIR) spectrometry is used to investigate molecular energy levels in gases.

Minimum Action Principles for the Electromagnetic Field Assuming Two Internal Parameters

Researcher: Major Billy Ray Smith, Jr., USAF

Assuming the canonical momentum for a particle in an electromagnetic field represents an exact differential over a two-parameter internal space, the four-space coordinates can be found as functions of those two internal parameters, yielding a two-dimensional surface. The actual trajectory of the particle must be a curve lying within this space, and is determined by the value of the charge-to-mass ratio of the particle, which represents a velocity in the two-parameter internal space. The goal of the research is to find a geometric interpretation of the action which also permits the gauge invariance of the electromagnetic field to be interpreted geometrically. The success of this approach is in doubt since the solution of the partial differential equation obtained from the canonical momentum predicts that a stationary charge with time-varying charge-to-mass ratio should accelerate, in contradiction with accepted charged particle kinematics.

Research Course Projects

Computer Automation and Control of the LeCroy 7200 Gigasample/Sec Digital Oscilloscope for Acoustic Scattering Experiments

Researcher: Midshipman 3/C Joseph W. Bartish, USN
Adviser: Associate Professor Murray S. Korman

Ultrasonic scattering experiments require the repeated capture of transient pulses that carry with them detailed information about the scatter target. For scattering from random media such as bubble clouds in water or a submerged turbulent jet plume, the transient pulses must be processed to uncover the statistical properties of the scattering medium. An Apple IIe computer is programed to control and automate the digital oscilloscope through an IEEE-488 general purpose instrument bus. At the completion of the project, one could automate the triggering, capture, and processing of essential algorithms such as the Fast-Fourier Transform, amplitude probability density function, signal averaging, cursor control file storage, and hard copy data plots.

Scattering of Sound by Bubble Clouds

Researchers: Midshipmen 1/C Karin M. Hogan and Katherine L. Banta, USN
Adviser: Associate Professor Murrary S. Korman

Experimental results are shown for the scattering of ultrasonic pulses by a small volume of air bubbles in water. Two different types of bubblemakers are used to generate the bubble clouds. The first one uses an array of short wires spaced uniformly over a horizontal square area. A transient electronic pulse (of width τ), which has a period T, is simultaneously sent to each individual wire to generate microbubbles through electrolysis. The individual bubble radius generated at each wire is found to depend on the period of the repeated transient pulse. This bubblemaker is used to generate a vertical column of bubbles. The second bubble maker involves the regulation of a transiting volume of air stored in a chamber placed between two solenoid valves. The air escapes through a fine pore-fritted disk to produce a transient bubble cloud. Preliminary scattering measurements are presented. Comparisons with theory are made from estimates of the void fraction β, the average bubble radius r_o, and other geometrical parameters of the cloud.

CCD Photometry of a Contact Binary System

Researcher: Midshipman 1/C Matthew N. Hammond, USN
Adviser: Associate Professor C. Elise Albert

V523 Cassiopeiae is a W Ursa Majoris contact-type close binary star system. It consists of two stars whose collective luminosity varies with time due to the eclipsing of one component by the other. The resulting light curve describes the relative position of the two components with respect to the line of sight between Earth and the system. The period should be regular, similar to the orbital periods of the planets around the Sun; but, like many of the WUma-type systems, the period of V523 Cas experiences unexplained period shifts. The observation of V523 Cas was a joint venture with Mr. James A. DeYoung, Mr. Richard E. Schmidt, and Mr. Larry I. Gritz of the U.S. Naval Observatory. V523 Cas was observed on five different nights in January and February 1991. Two hundred images were obtained using the U.S.Naval Observatory 0.61 meter Cassegrain reflecting telescope at Washington, DC, and a Met: chrome II coated Thomson CSF THX31156 1k-by1k CCD. The effective field of view was approximately 64 square minutes of arc, using a Kron-Cousins R

filter. A photometry software package was used to isolate V523 Cas and the five brightest comparison stars of known magnitude present in each image. Differential instrumental magnitude light curves were constructed for each night's run and combined into a composite image for period analysis. The method of Kwee and Van Woerden, a mathematical graph folding technique, was used to determine the times of minimum light. O-C diagrams are plots of the difference between the observed times of minima and the epochs derived from previous observations for period analysis. Both linear least squares and parabolic fits were applied to the O-C diagrams. The linear fit appears to be more accurate and indicates an instantaneous period change of -0.095 phase. It is believed that the shift could be due to mass transfer, the evolution of one of the components, or gravitational influence by a distant, third body.

A Computer-Controlled Apparatus for Measuring the Angular Scattering of Ultrasound from a Random Medium

Researcher: Midshipman 1/C David R. Leroux, USN
Adviser: Associate Professor Murray S. Korman

Measurements of the scattered sound intensity, I (θ), versus angle θ from submerged targets (such as a bubble cloud) require long tedious data runs. The task of generating a family of intensity curves (allowing for the adjustable parameters of a target) becomes insurmountable. An Apple IIe computer with an IEEE-488 instrument bus is programmed to control a digital oscilloscope (for data acquisition) and a stepper motor rotational unit (for angular positioning of the transmitting transducer). Typically, an average of 32 trails is used to measure the incoherent scattered energy from the received pulses at any particular angle. Scattering results from a cylindrical air bubble column are presented, along with some theoretical predictions.

Fourier Analysis of the Corona Feedback System on the USNA Pelletron Accelerator

Researcher: Midshipman 2/C Charles A. McCartney, USN
Adviser: Assistant Professor Jeffrey R. Vanhoy

The manufacturer of the 1.7 MV 5SDH Pelletron Accelerator has claimed that the the beam energy of the machine is stable to χ 300 eV. Should this limit be reachable with the Physics Department's accelerator, then research programs could be initiated with resonance reactions at energies and resolutions not under consideration at other laboratories.

As a first step, the resolution of the machine was measured utilizing the narrow width of the $^{27}Al(p,g)$ resonance at E_p = 0.993 MeV. The energy control slits are presently set at $\pm$0.50 mm and located χ 0.5m from the center of the analyzing magnet. A resolution of χ 1.7 keV FWHM was found. Calculations indicate that the resolution is limited by the closeness of the slits to the analyzing magnet and must be moved further away to improve the performance.

A study was undertaken to evaluate the performance of the present energy control system and identify sources of energy ripple. Using the LabVIEW data acquisition package for the Mcintosh, control slit currents were recorded and their Fourier transforms examined.

For slit currents less than 2 nA, the dominant frequency components identified are 60, 120, and 180 Hz. Small components of 240 and 540 Hz may also be present. For slit currents of χ 12 nA, the lower frequency components are missing, but there is a rather wide effect in the FFT at approximately 480 Hz. The 60 and 120 Hz components correspond to line frequency and rectified 60 Hz. An estimate of the frequency that charging pellets enter the HV terminal gives χ 400 Hz. Thus the higher frequency effect may correspond to the pellet frequency.

Examination of the slit amplifier circuit diagram indicates that the logarithmic amplifiers are referenced to 1 nA -- and thus do not generate a proper energy correction signal below that point. For slit currents less than χ 2 nA the slit feedback system should not be used, as it actually introduces and amplifies energy fluctuations in the beam. If small slit currents are to be the norm of operation, then resetting the reference point for the log amplifiers is in order.

The Photorefractive Effect in BSKNN

Researcher: Midshipman 1/C Justin M. Shineman, USN
Adviser: Assistant Professor Steven R. Montgomery

The objective of this project was to observe some of the more well known effects that are possible using the photorefractive effect. A photorefractive material is a material whose index of refraction can be changed by light. If the light in the medium consists of two intersecting beams that form an interference pattern, then the periodically varying index that results can act as a grating. It was the scattering of light by these gratings that was explored.

The medium that was used in this study was a cerium-doped crystal of barium strontium potassium sodium niobate (BSKNN). The specific effects examined were self-pumped phase conjugation and two-beam coupling. The researcher initially looked at self-pumped phase conjugation with a simple laser beam and ended the study of self-pumping by phase conjugating an image bearing beam. When the light incident was forced to pass through a random scatterer the reconstructed phase conjugate image was observed to appear.

The two-beam coupling experiment consisted of sending two laser beams through the crystal in such a manner as to overlap the beams inside the crystal. The resulting grating scatters light from one beam to the other in a process known as two-beam coupling. The output power of the beams was monitored as a function of time and, as expected, the power in one beam was increased at the expense of the other beam. A surprising result was the extreme vibration sensitivity of the experiment. The process would not work until the optical table was floated on a cushion of compressed gas.

Using LabVIEW for Quantum Mechanics

Researcher: Midshipman 2/C Gerhard S. Schoenthal, USN
Adviser: Assistant Professor James R. Huddle

LabVIEW is a graphical user interface ("GUI") programming environment for Macintosh computers. Under the LabVIEW environment, programming is accomplished by building a flow chart, or "block diagram." LabVIEW compiles the block diagram into computer code and executes the code, eliminating the need for the tedious manual translation of ideas into statements which the computer can parse.

The objectives of this project were to become proficient in programming in LabVIEW and to use LabVIEW for a number of tasks in conjunction with the Physics of the Atom I course (SP324). LabVIEW programs were written to find the expansion coefficients for the Hermite Polynomials, and to plot wave functions and probability densities for the quantum mechanical simple harmonic oscillator and infinite potential well problems. A LabVIEW program designed to interface a Keithley Model 617 Programmable Digital Electrometer to a Macintosh II computer for use in the Physics of the Atom Laboratory is in an early stage.

C-V Profiling of Ion-Implanted AlGaAs

Researcher: Midshipman 1/C Thomas W. Trelenberg, USN
Adviser: Professor Robert N. Shelby

The purpose of this project was to spacially locate trapping states in a AlGaAs sample. The AlGaAs sample was beryllium doped by ion implantation and back-implanted with phosphorous to minimize diffusion beryllium diffusion during annealing. The ion implantation causes damage to the crystal structure as the particles pass into the crystal and eventually come to rest. This damage can show up as trapping states with energies located between the valence and conduction bands. These trapping states cause a change in the intrinsic capacitance of a p/n junction made from the material, depending on whether the trap is occupied by an electron. Using capacitance vs. applied bias measurements, C-V profiling, the position of these trapping states was determined, and possible paths for emission and capture, which might depend on external conditions were considered. Data runs were taken at temperatures from 20K to 200K to investigate the dependence of position measurements on emission rates at various temperatures. Deeper traps (deeper than thermal energies could empty) were observed by forcing emptying of these traps using infrared radiation supplied by an IR LED which was powered at 20mA for all data runs. The primary trapping state was found to have a peak concentration of about 10^{23} $1/m^3$ with a peak location near the edge of the beryllium profile.

Publications

ANTHONY, John M., James R. HUDDLE, and Jeffrey R. VANHOY, Assistant Professors, F. David CORRELL, Associate Professor, and Steve A. MACLAREN, Midshipman 1/C, USN, "NATALY Naval Academy Tandem Accelerator Laboratory SNEAP 1990 Report," *Proceedings* of the Symposium of Northeastern Accelerator Personnel - 1989, Eds. N.F. Ziegler, G.D. Mills, M.J. Meigs, R.C. Juras, N.L. Jones, C.M. Jones, D.L. Hayes and E.D. Berners, Singapore: World Scientific, 1990, p. 517.

This paper announced the existence of the US Naval Academy's Pelletron accelerator. Details of the laboratory equipment and use were discussed.

CORRELL, Francis D., Associate Professor, James R. HUDDLE, and Jeffrey R. VANHOY, Assistant Professors, "Undergraduate Research and Teaching with a Small Tandem Accelerator," Nuclear Instruments and Methods in Physics Research (1991), 1180-1184.

The U.S. Naval Academy is developing an accelerator laboratory to support undergraduate research and teaching. The laboratory includes a 1.7-MV tandem electrostatic accelerator, an RF charge-exchange negative ion source, and a beamline containing a scattering chamber and an external-beam ion milliprobe. The milliprobe was built as part of one senior honors project, and is being used in another to study archeological samples by in-air PIXE. The laboratory has been used in a senior-level nuclear physics course to demonstrate resonant scattering of protons from 12C and in a junior-level atomic physics course to demonstrate Moseley's law and the principles of PIXE analysis. This paper describes the laboratory and its applications during the first year of operation.

CORRELL, F. David, Associate Professor, co-author, "A Simple External-Beam Ion Milliprobe System for In-Air PIXE," Nuclear Instruments and Methods in Physics Research B56/57 (1991), 708-711.

A simple external-beam ion milliprobe system was designed and constructed as part of an undergraduate honors research project. The system includes an adjustable object slit, a compact electrostatic quadrupole triplet lens, a lens positioner, and a shielded tip with a thin Kapton window through which the beam exits the accelerator vacuum and enters a sample enclosure with interlocked doors. Auxiliary equipment includes a four-segment lens-entrance collimator with a beam-current monitor that facilitates steering the beam and an interlock system that intercepts the beam when any of the doors to the sample enclosure is opened. Details of the design and construction of the system were presented and its performance was described.

CORRELL, F. David, Associate Professor, co-author, "A Warning-Sign and Safety-Interlock System for an NEC 5SDH Accelerator," Nuclear Instruments and Methods in Physics Research B56/57 (1991), 1173-1175.

This paper describes a system designed and assembled to protect users of a small tandem accelerator from serious exposure to ionizing radiation. This goal is complicated by the fact that the accelerator, target area, control console, and data acquisition area are all contained in a single room. In this system, commercially available gamma and neutron monitors, illuminated warning signs and magnetic door switches are combined with a custom-built interlock chassis and a simple modification to the accelerator's chain motor power contractor. A key switch prevents unauthorized persons from energizing the chain. Warning signs above the entrances to the accelerator lab indicate one of three operating conditions: accelerator off, chain power on, and radiation warning (radiation levels above 0.1 mR/h). If radiation levels in the lab exceed 2 mR/h, power to the chain motor is cut off. Chain power is also cut off when one of the lab doors is opened, unless the operator deliberately and temporarily overrides the system to permit entrance or exit.

ELDER, Samuel A., Professor, "A Video Tutorial on Modal Analysis," *Journal of the Acoustical Society of America*, Supplement 1, **88** (Fall 1990), S41.

A modal analysis system, consisting of a B&K digital spectrum analyzer and an IBM desktop computer with SMS modal analysis software, is used for measurements in junior- and senior-level physics courses in acoustics and sonar. In order to make this complex system accessible to students in a 2-hour lab, a brief booklet together with a video tutorial has been developed which bypasses conventional manuals. The student is quickly guided through the maze of buttons and menu

choices to perform aparticular measurement, as the correct procedure is illustrated, step-by-step. The half-hour tape is divided into separate segments dealing with specific parts of the procedure, such as analyzer screen setup, hammer technique, defining model geometry, data acquisition, and analysis. The combination of the tape and hardcopy booklet makes it possible for students to perform an experiment with minimum direct assistance from the instructor, an important factor for labs sometimes assigned as out-of-class projects.

ELDER, Samuel A., Professor, "A Flow-Powered very Low Frequency Underwater Tone Source," *Journal of the Acoustical Society of America*, **89**, 4, 2 (April 1991), 1973.

Previous studies of underwater flow excited cavity resonance in streamlined towed models have shown that large amplitude acoustic oscillations can be achieved at frequencies under 40 Hz for towing speeds in the range of 5-15 kn. The present investigation aims to develop an understanding of the phenomenon that could permit its utilization as a nonpowered low-frequency underwater tone source. A resonant cavity was constructed in the form of a rectangular box with a vertical slot cut in the side, allowing uncomplicated prediction of wall vibration and radiation. The box was then mounted in a fiberglass fairing to produce a uniform turbulent boundary layer at the location of the slot. Before towing, identification of those vibration modes that provoke flow into and out of the cavity was performed in the laboratory, using modal analysis. Early tow tank runs are showing that tonal radiation seems to occur at expected range of speeds and frequencies, though the level of the sound is less than desired. Further "voicing" of the device is underway (sharpening the edge of the slot, raising the Q of the resonator by using more resilient mounting, etc.).

ENGLE, Irene M., Associate Professor, "Idealized Voyager Jovian Magnetosphere Shape and Field," *Journal of Geophysics Research*, **96** (1991), 7793-7802.

A magnetic field arising from the equatorial sheet current deduced from Voyager I and II observations has been added to a planetary dipole field to provide a model of magnetic field inside the magnetopause. This internal field was used to calculate the magnetopause surface in a cyclic process. During each cycle, the surface was calculated and the resulting field due to currents on the magnetopause was calculated for inclusion in the total field used to calculate the next order surface. The resulting magnetopause is, as anticipated, flatter in shape than one resulting primarily from a dipole internal field source, but not dissimilar in overall height to-width configuration to that of the magnetopause calculated for the larger inflated magnetopause observed by Pioneer 10. An array of magnetic field values for locations internal and external to the magnetopause due to currents on the surface has been computed by integrating over the entire magnetopause. A model for the total magnetospheric field of this semi-inflated magnetosphere has been constructed by adding this latter contribution to the internal source fields to obtain a global model of a semi-inflated Jovian-like magnetospheric field. The magnitude of the contribution due to the surface currents to the total magnetic field in the region of the orbits of the Galilean satellites is calculated to be considerably larger for this Voyager model than for the Pioneer model.

ERTEL, John, Associate Professor, "Partial Radiation Efficiency of Line Driven Panels," *Journal of Sound and Vibrations*, **144**, 1 (1991), 71-86.

The power and partial power radiated by a vibrating surface facing a fluid are defined in terms of radiation and partial radiation efficiency, respectively. The power and partial power radiated by the surface are also estimated in terms of a designated velocity distribution on this surface. Equating the respective expressions for the power and partial power radiated, the radiation and partial radiation efficiency are estimated in terms of the velocity distribution and the speed of sound in the fluid. Using these estimates, the partial radiation efficiencies of line driven unribbed and regularly ribbed panels are cited in numerical examples.

FONTANELLA, John J., Professor, and Mary C. WINTERSGILL, Associate Professor, and John J. WILSON, Midshipman 1/C, USN, "Dielectric Relaxation Studies on Polymer Electrolytes," *Proceedings* of the Second International Symposium on Polymer Electrolytes, ed. B. Scrosati, London and New York: Elsevier Applied Science, 1990, pp. 35-48.

Studies of dielectric relaxation (DR) in poly(propylene oxide) (PPO) and ionic conductivity in PPO containing lithium or sodium salts reveal that the activation energy and activation volume associated with the glass transition, or α-relaxation, in PPO are quite similar to the conductivity activation parameters in PPO-salt complexes. It is also found that both the dielectric loss in PPO and the electric modulus in PPO-salt complexes can be fitted to the Stretched Exponential (SE) decay

function in which the SE parameter, β, is approximately temperature-independent and, again, quite similar in value for the two processes.

Finally, new results for amorphous oxymethylent linked poly(ethylene oxide) and two of its Na-salt complexed are presented.

FONTANELLA, John J., Professor, and Mary C. WINTERSGILL, Associate Professor, "Application of the Bendler-Shlesinger Generalization of the Vogel Equation to Ion-Conducting Polymers," *Journal of Polymer Science,* Polymer Physics Edition, **29** (1991), 747-752.

Previously published audio frequency electrical conductivity results for ion-conducting polymers have been reanalyzed in terms of the Bendler-Shlesinger (BENSH) generalization of the Vogel equation. The BENSH equation provides a better fit of the data for PPO and PDMS than does the Vogel equation while the opposite is true for PEO and PPZ, the differences being small in all cases. However, the data for PPO and PDMS are both over a wider temperature range and are more reliable, and thus the results favor the BENSH formalism. Consequently, it is concluded that the BENSH equation, and hence the defect-diffusion model, provides an excellent description of the conductivity of ion-conducting polymers.

HUDDLE, James R., Assistant Professor, co-author, "Tribomechanical Properties of SiC Implanted with Energetic Si Ions, Materials Research Society Extended Abstract (EA-23), 69 (1990).

Three samples of α-SIC were each implanted with Si ions of energy 6, 4, 1 and 0.3 MeV to introduce radiation damage to a depth of 2.5 μm. One sample was given a total dose calculated to be sufficient to cause complete amorphisation of the surface, one was given four times that dose, and the third was given one quarter the "critical" dose. Tribomechanical tests on these samples and on a control sample which was not implanted show dramatic differences in hardness and in frictional coefficient.

KORMAN, Murray S., Associate Professor, and Stephen C. RIFE, Midshipman 1/C, USN, "Experiments on the Nonlinear Scattering of Crossed Focused Beams in the Presence of Turbulence," Frontiers of Nonlinear Acoustics: *Proceedings* of the Twelveth International Symposium for Nonlinear Acoustics, eds. M. F. Hamilton and D. T. Blackstock, London: Elseveir Science Publishers Ltd, London, 1990, pp. 271-276.

An experimental study, involving the nonlinear interaction of mutually perpendicular crossed ultrasonic beams overlapping (at a common focal point) and interacting in the presence of turbulence leads to measurements of the farfield radiated sum frequency pressure. Earlier experimental results [M.S. Korman, S.C. Rife, "Nonlinear Sound Scattering of Crossed Focused Beams in the Presence of Turbulence, "Proc. Intl. Cong. Acoust., Belgrade, Yugoslavia, 1989, Vol. 1, pp. 291-294.] measured the profile of the radiated sum frequency pressure by scanning the overlap region across the width of turbulence produced by a submerged circular water jet ($Re = 8.5x10^4$). In scanning, the receiver transducer moves fixed relative to the senders (of primary frequencies $f_1 = 2.05$MHz and $f_2 = 1.95$MHz). Pressure scans compare well with known values of the radial turbulent rms velocity profile, $u_r(r)$. This work is extended to include measurements of the profiles of frequency broadening, skewness, and kurtosis that are obtained from the frequency spectrum of the nonlinearly scattered sum frequency wave. Angular measurements of Doppler shift and spectral broadening are used to predict the mean flow speed and rms turbulent velocity on the jet axis.

LOMAX, Joseph F., Assistant Professor, (Chemistry Department), John J. FONTANELLA, Professor, Mary C. WINTERSGILL, Associate Professor, and Anthony J. KOTARSKI, Midshipman 1/C, USN, "Dielectric Loss in Vanadyl Pnictates," *Proceedings* of the Materials Research Society Symposium, Vol. 210 Solid State Ionics II, eds. G. Nazri, D. F. Shriver, R. A. Huggins, and M. Balkanski, Pittsburgh: Materials Research Society, (1991), pp. 681-686.

The results of audio frequency complex impedance studies for vanadyl phosphate and its hydrates ($VOPO_4.nH_2O$; $n = 0,1,2$) are reported. Measurements wre made at seventeen frequencies between 10 and 10^5 Hz over the temperature range 5.5-380K. Two low-temperature features were observed and are correlated with particular water species between the $VOPO_4$ layers. In light of chemical evidence and complex impedance measurements on related compounds, it is speculated that $VOPcO_4.nH_2O$ (Pc = P, As) can be thought of as a mixed nonstoichiometric compound $[VO(HPcO_4)]x[VPOcO4]_{1-x}.nH_2O)$, and the solid Brønsted acid nature of the compound is related to proton movement between layer pnictates and intralayer waters.

TANKERSLEY, Lawrence L., Professor, co-author, "Chromatic Time Lag in Picosecond Streak Camera Measurements," *Applied Optics*, **29**, 16 (1990), 2369.

Ihlemann et al. [Rev, Sci. Instrum. 59, 2502 (1988)] have found unexpectedly large group velocity dispersion produced by commercial picosecond

streak camera objective lenses. This work supports and extends their lens data.

TANKERSLEY, Lawrence L., Professor, co-author, "Control of Transverse Spatial Modes in Transient Stimulated Raman Amplification," *Journal of the Optical Society of America* B, **7**, 7 (1990), 1336.

The researchers have studied the transverse modes of a transient stimulated Raman signal generated in unsaturated Raman amplifiers with Fresnel numbers from one to seven, both with and without a seed Stokes pulse. In the absence of a seed Stokes pulse and for a pump Fresnel number greater than 1.5, the spatial intensity pattern of the stimulated Stokes signal is highly variable from shot to shot, reflecting the random nature of the quantum-noise source. However, when a separately generated and sufficiently strong seed Stokes pulse with a Gaussian spatial profile is injected into the amplifier, the spatial mode of the output Stokes beam assumes a smooth Gaussian spatial pattern that is significantly smaller in diameter than either the pump or the seed Stokes beam. This spatial mode control, which is due to the injected Stokes signal, persists down to a level of approximately 300 seed Stokes photons per spatial mode and, surprisingly, is observed to suppress the noise-initiated signal by at least a factor of 10 in the outer regions of the amplified Stokes beam.

The researchers have also studied the Stokes pulse-energy statistics over a range of Fresnel numbers. Data taken with systems having Fresnel numbers between 4 and 7 follow the same pattern as the spatial-mode-control results in that the statistical character of the Stokes pulse energies changes rapidly from that characteristic of a quantum-noise-initiated process to one characteristic of a stable source as the level of the injected seed Stokes is increased. However, for interaction regions with Fresnel numbers of 1 or smaller, the Stokes pulse-energy statistics show a gradual change as the level of the seed Stokes signal is increased and do not become stabilized until the seed Stokes is more that 100 times the total level needed to control the spatial character of the output Stokes in the larger-Fresnel-number cases. This slow change in the statistics for the Fresnel 1 system, and suppression of the quantum-noise-initiated signal in the larger-Fresnel-number systems, is not fully understood at this time. This paper was recognized with NRL Alan Berman Research Publication Awards.

TANKERSLEY, Lawrence L., Professor, co-author, "Spectral and Temporal Characteristics of Spontaneous Raman Scattering in the Transient Regime," *Journal of the Optical Society of America* B, **8**, 2 (1991), 300.

The authors demonstrate explicitly that the quantum theories that predict stimulated Raman scattering is initiated from zero point fluctuations of either the material oscillators or the electromagnetic field are equivalent, and that the process can be viewed as arising from both types of fluctuation. They further demonstrate that in the transient regime the spontaneous Stokes intensity reproduces the pump in amplitude and phase, as predicted by quantum theory, without any of the integrating effects normally associated with transient processes.

VANHOY, Jeffrey R., and James R. HUDDLE, Assistant Professors, F. David CORRELL, Associate Professor, and William D. KULP and Steve A. MACLAREN, Midshipmen 1/C, USN, "NATALY Naval Academy Tandem Accelerator Laboratory SNEAP 1990 Report," *Proceedings* of the Symposium of Northeastern Accelerator Personnel - 1990, eds. Tracy Tipping and Robert Krause, World Scientific, (1991), pp. 346-347.

This report describes several systems installed at the Naval Academy Tandem Accelerator Laboratory (NATALY) during the past year, including a radiation monitorting system, and external beam ion milliprobe, and a VAX station-based data-acquistion system.

VANHOY, Jeffrey R., Assistant Professor, co-author,"University of Kentucky Laboratory Report to SNEAP 1989," *Proceedings* of the Symposium of Northeastern Accelerator Personnel, eds. N.F. Ziegler, G.D. Mills, M.J. Meigs, R.C. Juras, N.L. Jones, C.M. Jones, D.L. Hayes, and E. D. Berners, R. Juras. Singapore: World Scientific, 1990, p. 500.

This paper detailed the myriad number of problems encountered over the past year while upgrading the University of Kentucky's CN Van de Graaff Laboratory. Much of the report focuses on the failure patterns and failure modes of Caddock MG-815-15-30 resistors used in the high field gradients.

WINTERSGILL, Mary C., Associate Professor, and John J. FONTANELLA, Professor, co-authors, "^{7}Li NMR Study of Polymer Electrolytes Based on Composites of Poly[bis((methoxyethoxy)-ethoxy)phosphazene] and Poly(ethylene oxide)," *Chemistry of Materials*, **3** (1991), 534-538.

Polymer electrolytes consisting of mixtures of poly[bis(methoxyethoxyethoxide) phosphazene] (MEEP) and poly(ethylene oxide) (PEO) or poly(propylene oxide) (PPO), complexed with $LiClO_4$ or $LiBF_4$ have been studied by differential scanning calorimetry (DSC) and ^{7}Li nuclear

magnetic resonance (NMR) spectroscopy. Both types of measurements demonstrate that the MEEP/PEO composites are multiphase in that amorphous MEEP-like and crystalline PEO-like phases are present in the samples. The NMR results show that significant Li_+ ion mobility in the MEEP-like phase occurs only above the lowest temperature glass transition as indicated by DSC measurements. Strong cation-anion association effects are suggested by dipolar broadening in BF4-containing materials, and by precipitation of salt crystallites from the MEEP/PPO composite at elevated temperature.

WINTERSGILL, Mary C., Associate Professor, Douglas R. FIGUEROA, Visiting Professor, and John J. FONTANELLA, Professor, "Thermally Stimulated Depolarization Currents and Ionic Conductivity of Cubic Lead Fluoride Containing Small Rare Earth Ions," *Radiation Effects and Defects in Solids*, **114** (1990), 263-271.

This work is concerned with thermally stimulated depolarization current (TSDC) and ionic conductivity studies in lead fluoride containing the small rare earths Dy, Ho, Er and Yb. The TSDC scans from 80 to 300K show two peaks. For $Pb_{1-x}Er_xF_{2+x}$ one is located at 106K, and another, which is much stronger, occurs at about 160 K. The former is associated with a dipolar defect containing at least two rare earths and the latter is attributed to the development of F^- space charge during polarization of the sample. The activation energies obtained from both the high temperature TSDC peak and the ionic conductivity are the same, which corroborates the latter assignment. In addition, the ionic conductivity is shown to be independent of concentration. Those results can be understood if rare earth clustering, which is either absent or is unobservable dielectrically for large rare earths such as lanthanum, occurs extensively even at very low concentrations of the small rare earths. The explanation is that the majority of fluorine charge compensators are trapped by clusters.

WINTERSGILL, Mary C., Associate Professor, and John J. FONTANELLA, Professor, "Nuclear Magnetic Resonance Studies of Polymer Electrolytes," *Proceedings* of the Materials Research Society Symposium, Solid State Ionics II, eds. G. Nazri, D. F. Shriver, R. A. Huggins, and M. Balkanski. Pittsburgh: Materials Research Society, 1991, pp. 237-248.

The results of several investigations of solvent-free polymer electrolytes by nuclear magnetic resonance (NMR) spectroscopy conducted by the authors and other groups are reviewed. ^{23}Na NMR spectra of a wide variety of amorphous polymer electrolytes are characteristic of the second-order quadrupole broadened central $\pm$ 1/2 transition with a distribution of quadrupole couplings. The temperature dependence of the linewidth is similar across a wide range of materials, and highlights the importance of polymer segmental motions above the glass transition temperature to ion mobility. Strong cation-anion interactions in poly(propylene oxide) complexes are indicated by measurements of mobile ion concentrations and, in some cases, the observation of salt precipitation at elevated temperature.

WINTERSGILL, Mary C., Associate Professor, and John J. FONTANELLA, Professor, co-authors, "ESR Studies of Divalent Copper in Polymer Electrolytes," *Proceedings* of the Second International Symposium on Polymer Electrolytes, ed. B. Scrosati. London and New York: Elsevier Applied Science, 1990, pp. 61-71.

Electron spin resonance (ESR) spectra have been obtained in poly(propylene oxide) (PPO) based solid electrolytes, in particular the compositions $(PPO)_8NaClO_4$ containing a small amount of Cu^{2+} spin probe, and $(PPO)_nCu(CF_3SO_3)_2$, where n = 9, 12, 27. Temperature-dependent shifts in the parallel (to the magnetic field) hyperfine component reflect motions associated with the glass transition and yield approximately Arrhenius activation energies for the motional correlation time, which increases with increasing copper salt concentration. The ionic conductivity of the 9:1 complex exhibits a free volume-type temperature dependence, although with much less curvature than is usually observed in amorphous systems.

Presentations

ALBERT, C. Elise, Associate Professor, "Recent Developments in Stellar Evolution: Life and Death of a Star," Society of Physics Students Conference, University of Maryland, College Park, Maryland, 20 April 1991.

ANTHONY, John M., Assistant Professor, "Electrons Are People Too," Kansas State University Colloquium, Manhattan, Kansas, 7 July 1990.

ANTHONY, John M., Assistant Professor, "State Selected Single Electron Capture Processes in 3 to 8 MeV Collisions of C4+ with H and He," Eleventh International Conference on the Applications of Accelerators in Research and Industry, Denton, Texas, 5-8 November 1990.

BRILL, Donald W., Professor, "Acoustic Scattering From Submerged Finite-length Cylinders with End Caps and Internal Ribs: A Comparison of Methods," 120th Meeting of the Acoustical Society of America, San Diego, California, 26-30 November 1990.

CORRELL, F. David, Associate Professor, "Hydrogen Analysis Using Elastic Recoil Detection," Naval Research Laboratory Diamond Film Group, Washington, DC, 1 August 1990.

CORRELL, F. David, Associate Professor, "Undergraduate Research and Teaching with a Small Tandem Accelerator," Eleventh International Conference on the Application of Accelerators in Research and Industry, Denton, Texas, 5 November 1990.

CORRELL, F. David, Associate Professor, "The Material Relationships of Prehistoric Territoriality: PIXE Trace-Element Characterizations of Middle Woodland Rhyolite in Southern Maryland," Middle Atlantic Archeological Conference, Ocean City, Maryland, 7 April 1991.

CORRELL, F. David, Associate Professor, James R. HUDDLE and Jeffrey R. VANHOY, Assistant Professors, and Steve A. MACLAREN and William D. KULP, Ensigns, USN, "A Simple External-Beam Ion Milliprobe System for In-Air PIXE," Eleventh International Conference on the Application of Accelerators in Research and Industry, Denton, Texas, 5-8 November 1990.

ELDER, Samuel A., Professor, "A Video Tutorial on Modal Analysis," 120th Meeting of the Acoustical Society of America, San Diego, California, 27 November 1990.

ELDER, Samuel A., Professor, "A Flow-Powered Very Low Frequency Underwater Tone Source," 121st Meeting of the Acoustical Society of America, Baltimore, Maryland, 2 May 1991.

ENGLE, Irene M., Associate Professor, "The Field of the Jovian Magnetosphere, Including Contributions of the Magnetopause Surface Currents," 1990 Plenary Meeting of Congress of Space Research, The Hague, The Netherlands, 27 June 1990.

ENGLE, Irene M., Associate Professor, "Planetary Magnetospheres," Dickinson College Colloquium, Carlisle, Pennsylvania, 12 November 1990.

ENGLE, Irene M., Associate Professor, "Planetary Magnetospheres," Carnegie Institution of Washington, Division of Terrestrial Magnetism, 8 May 1991.

ENGLE, Irene M., Associate Professor, "Diurnal Variation on Jovan Magnetopause Position," American Geophysical Union, Baltimore, Maryland, 29 May 1991.

ERTEL, John P., Associate Professor, "Teach'n 'em the stuff you gotta teach 'em before you can teach 'em the stuff you wanna teach 'em," Annual Spring Meeting of the Middle Atlantic Section of the American Society for Engineering Education: Meeting Accreditation Challenges in the Classroom, City College of New York, Brooklyn, New York, 27 April 1991.

FONTANELLA, John J., Professor, Mary C. WINTERSGILL, Associate Professor, and Christopher S. COUGHLIN, Visiting Researcher, "Electrical Conductivity, NMR and Thermal Analysis Studies of Ion-Containing Polymers," Fifteenth Biennial Polymer Symposium, Fort Lauderdale, Florida, 17-21 November 1990.

HOGAN, Karin M. and Katherine L. BANTA, Midshipmen 1/C, USN, and Murray S. KORMAN, Associate Professor, "Scattering of Sound by Bubble Clouds," 121st Meeting of the Acoustical Society of America, Baltimore, Maryland, 2 May 1991.

HUDDLE, James R., Assistant Professor, "Characterizatation and Tribology of Carbonaceous Films Formed by the Ion Beam Assisted Deposition of Silicone Fluids," International Conference on Metallurgical Coatings and Thin Films (ICMCTF-91), San Diego, California, 22-26 April 1991.

HUDDLE, James R., Assistant Professor, and James R. DIRE, Lieutenant, USN, "Total Solar Eclipse of 11 July 1991: Local Circumstances and Weather Outlook for Hawaii and Mexico," USNA Astronomy Club Meeting, U.S. Naval Academy, Annapolis, Maryland, 25 February 1991.

HUDDLE, James R., Assistant Professor, "Tribomechanical Properties of SiC Implanted with Energetic Si Ions," Fall Meeting of the Materials Research Society, Boston, Massachusetts, 26 November - 1 December 1990.

HUDDLE, James R., Jeffrey R. VANHOY, Assistant Professors, and F. David CORRELL, Associate Professor, "A Warning-Sign and Safety Interlock System for an NEC 5SDH Accelerator," Eleventh International Conference on the Application of Accelerators in Research and Industry, Denton, Texas, 5-8 November 1990.

KORMAN, Murray S., Associate Professor, and L. Gene BAKER, Lieutenant Commander, USN, (Oceanography),"Demonstrations of Undergraduate Acoustics Experiments," 120th Meeting of the Acoustical Society of America, San Diego, California, 26-30 November 1990.

KORMAN, Murray S., Associate Professor, "Nonlinear Scattering of Crossed Focused Beams in the Presence of Turbulence Theoretical Results," 120th Meeting of the Acoustical Society of America, San Diego, California, 26-30 November 1990.

KORMAN, Murray S., Associate Professor, "Demonstrations on the Scattering of Sound by Bubble Clouds," 121st Meeting of the Acoustical Society of America, Baltimore, Maryland, 2 May 1991.

LEROUX, David R., Midshipman 1/C, USN, and Murray S. KORMAN, Associate Professor, "A Computer-Controlled Apparatus for Measuring the Angular Scattering of Ultrasound from a Random Medium," 121st Meeting of the Acoustical Society of America, Baltimore, Maryland, 2 May 1991.

LOMAX, Joseph F., Assistant Professor, (Chemistry), John J. FONTANELLA, Professor, and Mary C. WINTERSGILL, Associate Professor, "Dielectric Loss in Vanadyl Phosphate and its Hydrates," Meeting of the American Chemical Society, Washington, DC, 24-30 August 1990.

LOMAX, Joseph F., Assistant Professor, (Chemistry), John J. FONTANELLA, Professor, Mary C. WINTERSGILL, Associate Professor, and Anthony J. KOTARSKI, Midshipman 1/C, USN, "Ion Movement in Vanadyl Pnictates and their Intercalation Compounds," 1990 Fall Meeting of the Materials Research Society, Boston, Massachusetts, 26 November-1 December 1990.

MONTGOMERY, Steven R., Assistant Professor, "Photorefractive Rings and Their Polarization Dependence," Meeting of the Optical Society of America, Boston, Massachusetts, 7 November 1990.

MONTGOMERY, Steven R., Assistant Professor, "Optical Coherence Length of a Variable Bandwidth Source," American Association of Physics Teachers, San Antonio, Texas, 24 January 1991.

SMITH, Billy R., Major, USAF, "What if. . . An Examination of the Expanding Universe from the Newtonian Perspective with Implications for the Electric Field and Dirac Vacuum," U.S. Naval Academy Physics Society, Annapolis, Maryland, 4 March 1991.

TANKERSLEY, Lawrence L., Professor, "Femtosecond Time-gated Image Amplification for Medical Applications," Conference on Lasers and Electro-Optics, Baltimore, Maryland, 12-17 May 1991.

TANKERSLEY, Lawrence L., Professor, "Amplification and Imaging using Spontaneous Backscattered Raman Light," Quantum Electronics and Laser Science, Baltimore, Maryland, 12-17 May 1991.

VANHOY, Jeffrey R, Assistant Professor, "140Ce Branching Ratios and Neutron Scattering Cross Sections," Meeting of the Texas Section, American Physical Society, San Antonio, Texas 21-24 January 1991.

VANHOY, Jeffrey R., Assistant Professor, "Study of Low-Energy I=1 States in 162Dy and 164Dy by Inelastic Neutron Scattering," Symposium on Recent Advances in Nuclear Structure Research, American Chemical Society Meeting, Atlanta, Georgia, 14-19 April 1991.

VANHOY, Jeffrey R., Assistant Professor, "Transition Rates from Inelastic Neutron Scattering on 140Ce," Spring Meeting of the American Physical Society, Washington, DC, 22-25 April 1991.

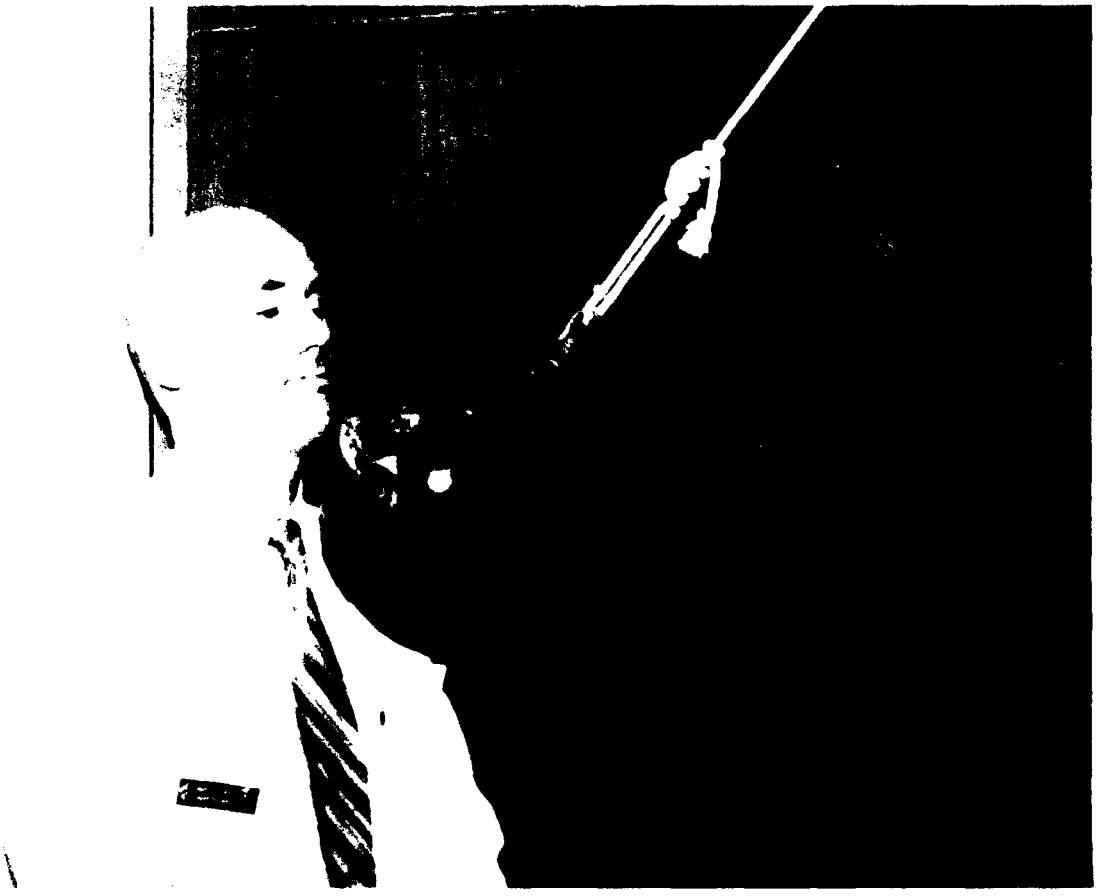
VANHOY, Jeffrey R., Assistant Professor, "Neutron-Proton p-h Structure of Collective States in 48Ca", Spring Meeting of the American Physical Society, Washington, DC, 22-25 April 1991.

VANHOY, Jeffrey R., Assistant Professor, "Acquired Polarization Effects in Parity Violation Experiments with Neutron Beams," Spring Meeting of the American Physical Society, Washington, DC, 22-25 April 1991.

WINTERSGILL, Mary C., Associate Professor, John J. FONTANELLA, Professor, and Christopher S. COUGHLIN, Visiting Researcher, "Dielectric and Thermally-Stimulated Depolarization Current Characterization of Ion-Conducting Polymers," Twenty-Ninth Eastern Analytical Symposium, Somerset, New Jersey, 12-16 November 1990.

WINTERSGILL, Mary C., Associate Professor, and John J. FONTANELLA, Professor, "Nuclear Magnetic Resonance Studies of Polymer Electrolytes," 1990 Fall Meeting of the Materials Research Society, Boston, Massachusetts, 26 November-1 December 1990.

WINTERSGILL, Mary C., Associate Professor, and John J. FONTANELLA, Professor, "Low Temperature Dielectric Properties of TFE and Copolymers and Teflon AF," Mid-Atlantic Regional Meeting of the American Chemical Society, Newark, Delaware, 21-22 May 1991.



Division of Professional Development

DEPARTMENT OF

Leadership and Law

Commander Michael R. King, USN
Chair

Research by members of the Department of Leadership and Law during the 1990-1991 academic year was centered on issues relevant to the Naval Academy and the Brigade of Midshipmen. Department research included the continuation of Dr. Colleen Smiley's study of "Eating Behaviors and Perceptions of Eating Problems Among the Midshipmen" and Dr. Paul Roush's work involving "Enhanced Leadership Training for the Brigade of Midshipmen." Dr. Karel Montor's "Time Study" from last academic year has been expanded into "The Use of Time by Midshipmen" under the cognizance of Dr. Paul Roush. New research includes Dr. Ralph Juhnke's study of "The Nature of Preconceived Categories on Leadership Effectiveness" and Dr. Roush's investigations into "Performance of USNA Graduates." These areas of research have provided significant insight into improving the performance and leadership development of midshipmen. The published works and speaking engagements of the Leadership and Law staff further indicate their high level of involvement and concern with current Naval Academy and military issues.

Independent Research

The Nature of Preconceived Categories on Leadership Effectiveness

Researcher: Assistant Professor Ralph G. Juhnke

This research continues past efforts to identify psychological correlates of leadership perceptions by expanding the area of inquiry. The focus of this investigation concerns the nature of preconceived categories of leadership and is designed to address current theoretical debates regarding the nature and structure of cognitive leadership categories.

Applications of Psychological Preferences in the Military

Researcher: Assistant Professor Paul E. Roush

This is a continuation of a research project begun in July 1987. The purpose of the research is to assess how knowledge of psychological preferences can be used in the military in the many manifestations of "know yourself, know your people, know your job." The primary research instrument is the Myers-Briggs Type Indicator (MBTI). The effort thus far has resulted in more than ten thousand administrations of the instrument and development in conjunction with computer services of five computer programs for scoring the MBTI, accessing the data, and linking it to a wide range of variables. The study has included analysis of MBTI associations with leadership feedback, transformational and transactional leadership, academic performance, voluntary attrition, time management, preference stability over time, service selection, leadership positions in the Brigade, conduct grades, military performance grades, and accuracy of self-assessment.

It has resulted thus far in four presentations; three at regional conferences of the Association of Psychological Type, and one at the institutional research conference of the service academies. Two additional presentations are scheduled for the summer of 1991. Thus far, the project has resulted in the publication of an article in the *Journal of Psychological Type*, and a second article, this one in *Military Psychology*, is currently in press. Leadership curricula and materials have been modified for the introduction of MBTI theory and practice in two leadership courses taken by all midshipmen to sensitize them to the meaning and importance of individual differences. Local programming support for this project is provided by Julie Palmer in Computer Services.

Enhanced Leadership Training

Researcher: Assistant Professor Paul E. Roush

This project began in September 1987. Phase one of the research project involved development of NL301, a summer leadership course taken by all midshipmen. The course required each second classman to subject the plebe development program to a more rigorous and systematic scrutiny than had been the case prior to NL301. The course injects planning into that process and serves as a rational counterpoint to the traditional approach of simply requiring new plebes to repeat upperclassmen's plebe experiences. In another aspect of NL301, class sessions are set aside for analysis by the midshipmen of very difficult problems facing the Brigade. Midshipmen recommend solutions which, in turn, are screened, compiled, and forwarded for consideration by the Commandant.

Phase two of the project involved development of linkages between the classroom leadership work and the practical leadership experience in Bancroft Hall. Initially, that involved writing projects which provided valuable feedback concerning the leadership experiences, from both the leaders' and the followers' perspectives. During academic year 1990-1991 the process was further expanded. The plebes used their personal computers to respond anonymously on three occasions to questions dealing with the leadership practices of the second classmen in their respective squads. On two occasions, after the upperclass had assessed themselves using the same criteria, the ratings supplied by the plebes were provided to the upperclass (in the form of aggregated data) as constructive feedback, during the second class leadership course in the spring semester. The feedback was the basis for significant changes in leadership behavior and in self-perception among many of the second classmen. This phase of the project will be the basis for two presentations in July 1991, one at the International Conference of the Association for Psychological Type and the second at the bi-annual research conference of the Center for Creative Leadership.

Phase three involved having the second classmen in one of the six battalions receive different leadership instruction from that provided all the other battalions in the spring 1991 semester. The special instruction emphasized a particular counseling approach, and required significant documentation of the counseling process as part of the course work. The second classmen involved were rated by the plebes as making significantly greater improvement in positive leadership practices than were the second classmen in the other battalions. That counseling program will be instituted Brigade-wide beginning in the 1991-1992 academic year. Local programming support for the Leadership Feedback project is provided by Lieutenant Blake Bush, USN, of the Professional Development Division.

Performance of USNA Graduates

Researcher: Assistant Professor Paul E. Roush

This research program is ongoing in conjunction with the Naval Personnel Research and Development Center (NPRDC). During academic year 1990-1991 nearly two million fitness reports in the NPRDC database were analyzed at San Diego. The fitness reports encompassed a span of eighteen years (1972-1990) and all officer accession sources. The indicators of performance included continuation rates (a measure of willingness to remain on active duty) and rate of recommendation for early promotion. Outcomes to date include comparison of performance of Naval Academy graduates with that of officers from other accession sources, comparison among Academy graduates by gender and by majority-minority status, and comparison of women graduates and minority graduates with women and minority officers from other accession sources. Marine Corps fitness-report data have been acquired from Headquarters, Marine Corps, and are currently undergoing analysis at NPRDC. Future directions in this independent research include the development of a cost model to assess more adequately the total cost (as opposed to merely the undergraduate educational cost) to the Department of Defense per unit of time served in the fleet by officers from the various accession sources. In addition the currently defunct Graduate Performance Evaluation System (GRAPES) will be revised in both its content and administration in hopes of its eventual resuscitation.

Use of Time by Midshipmen

Researcher: Assistant Professor Paul E. Roush

This research project is an expansion of one begun in 1989 by Dr. Karel Montor of the Leadership and Law Department. The project involves stratified-random sampling of approximately a fourth of the Brigade in the fall semester and again in the spring semester to survey time use by the members of the Brigade. Midshipmen respond, using their personal computers, by distributing into 32 categories the 168 hours that constitute a week. The results are analyzed in order to assemble evidence regarding potential initiatives and to assess the effectiveness of previous initiatives intended, for example, to put limits on certain activities and to maximize time available for study. Data are analyzed to ascertain time-use differentials by classes, by athletes versus non-athletes, by gender, QPR, major, service selection, and other variables. Local programming support for the time-study project is provided by Lieutenant Blake Bush, USN, of the Professional Development Division.

Eating Behaviors and Perceptions of Eating Problems Among the Midshipmen

Researcher: Assistant Professor Colleen S. Smiley

Eating disorders among college-aged populations have received much attention in recent years in both popular and scientific literature. Because midshipmen are college students required to conform to strict appearance guidelines in an environment that many consider stressful, the conditions are potentially ripe for the development of eating problems. This pilot study was undertaken to gather baseline data on eating behaviors and attitudes for comparison with populations reported in the literature, as well as to ascertain whether further study was warranted with the midshipman population. An anonymous survey was given to 226 volunteer midshipmen (46%-1/C, 31%-2/C, 13%-3/C, 10%-4/C). The survey, a self-report instrument, was designed to measure current eating, dieting, and exercise habits, as well as behaviors and attitudes associated with eating problems, and the perceptions concerning eating problems among midshipmen. Data analysis continues. Preliminary results indicate significant differences between the sexes on several of the measured variables. Significant differences were also found between varsity and non-varsity athletes. The data suggest the need for additional research. A follow-up study, utilizing a more representative sample and incorporating additional measures, is being planned.

Publications

ROUSH, Paul E., Assistant Professor, "MBTI Type and Voluntary Attrition at the United States Naval Academy," *Journal of Psychological Type*, **18** (1989), 72-79.

This researcher used a Selection Ratio Type Table (SRTT) comparison of midshipmen at the United States Naval Academy in the classes of 1991 and 1992 with those midshipmen from these two year groups who voluntarily resigned during the first semester of their freshman (plebe) year. Emphasis is placed on the stress that results from the plebe indoctrination process and the responses to stress as assessed by Myers-Briggs Type Indicator (MBTI) preferences. Students with preferences for introversion, intuition, feeling, and perception were most at risk. SRTT differences are hypothesized to be based in part on differential academic requirements and on inter-class differences.

ROUSH, Paul E., Assistant Professor, "The Exclusionists and Their Message," *Naval Law Review*, **39** (1990), 163-170.

This is an analysis of recurring themes used by proponents of combat-exclusion legislation to rationalize continued prohibition against women serving on combatant ships or on aircraft with a combat mission. Emphasis is on refutation of the notions (1) that women are not qualified for combat, (2) that psychosexual dynamics are dominant in the areas of exclusion, (3) that readiness would be adversely affected by the presence of women in such environments, and (4) that the society at large has no right to intrude in the military arena.

ROUSH, Paul E., Assistant Professor, "Combat Exclusion: Military Necessity or Another Name for Bigotry?" *Minerva: Quarterly Report on Women and the Military*, **8**, 3 (1990), 1-15.

This is a revised and significantly expanded version of the Naval Law Review article described above. New emphases include (1) analysis of the bases for establishing standards used to rationalize exclusion of women from service in combat units; (2) development of the evidence to show that lost time for military men significantly exceeds that for military women, but that the differential is masked by the presence of a disciplinary infrastructure which constitutes a staffing overhead rarely taken into account by the proponents of exclusion; and (3) a refutation both of the efficacy of artificial stress as either a necessary or sufficient condition for performance in combat, and of the concomitant alleged fungibility of stress.

SMILEY, Colleen S., Assistant Professor, Barry GITTLEMAN, Ensign, USN, and Terrence DWAN, Associate Professor (Weapons and Systems Engineering), "Systems Identification: Human Tracking Response," *Proceedings* of the Twenty-first Annual Pittsburgh Conference, **21**, 5, 2-4 May 1990, pp. 2419-2424.

Engineers often analyze and simulate mechanical, electrical, or combinational systems. A human in these systems complicates matters; however, the most accurate model of high-tech aircraft would be incomplete without some model of the pilot. Humans exhibit many characteristics which must be accounted for in system design. Experiments were performed to develop transfer functions for the human tracking response. Experiments tested one-dimensional, sine-wave tracking to determine time delay and the transfer function. Using system identification techniques, best models were selected for each of five different frequencies of the test sine-wave input. Bode plots, magnitude and phase, for the system that best models were also given. The entire process provides an excellent tutorial in programming, system modeling, and simulation.

Presentations

JUHNKE, Ralph G., Assistant Professor, "Distorting Factors in Leadership Perception: Are We Seeing Only What We're Looking For?" Annual Meeting of the American Psychological Association, Boston, Massachusetts, 10 August 1990.

REINHART, David F., Lieutenant Commander, USN, "The Use of Performance Enhancement Techniques in Athletic Training," Spring Women's Athletic Teams, the U.S. Coast Guard Academy, New London, Connecticut, 7-8 February 1991.

REINHART, David F., Lieutenant Commander, USN, "The Role of Sports Psychology in Team Sports," Spring Coaches luncheon, U.S. Coast Guard Academy, New London, Connecticut, 7-8 February 1991.

ROUSH, Paul E., Assistant Professor, "MBTI Test-Retest Results in a Highly-Structured Environment," Association for Psychological Type, Great Plains Regional Conference, St. Louis, Missouri, 23 June 1990.

ROUSH, Paul E., Assistant Professor, "Combat Exclusion: Another Name for Bigotry?," Women Officers' Professional Association, Professional Development Symposium: The Complete Professional, National Defense University, Washington, DC, 28 June 1990.

ROUSH, Paul E., Assistant Professor, "Military Necessity and the Combat Exclusion Law," Women in the Military Workshop, Convention of the American Psychological Association Workshop, Boston, Massachusetts, 9 August 1990.

ROUSH, Paul E., Assistant Professor, "Type and Time Management: How Valid are the Stereotypes?," Association for Psychological Type, Great Lakes Regional Conference. Dayton, Ohio, 13 October 1990.

ROUSH, Paul E., Assistant Professor, "The Intervention Dilemma: A Paradigm for Decision?," Conference on the Ethical Dimensions of the Changing Use of Force in International Affairs, University of Notre Dame, South Bend, Indiana, 25 October 1990.

ROUSH, Paul E., Assistant Professor, "Combat Exclusion: Military Necessity, or Another Name for Bigotry?," The Leaders' Forum, U.S. Naval Academy, Annapolis, Maryland, 10 January 1991.

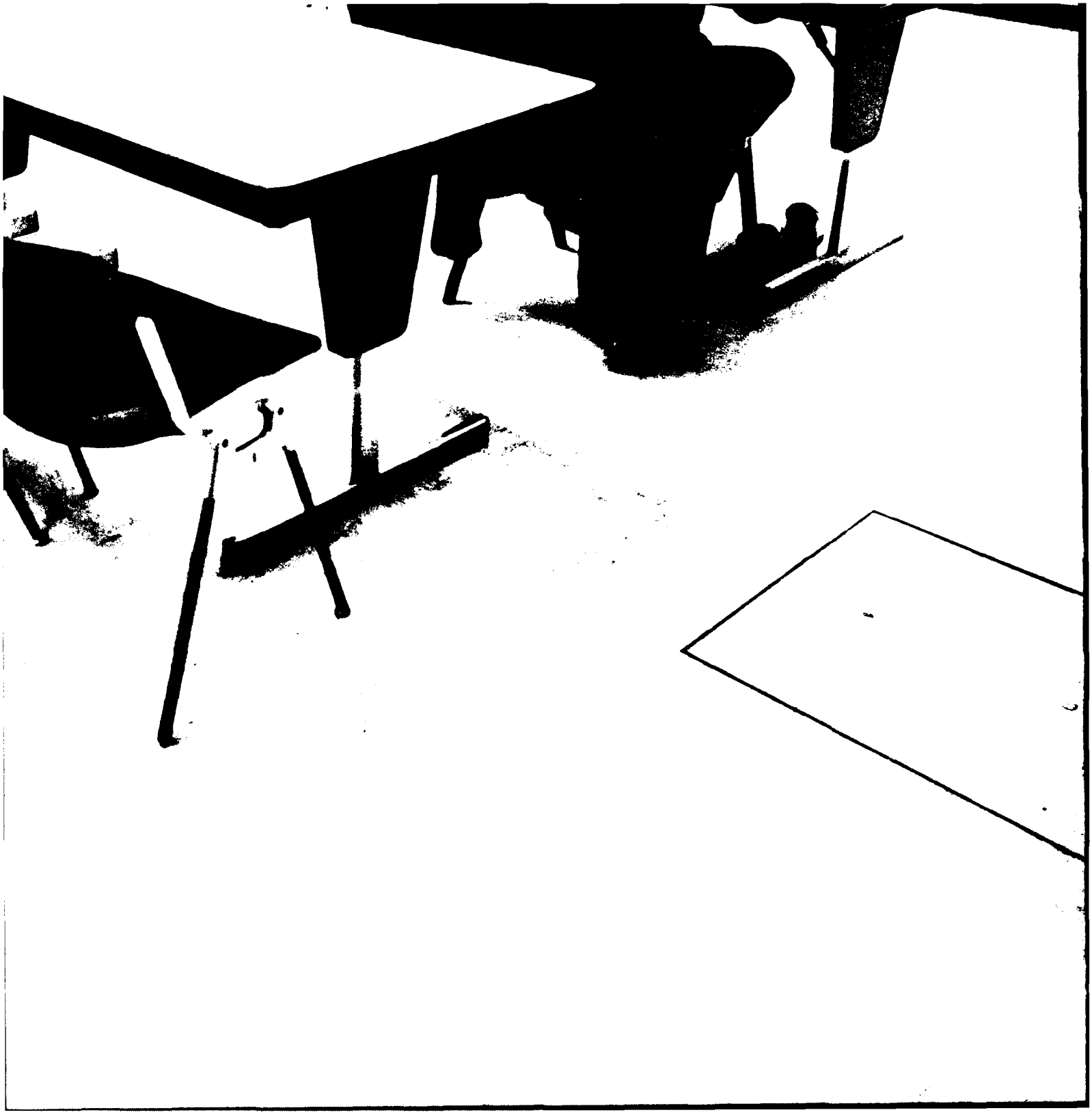
ROUSH, Paul E., Assistant Professor, "The Weinberger Doctrine and Panama: An Intervention Paradigm?," Joint Services Conference on Professional Ethics, National Defense University, Washington, DC, 10 January 1991.

ROUSH, Paul E., Assistant Professor, "Leadership Feedback," and "Electronic Evaluation," Conference on Integration of Technology in Education and Training, U.S. Naval Academy, Annapolis, Maryland, 14 March 1991.

ROUSH, Paul E., Assistant Professor, "Rethinking Who Fights our Wars -- and Why," The Harvard Law School Symposium on Women in the Military, Harvard University, Cambridge, Massachusetts, 6 April 1991.

ROUSH, Paul E., Assistant Professor, "Women in Arms: Lessons from the Gulf," Panelist : War's Aftermath -- The Issue of Women in the Military; A Conference sponsored by the Center for Defense Journalism, the Rockford Institute, and the Office of Senator Daniel Coats. Russell Senate Building, Washington, DC, 19 April 1991.

Division of
U.S. and International Studies



DEPARTMENT OF

Economics

Professor Rae Jean B. Goodman
Chair

The Economics Department faculty concluded another successful year of research. Two distinguished visiting professors contributed to this success. Dr. Estelle James of SUNY at Stony Brook was a Secretary of the Navy Fellow in the Economics Department. During her tenure, she presented five papers, published three articles, taught Public Finance (FE431), and provided support for midshipmen research projects. Dr. Kenneth Coffey of the Office of the Assistant Secretary of the Navy (Manpower and Reserve Affairs) was the holder of the Manpower, Personnel and Training Research Chair, sponsored by the Deputy Chief of Naval Operations (Manpower, Personnel and Training). His research dealt with the economic effects of mobilization of reserve forces from a wide range of professions. In addition he taught Defense Economics (FE335). Professor Reed Johnson continued to be the outstanding researcher in the department; he published five articles and presented two papers. Professor Little pursued his research in military labor topics; he published one paper this year and has initiated research in two related areas. After his six years as department chair, Professor Fredland has developed several research proposals. One of the year's highlights for the Economics Department was the agreement with the Defense Systems Management College to provide faculty support for research in defense acquisitions and contracting topics.

Sponsored Research

The Relationship Between Fleet Performance and Undergraduate Education

Researcher: Professor William R. Bowman
Sponsor: Chief of Naval Operations, OP-01

The major objective of this study was to determine statistically the relationship between Navy officer retention/performance and pre-commissioning academic curriculum, student performance, and accession source. Regression models of officer promotability, conditioned upon the voluntary choice of staying in the Navy across higher grades, are developed for the major URL officer communities. Policy implications of the study address the ability to develop improved officer selection screening models for the Naval Academy and scholarship R.O.T.C. programs, and assessing the relative performance of Navy officers by major accession sources.

Prior work to date, focusing on the relative costs of the major accession sources and the average length of service of graduates, concludes that service academies are the least cost-effective means of generating commissioned officers. These studies are flawed in two major aspects: first, the cost measures are biased against the service academies by including huge fixed costs in the calculations that would not vary with planned officer source drawdowns, and second, the measure of returns to investment costs does not account for quality/performance differences of officers among the major accession sources. This study funded by OP-01 addresses both of these weaknesses.

An extensive database of individual officer background and experience in the fleet is developed for the population of Navy officers who have appeared before any officer selection board over the last ten years. Officer promotion data (early select, in-zone select, select above zone, and fail to select) and significant Navy experience factors (qualifications achieved, service schools attended, ship/plane duty stations, etc.) are measured, along with the selectivity of undergraduate schooling, academic major program, overall grade point average, and measures of academic technical training (college math, science, and engineering curriculum). In addition, the reason for leaving is added to the records for those separating from the Navy.

Under the first phase of the study, statistical models of officer retention and performance have been developed for officers initially selecting the surface warfare and aviation pilot communities. Retention and performance of officers are measured at the O-4 grade level (Lieutenant Commander near the nine-year point of service). Future work will expand the methodology to other major officer communities and across grades through O-6 (Captain). Preliminary results indicate the best predictor of officer fleet experience is the overall grade point average, while technical major and course curriculum differences have little if any effect on performance and often reduce officer retention.

Income Differentials Experienced by Naval Reserve Doctors and Dentists Recalled to Active Duty during "Desert Storm" and "Desert Shield"

Researcher: Research Professor Kenneth J. Coffey
Sponsor: Chief or Naval Operations, OP-01

Because many health professionals make considerably more money than military medical personnel, there is great concern that there will be a major exodus of Navy Reserve doctors due to unacceptably high levels of income losses during their active duty periods. To help Navy policy-makers in addressing possible corrective actions, this research will (1) reconcile several differing lists of recalled doctors to a "most accurate" list; (2) expand the list to include available computerized deomographic, military service, and military pay data; (3) further expand the list by providing data from hard-copy on civilian medical skills, types of civilian employment, and civilian positions; (4) then compare their military earnings to at least five existing surveys of civilian medical earnings, by

specialty and employment; (5) then survey the recalled Reserve doctors concerning their actual income losses (or gains) and their continuing medical practice expenses; and (6) finally, resurvey those with private practice incomes to determine longer-term impacts of their recalls on their businesses.

Defense Contractor Profitability and Tobin's q

Researchers: Professors J.Eric Fredland and Roger D. Little
Sponsor: Defense Systems Management College

The profitability of major defense contractors is apparently driven by the size of procurement budgets and by Defense Department policy regulating profit that can be earned by firms doing defense business. The purpose of this research is to examine the extent to which these factors--procurement budget size and profit policy--are reflected in financial market assessments of these firms. The analytical tool used is the q ratio, first developed by James Tobin and now widely used as a measure of monopoly power and as an approach to measuring the relationship between financial markets and capital investment. The q ratio is the ratio of market value of the firm to the replacement cost of its capital stock. In theory, when the q exceeds one, investment in new capital enhances market value. If a firm is in a competitive industry, q will tend to move to unity as entry and/or expansion leads to exploitation of available investment opportunities. In an industry with significant barriers to entry, however, q will tend to exceed one, reflecting the existence of monopoly profits. Defense contractors operate in an environment with significant entry barriers. Their profitability is potentially subject to sharp fluctuation, however, when budgets change and perhaps when Defense Department policy regarding contractor profit changes. If these changes in fact affect profitability to any great degree, they should be reflected in fluctuations in the q ratio. The researchers would expect q's to differ for defense firms relative to other manufacturing firms when comparing data from the 1970's with data from the years of defense buildup during the 1980's. Changes in q for defense firms could also correlate with DOD contracting or profit policy changes. The Compustat database will be used to carry out this work.

Toward Resolving the Tension Between Theory and Fact: An Analysis of Direct Investment Behavior of U.S. Multinationals

Researcher: Assistant Professor Ksenia Kulchycky
Sponsor: Naval Academy Research Council (OMN)

This research proposed analysis of the different roles comparative advantage and internalization issues play in the determination of U.S. direct investment and trade. In this paper, rival theories are put head to head, rather than examined individually, using subjective judgement to determine whether they explain "enough." Compustat data will be added to a previously constructed Department of Commerce data set. This will allow for the analysis of the role of economies of scale, market structure, product diversity and additional measures of the intrinsic uncertainty faced by multinationals in the determination of the cross-country distribution of direct investment and trade.

The Theoretical Foundation of J. Laurence Laughlin's Attack on the Quantity Theory of Money

Researcher: Professor Clair E. Morris
Sponsor: Naval Academy Research Council (OMN)

J. Laurence Laughlin was a leading figure in formulating public opinion on economic matters in this country during the late nineteenth and early twentieth centuries. He was particularly influential in shaping attitudes toward monetary reform, which was a burning issue arising from the devastating financial crises that characterized the period. The purpose of this project was to elaborate further our understanding of Laughlin's part in bringing about a movement that ultimately led to the passage of the Federal Reserve Act of 1913.

Central to the purpose was a need to understand the process by which Laughlin arrived at his position on the role of money in determining economic activity, a position which was seen at the time as a very strong statement in opposition to the quantity theory of money, which was the prevailing conventional wisdom. Thus, the focus of this objective was on how Laughlin assessed the evidence available to him, and how he structured an alternative theory to explain the financial reality that he observed.

The researcher reviewed Laughlin's extensive writings, both popular and scientific, that were specifically directed at the empirical relationship between the money supply and the price level. His draft manuscripts and notes were also researched to discover what evidence he felt to be most relevant.

The result was substantial insight into the basis for Laughlin's position on the quantity theory, but perhaps more revealing was the way he was able to build a general theory of price determination that had wide appeal among professional economists for the next 50 years.

A paper currently awaits revisions based on comments received at the Eastern Economic Association Meetings in Cincinnati, and will shortly be submitted for publication.

Competition, Effort, and Learning in Economic Education

Researchers: Associate Professor Thomas A. Zak and
Professor Rae Jean B. Goodman
Sponsor: Naval Academy Research Council (OMN)

This research attempts to model the effect that different reward structures have on the level and distribution of students' learning. Examining this issue allows consideration of the impact incentive structures have on student effort. The researchers also address the issue of whether students find it beneficial to behave cooperatively or competitively, as they seek to draw inferences about possible student coalitions if those students find it beneficial to cooperate with one another in the production process.

Drawing on the "tournament" and "principal-agent" literature, the researchers view learning as a problem of monitoring in a multiple principal-agent environment with multiple tournaments (tests). Learning, in a sense, is a public good. In a production context, student output depends upon self inputs, as well as those of others in the class (peer effects). Where inputs are properly measured to include measures of effort as well as ability, there is no reason to believe that the effort expended by one student has no effect on the effort expended by other students. Depending on the nature of the reward structure, students may also choose to operate cooperatively or competitively. Also considered were the effect of credible precommitment of effort and other inputs by some students on the learning process.

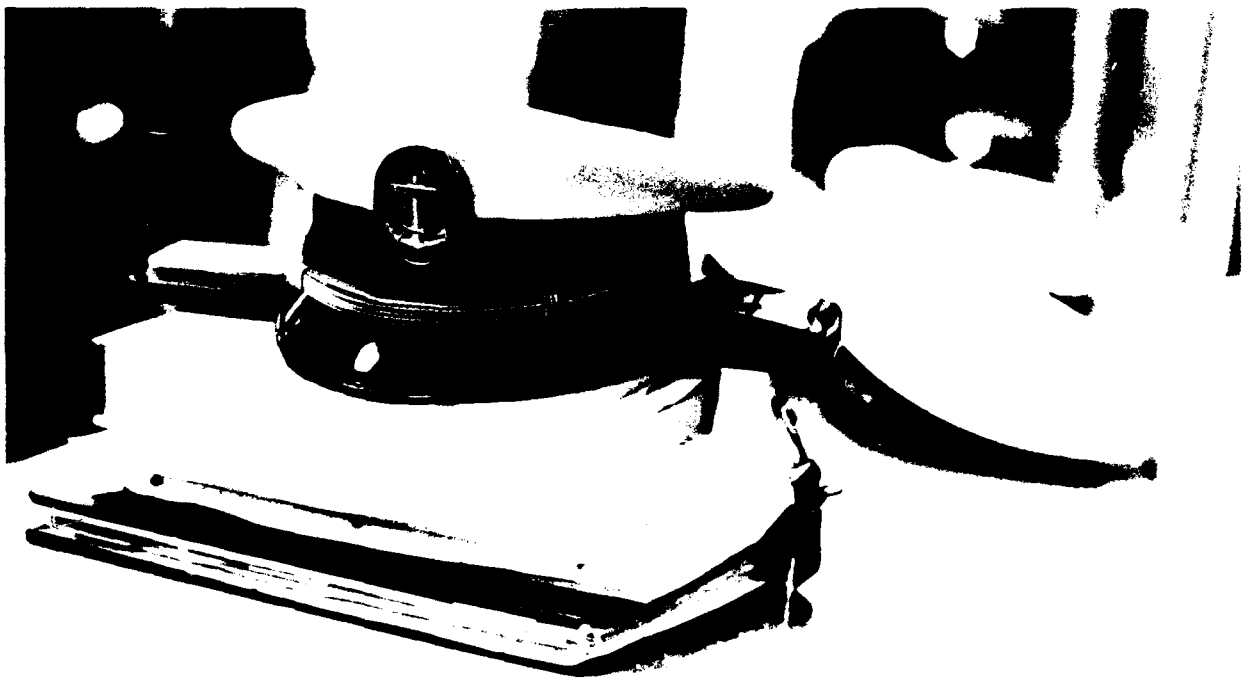
The model treats students as value maximizers, where the probability of gaining a single fixed prize depends positively on a student's own effort, and negatively on the effort of classmates. The researchers also posit diminishing returns to effort in generating higher probabilities of success, which produces some interesting results. In particular, in cases where the student's learning depends upon inputs from other students, the reward structure plays an important role in determining both the level and distribution of learning. For a given prize (e.g., a fixed grade distribution), increasing the

effort level from student i possibly reduces the marginal return from effort expended by student j.In the context of fixed prizes, students have incentives not to cooperate with one another. To the extent that they can choose whether to have complementary or substitutive cross-effects in the production process, the nature of the competition in which they find themselves matters.

With a single prize, when one student increases individual effort level, the probability that every other student wins the prize declines, given their own effort levels. To reestablish the old probability requires investing more effort themselves. Some students may precommit to a higher effort level, knowing that this induces the followers to produce less effort than they otherwise would. One way out of this box is to eliminate the fixity of the prize. Indeed, if all students can "win" by doing well (just as all can fail by not doing so), teachers may choose a strategy that ties the reward for any student to overall class performance.

The intuition behind these results is that the structure of the competition affects the way students perform by affecting whether their effort levels are substitutes or complements in one another's education process. Perhaps the optimal incentive scheme includes the real possibility of failure (punishment for nonperformance) but no limit to the number of good outcomes.

Oliver R. Grawe also collaborated on this project.



Independent Research

Issues Concerning Mobilizations of the Reserve Forces During the Korean, Berlin, Vietnam, and Middle East Conflicts

Researcher: Research Professor Kenneth J. Coffey

This research will examine in detail the four major mobilizations of Army, Navy, Air Force and Marine Reservists and National Guardsmen since World War II. Heavy emphasis will be placed on examining detailed unit histories and "After-Action" reports in order to identify major successes and failures. The hypothesis of the research is that the successes and failures first experienced in Korea continued through the mobilizations for Berlin, Vietnam, and the Middle East, and that this pattern of Reserve Forces successes and failures provides a matrix for assessing the most appropriate size, force mix, and roles, and missions of our Reserve Forces in these post Cold War years. Utilizing this matrix, justifiable changes in our Reserve Forces will be advanced and defended.

Are the Preliminary Announcements of Some Macroeconomic Variables Rational?

Researcher: Assistant Professor Hareesh M. Dhawale

The paper examines whether (nominal) preliminary estimates of gross national product, wages and salaries, total personal consumption, and disposable personal income are rational forecasts of the final estimates. The unbiasedness and efficiency tests over the full sample from 1966:1 to 1990:1 and the 2 sub-samples 1966:1 to 1978:1 and 1978:2 to 1990:1 surprisingly reveal that data for these variables have actually improved over time. These results run counter to the literature, which contends that economic data have recently become less reliable. The paper is currently under journal review.

Earnings of Foreign-Born Wives of Servicemen

Researchers: Professors J.Eric Fredland and Roger D. Little

Theory holds that migration is a response to economic incentives. Studies generally find that migrants do quite well economically within a short time after their move. The question addressed in this project is whether this phenomenon applies to the foreign-born wives of servicemen, who presumably are not motivated to move by economic considerations. Multivariate statistical techniques will be used to examine a rich data set. A literature review has been substantially completed. Data analysis will take place during the summer of 1991. A presentation of results is scheduled for the biennial meeting of the Inter-University Seminar on Armed Forces and Society in October 1991.

Employment-Based Social Accounting Matrices (SAM) for Rural Development Analysis

Researcher: Associate Professor Arthur Gibb, Jr.

This research explores the possibility of constructing a SAM for a rural micro-region using employment data as the basis for generating a full set of income and expenditure estimates. For many issues of rural-urban linkage analysis the pressing need is for a more detailed understanding of structure rather

than behavior, the latter being fairly well understood by now.

The research is based on the empirical evidence generated by rural-urban linkages study in a micro-region of Central Luzon in the early 1970's. The basic argument is that the rural economy is relatively simple and permits simplifications in identifying skill levels, capital use, and capital origin with particular production activities. Rural economy also permits production activities to be identified with the production, consumption, and public service linkages to agriculture. A crucial cross-classification is whether activities are full-time or part-time.

An initial version of the SAM has been estimated and is being put onto a spreadsheet. It will subsequently be subjected to various consistency tests, especially comparing its results to those of other regional SAM's.

Rural Non-Farm Employment: Defining a Sector Functionally and Spatially

Researcher: Associate Professor Arthur Gibb, Jr.

This research is a review of the literature on rural non-farm employment in developing nations. It was prepared for the Employment and Development Department of the International Labour Office, a United Nations agency based in Geneva. Employment in non-agricultural activities in rural areas in the typical developing nation accounts for as much as three-quarters of total non-agricultural employment but has been an ill-defined variable. This research reviews the available evidence in order to establish the magnitudes of the consumption, production, and public service linkages of such employment to agriculture. It also distinguishes its location in terms of core, periphery, and "urban shadow" rural regions. The evidence on how various public policies influence rural non-farm employment is also reviewed.

The review concludes that indirect policy measures are more important than direct ones as influences on rural non-farm employment growth. Specifically, the price policies which influence farm incomes and the policies which promote agricultural growth, and hence farm incomes, are the primary policy measures. Other key policy areas include measures to assure the smooth flow of supplies to the rural economy and the optimal development of roads, irrigation systems, and small market towns. It is recommended that systems for collecting employment statistics be modified to produce data series able to reflect the impact of such policies on rural non-farm employment generation.

A first draft was completed in June 1990. Detailed comments were received from the ILO in August 1990. Revision is in process in light of those comments and of information received at the American Association of Collegiate Planners meeting attended in October.

Examination Performance and Incentives

Researchers: Professor Rae Jean B. Goodman and
Associate Professor Thomas A. Zak

The fundamental hypothesis is that providing a monetary incentive stimulates student performance on a standardized exam. The data used for the analysis are the performances of Midshipmen First Class economics majors on the Major Field Achievement Test for the 1989-1991 period. The experimental setup was to divide the class into separate classrooms, matching the academic quality of the two rooms by QPR rank. As students entered the "incentive" room, they were given a memorandum which informed them that there were monetary prizes for the top three performers by four QPR groupings. The students in the other room received the same memorandum as they exited the exam. The empirical analysis tests the hypothesis holding ability measures constant; the ability measures include economics QPR, overall QPR, SAT scores, performance in intermediate macroeconomics and microeconomics courses, numbers of economics courses completed, etc. The analysis has not been completed; however, the plan is to complete the research during the intersessional period.

A Theoretical and Empirical Analysis of the Public/Private Division of Responsibility for Education, from a Comparative Economics Perspective

Researcher: Visiting Professor Estelle James

This project uses the experience of many countries to analyze why some societies depend largely on the public sector to provide education, while others use the private sector more heavily. The consequences (for produce mix, equity, and efficiency) of the public/private mix are also explored. Public policies toward private education, including subsidies and regulations, are described, and their implications for U.S. policy are analyzed.

An Analysis of Efficiency and Quality in Higher Education Using NLS Data; or Which College and Curriculum Choices Lead to Higher Earnings and Production

Researcher: Visiting Professor Estelle James

This project studies 1985 earnings of the high school senior class of 1972, as a function of their college and curriculum choices. The experiences of men and women are compared.

Methods for Valuing Indirect Losses from Oil Spills

Researcher: Professor F. Reed Johnson

Litigation related to the Alaska and other oil spills has created a demand for better methods of estimating the nonuse and existence value of damaged natural resources. This research involves a series of experiments and surveys designed to measure people's knowledge, perceptions, and values related to such damages. Analysis of the data has required additional research in utility theory and econometrics. This research has yielded three internal research reports. Publication of the work will be delayed until pending litigation is settled.

This research was supported by the Research Triangle Institute sponsored by Exxon.

Tied Migration and Returns to Human Capital

Researcher: Professor Roger D. Little

The frequent rotation of military personnel provides a unique opportunity to study the consequences of tied migration on a group of women whose moves are anticipated and largely independent of economic forces. Possible consequences include reduced labor force participation and hours of work and lower returns to various forms of human capital investments. The analysis confirms these consequences and suggests that a three-year versus six-year rotation policy reduces military wives' earnings by 40 percent. Various multivariate techniques are used to test the hypotheses suggested above. The project is complete and has been accepted for publication.

Research Course Projects

Earnings of Foreign-Born Wives of Servicemen

Researcher: Midshipman 1/C Frank K. Chong III, USN
Advisers: Professors Roger D. Little and J. Eric Fredland

Theory holds that migration is a response to economic incentives. Studies generally find that migrants do quite well financially within a short time after their move. The question addressed in this project is whether this phenomenon applies to the foreign-born wives of servicemen who, presumably, are other-motivated. The researcher plans to use multi-variate statistical techniques similar to the ones employed in the "Tied Migration" project. At this point, the methodological approach is in hand, and the literature review is substantially complete. A proposal has been submitted to present the results at the Inter-University Seminar meetings in the fall of 1991.

Publications

JAMES, Estelle, Visiting Professor, "Private Education and Redistributive Subsidies in Australia," *Privatization and its Alternatives*, William T. Gormley, Jr., ed., Madison: University of Wisconsin Press, 1991, pp.79-115.

Australia is probably the only country to experiment with a large need-based private educational subsidy at the primary and secondary levels. Interestingly, it is the need of the school, rather than the individual student, which is assessed. A per capita payment is made from both the state and the central government, at higher rates for public schools and for "poor" private schools. Why was this system adopted and how does it work? Does it foster economic efficiency--competition, diversity, and satisfaction of diverse tastes at minimum cost? Or does it raise total costs and diminish support for a strong public school system? Is the need-based criterion desirable because it enhances quality and equity or undesirable because it increases the burden on the public treasury and encourages the withdrawal of private resources? These issues are analyzed in this chapter, both from a positive and normative vantage point.

JAMES, Estelle, Visiting Professor, "Private Higher Education: The Philippines as a Prototype," *Higher Education*, **21** (1991), 189-206.

In many developing countries today, private colleges and universities account for a large and sometimes even a dominant share of higher education enrollments. What difference does it make when higher education is provided through private rather than public institutions? Do the two sectors differ with respect to variables such as product mix, cost, quality, and socio-economic distribution of their student body and does this lead to predictable differences between systems that rely on public versus private provision? This paper analyzes the Filipino higher education system as a case in point.

JAMES, Estelle, Visiting Professor, "Public Policies Toward Private Education," *International Journal of Educational Research*, **15** (1991), 359-376.

This chapter surveys the wide range of public policies toward private education that are found in a sample of 35 developed and developing countries. It investigates two major questions: What is the relationship between subsidies and private sector size? Are subsidies accompanied by controls and if so, over what? Empirical evidence shows that private educational sectors in developing countries tend to be less subsidized than those in developed countries; nevertheless, they are often very large. This chapter argues that private sectors can flourish in developing countries without subsidies because of excess demand, while subsidies are a necessary condition for large private sectors in developed countries, where a free public alternative usually exists.

Government controls over private schools are found even without subsidies. However, heavy controls invariably accompany subsidies, particularly over teacher salaries and qualifications, price, and other entrance criteria. Large excess demand driven private sectors in developing countries have been criticized for their low quality, which is supposed to be raised by government regulations regarding organizational form and minimum input requirements. However, these interventions are often evaded by producers and consumers and, if not evaded, quality may come at the expense of quantity and efficiency.

JOHNSON, F. Reed, Professor, co-author, "Effects of Hazardous Waste Risks on Property Transfers: Legal Liability vs. Direct Regulation," *Natural Resources Journal*, 30, 3 (Summer 1990), 521-536.

Given the probable large number of sites contaminated with hazardous wastes, there could be significant benefits from a statutory system that effectively deters future contamination and encourages private remediation of existing sites. The authors compare the effectiveness of Superfund liability rules with New Jersey's ECRA regulatory program to clean up contaminated sites at the time of property transfers. Analysis indicates that regulatory delays raise private costs under ECRA relative to Superfund alone, but that external benefits of ECRA cleanup activities are greater as well. Furthermore, it is likely that unmitigated damages are less under ECRA.

JOHNSON, F. Reed, Professor, co-author, "Radon Risk Communication Research: Practical Lessons," *Journal of the Air and Waste Management Association*, 40, 5 (May 1990), 738-740.

Those responsible for state and local radon programs often express frustration about the small share of homes that have been tested for radon, and the small share of those with high readings that have been mitigated. There are now a number of completed studies that have examined how well alternative ways of communicating about radon risks have accomplished the goals of motivating appro-

priate testing and mitigation. This paper summarizes the research results that are most crucial for planning and implementing effective radon risk communication programs. The authors identify six reasons why people do not respond to radon as a serious threat and provide some remedies suggested by radon studies.

JOHNSON, F. Reed, Professor, co-author, "Can Public Information Programs Affect Risk Perceptions?," *Journal of Policy Analysis and Management*, **9**, 1 (1990), 41-59.

This article provides the first controlled evaluation of how different information materials explaining the risks from radon have influenced people's perceptions of these risks. Using a panel study, it was possible to observe how stated risk perceptions responded to information about indoor radon concentrations and brochures explaining the radon readings. The findings indicate that risk communication policies can be effective in modifying risk perceptions. Moreover, the panel cited three specific implications for radon policy: (1) Public officials should not adopt strategies that provide minimal risk information to the public as a means of avoiding undue alarm, for this can have the reverse effect; (2) measures of the effectiveness of risk communication will depend on how education and behavior changes are defined; and (3) categorical guidelines about risk without quantitative information can lead people to treat the levels as thresholds, creating an artificial discontinuity in their responses to small changes in risks perceptions.

JOHNSON, F. Reed, Professor, "Signal Detection and Perceived Risks: Homeowner Responses to Radon Risk Information," *New Risks: Issues and Management*, eds. Cox and Ricci. New York: Plenum Press, 1990, pp. 529-540.

Policies for reducing such risks as natural hazards, AIDS, household use of pesticides, and indoor air pollution often rely on dissemination of risk information to promote risk-reducing behavior. Economists often use state-dependent utility constructs to model this kind of problem. While this approach assumes a high degree of competence on the part of the decision maker, psychological evidence indicates that people frequently use simple rules when faced with complex decisions. This study employs Heiner's model of rule-governed behavior to analyze radon mitigation. Application of the reliability model is illustrated with observed mitigation responses of a sample of Maine homeowners.

JOHNSON, F. Reed, Professor, "Informed Choice or Regulated Risk? Lessons from a Social Experiment in Communication," *Readings in Risk*, eds. Glickman and Gough. Washington, DC: Resources for the Future, 1990, pp. 247-257. (Reprinted from *Environment*)

This article reports some results of a recent social experiment designed to test the sensitivity of people's responses to alternative presentations of the same facts about radon risks. Ethical issues enter the experiment in two ways. First, it was found that the way risk information is presented does matter and therefore involves ethical judgments. Second, ethical issues arose in the design of the social experiment itself. Discussed here are ways in which these two concerns limited the acceptable range and character of the experiment.

ZAK, Thomas A., Associate Professor, co-author, "Production Efficiency: The Case of Professional Basketball," *Sportometrics*, eds. B. Goff and R. Tollison. College Station, Texas: Texas A&M University Press, 1990, pp. 103-117.

This paper estimates a production function for professional basketball teams. Techniques well known in the production-function literature are applied to data collected during the 1976-1977 National Basketball Association season to determine the production frontier.

Production-frontier estimates yield information about the impact of various inputs used in the production process, as well as allowing interteam comparisons of potential output and average team efficiency. In addition, the paper considers the role of the "home-court advantage" and examines the source of this empirically observed phenomenon.

Presentations

DHAWALE, Hareesh M., Assistant Professor, "Output Effects of Government Purchases: A Recommendation," Western Economic Association Meetings, San Diego, California, 23 June 1990.

GOODMAN, Rae Jean B., Professor, and Thomas A. ZAK, Associate Professor, co-authors, "Competition, Effort and Learning in Economic Education," Western Economic Association International meetings, San Diego, California, 2 July 1990.

JAMES, Estelle, Visiting Professor, "Private School Finance and Public Policy in Cross-Cultural Perspective," U.S. Department of Education Conference on the Economics of Private Schools, Washington, DC, 10 May 1991.

JAMES, Estelle, Visiting Professor, "The Nonprofit Sector Around the World: Reflections About the Future," Distinguished Lecturer Series, Case-Western Reserve University, Cleveland, Ohio, 24 April 1991.

JAMES, Estelle, Visiting Professor, "Private Education and Public Regulation in Brazil," World Bank Conference on Growth, Inequality and Education, Rio de Janeiro, Brazil, 25 March 1991.

JAMES, Estelle, Visiting Professor, "Some Thoughts on the Distribution of Benefits from Nonprofit Organizations," Conference on the Distributional Consequences of the Nonprofit Sector, Duke University, Durham, North Carolina 30 Nov 1990, and the American Economic Association Meeting, Washington, DC, 28 December 1990.

JAMES, Estelle, Visiting Professor, "Toward a Research Agenda on the Public/Private Division of Responsibility for Social Service," Conference on The Public and Private Division of Social Services, Bellagio, Italy, 23 October 1990.

JOHNSON, F. Reed, Professor, "Paying for Safety: Voluntary Reduction of Residential Radon Risks," Air and Waste Management Association, Pittsburgh, Pennsylvania, 26 June 1990.

JOHNSON, F. Reed, Professor, "Valuing Ecological Risks," National Academy of Sciences Conference on Ecological Risk Assessment, Washington, DC, 28 February 1991.

MORRIS, Clair E., Professor, "An Episode in the History of Economics: Founding Fathers of the Chicago and Wisconsin Schools," Eastern Economic Association Meetings, Pittsburgh, Pennsylvania, 17 March 1991.

DEPARTMENT OF

Language Studies

Professor Gladys Rivera-La Scala
Chair

The Language Studies Department again enjoyed a very strong year, with outstanding classroom and scholarly performance by the faculty. In spite of budgetary and personnel constraints, we have continued to serve our mission successfully, with high enrollments and expanded Marshall Cox Overseas Study Programs in the summer of 1991. During the academic year, the department continued to benefit from the 12-meter earth station on Hospital Point. The antenna provides live programming to support language classes. It is expected that full program tracking capabilities will be available sometime during the summer of 1991. The new audio laboratory in Nimitz Library has proved to be extremely useful to faculty and students, providing a much needed resource for the testing and practice of listening comprehension.

In all other languages we are happy to report continued high enrollments, except for Chinese, and we are particularly encouraged by significant increases in the number of midshipmen enrolled in second year Japanese. We are equally proud of the large number of language minors (117) among 1991 graduates. This is especially rewarding when one considers that a very high percentage of minors elected to pursue language study at advanced levels.

Sponsored Research

The Pragmatic Exploitation of the Impersonal [Se]-structure in Spanish in Written and Oral Discourse

Researcher: Assistant Professor Penelope M. Bledsoe
Sponsor: Naval Academy Research Council (OMN)

This project explores the use of a common linguistic construction in Spanish that has evaded traditional grammatical explanations, thus making it difficult for non-native speakers of Spanish to master. The structure is a combination of a third-person clitic pronoun, [se] and a third-person singular or plural verb, forming an impersonal expression with [se] as a subject substitute. The exploitation of the [se] structure is straightforward and predictable when the true subject is unknown, universally known, or not important in the discourse. However, in many cases, the language user often exploits this structure in ways which are difficult to identify without considering social and conversational contexts.

The thesis of this research is that language users exploit this construction to avoid referring directly to a known subject in order to uphold certain conversational principles. The researcher proposes the pragmatic use of the impersonal [se] clitic as a subject substitute for a known subject is typically a reflection of politeness and formality conventions which require that in potentially embarrassing situations, the speaker should avoid attribution or designating who is responsible for what action. The clitic will be exploited pragmatically as a means of shifting responsibility off the logical subject. This research will focus on identifying the psychological, sociological, and linguistic mechanisms that govern its use among native speakers in order to test and elucidate prevalent theories on communication and social interaction. Data for this study have been collected from various sources of written and tape-recorded spoken discourse.

Literature of the Thaw in China and the Soviet Union

Researcher: Assistant Professor Susan W. Chen
Sponsor: Naval Academy Research Council (OMN)

The researcher has completed the first in a series of articles, to be compiled into a book on this subject. Post-Mao Chinese literature and Soviet Russian literature of the post-Stalin "thaw" developed along broadly parallel lines. Both are informed by a return to humanist values long banned by Marxist-Leninist orthodoxy, and they share many previously taboo themes. More than just a reflection of similarly altered social and political conditions, the strong resemblance between the two literatures can also be traced to the parallel reaction of Chinese and Soviet writers to their shared literary heritage of socialist realism.

The purpose of this project is to identify and study universal concerns among writers in socialist countries responding to newly relaxed literary controls.

Annapolis Interactive Video Project

Researchers: Associate Professor William H. Fletcher, Project Director; Assistant Professor Christopher D. Buck, Associate Professor Helen E. Purkitt, Professor John A. Hutchins, Assistant Professor Enrique Márquez, Professor Gladys M. Rivera-La Scala, Assistant Professor María E. Castro de Moux, Associate Professor Sharon D. Voros, Associate Professor Ludmila A. Pruner, and Professor John D. Yarbro
Sponsor: National Security Agency

Since its inception in 1985, this project has expanded into a team of professors who author interactive video (IAV) lessons for Spanish, French, Russian, and German. Project members have developed delivery and authoring software for a standard approach to creating lessons and have produced extensive documentation to guide authors through the process: authors combine selections from a set of some twenty presentation and exercise template types into a lesson structure and provide lesson content in text, graphic, and "control" (script) files produced with USNA-developed authoring tools and commercial graphic software. The project team regularly shares its software and its IAV expertise with other Naval Academy departments and with other government agencies.

In the past year team members have compiled five new videodiscs for Russian, Spanish, and Portuguese, and have revised the 44 existing elementary and intermediate Spanish lessons, adapting them to new textbooks and supplementing them with new video and content, and produced 14 lessons for 300-level Spanish. In order to strengthen integration of IAV lessons into the curriculum, written and oral pre- and postactivities were authored for each of the Spanish lessons. Work has continued on the project's longitudinal evaluation of language acquisition via computerized IAV, which has attracted widespread interest as the first study of its kind; a final report will appear in August 1991. The basic lesson delivery and authoring software is being reprogrammed in C++ to support many improvements in lesson design and to permit widespread distribution of project software.

The Annapolis Interactive Video Project continues to expand the scope of its internationally recognized pioneering work. A prototype computerized adaptive test with provision for video and digitized audio will be tested in July 1991 as part of Plebe validation and placement. This tool will ultimately permit rapid individualized assessment of listening proficiency with stimuli taken from authentic video.

Elements of Theoretical Linguistics in Priscian's *Institutiones*

Researcher: Associate Professor Audrey Gaquin
Sponsor: Naval Academy Research Council (OMN)

Twentieth-century linguistics, judging from a strictly modern point of view, dismisses Priscian's work as unscientific, lacking in method, and irrelevant to the progress of modern linguistics. Yet Priscian's place at the end of the long tradition of classical grammar, building on the work of his many predecessors and functioning as a principal source of information for medieval grammarians, points up his importance for the Western grammatical tradition.

An examination of Priscian's *Institutiones* shows that this work made available to Priscian's successors certain fundamental theories on the nature of language, as well as doctrines about specific grammatical points. The presentation of the different levels of language and definitions of the noun and verb represent the most extensive theoretical discussions in Priscian's work. These discussions stress the role of the communication situation in governing language production, analogies between language and the physical universe, and the definitive importance of the semantic component of language.

Discussions of specific subcategories of the parts of speech, such as the paradigm for the reflexive pronoun "sui," the formation of interrogatives, and the treatment of other types of "understood" elements in language help to define the semantic component as a set of what may be called semantic wholes. These must be broken down into their component parts and then matched with linguistic forms in order to generate language. Semantic wholes are partially influenced by the extralinguistic universe and by the communication situation.

Priscian views language as a phenomenon produced in the physical universe and in a communication situation, in which semantic wholes are matched with corresponding language forms, most of which, in turn, are generated by a smaller class of primary forms. The study of the semantic aspects of his theory promises to be useful not only for understanding classical linguistics, but also for evaluating Priscian's contribution to the medieval grammatical tradition.

Marco Antonio de la Parra y el nuevo teatro chileno (Marco Antonio de la Parra and the New Chilean Theatre)

Researcher: Associate Professor Elsa M. Gilmore
Sponsor: Naval Academy Research Council (OMN)

Chilean theatre has flourished in the twentieth century. It was particularly fruitful in the 1960's and early 1970's when members of the "Generation of 1950" produced a number of plays which have achieved international acclaim. In recent years, however, the Chilean theatre has lacked new luminaries. This void is now being filled by a 38-year-old post-modern satirist by the name of Marco Antonio de la Parra.

De la Parra appeared on the Chilean stage in the waning years of the Pinochet regime, as the nation was preparing to re-enter a democratic historical course. De la Parra's best known plays, *The Raw, the Cooked, and the Rotten* (1985), *Tango-Killer* (1985), and *Our Daily Secret Obscenity* (1987), have caused an artistic and political sensation in Santiago, and have already been performed to public and critical acclaim throughout the continent and abroad. One of them, *Tango-Killer*, was selected for the 1988 Kennedy Center Gala Festival in Washington, DC.

The author has reviewed de la Parra's dramatic production and appropriate criticism and has presented conference papers on each of the three plays mentioned above. In addition, a lengthy research article focusing on the dramatic structure of *Our Daily Secret Obscenity* has been accepted for publication by *Latin American Theater Review*. A second article, also to be published in a forthcoming Parra anthology (in English translation) is currently in preparation.

Readability and Intertextuality in Balzac's Fiction

Researcher: Assistant Professor Elizabeth M. Knutson
Sponsor: Naval Academy Research Council (OMN)

This research project expands upon work begun in the researcher's doctoral dissertation on the relationship between narrative intelligibility and intertextuality in Balzacian narrative. The project entails further development of several theoretical concepts of importance to modern literary criticism: readability, verisimilitude, and intertextuality. The study explores definitions of these concepts, specifically as they relate to three genres of nineteenth-century narrative--melodrama, realism, and the fantastic--all of which are represented in the range of Balzac's work. The novels studied in this context are *Splendeurs et misères des courtisanes*, *Le Cousin Pons*, and *La Peau de Chagrin*, respectively. Shorter fictional works of Balzac may be added to the study as the research progresses.

Text characteristics, generic norms, and extratextual factors which affect readability are analyzed in each novel. In addition, the function of intertextuality (presupposed or explicit allusions to other literary texts) and autotextuality (self-referential structures which emphasize literariness) is defined and analyzed in each genre. Finally, the potentially conflictual or problematic relationship between intertextuality and representation is examined from the perspective of twentieth-century critical practice.

Urban Landscapes in Chinese and Japanese Fiction

Research: Assistant Professor Stephen J. Roddy
Sponsor: Naval Academy Research Council (OMN)

The aim of this project was to seek to describe and interpret the depiction of urban life in several examples of Japanese and Chinese fiction. By contrasting these works in terms of the perceptions they present of the urban milieux of their day, light can be shed on the various ways in which the urban environment functioned as a literary topos within these two traditions. Of special interest for comparative purposes was the apparent influence of Confucian philosophical doctrines on the novelists in question. While many Chinese novelists share a concern with the overarching moral implications of the emerging urban social order, Japanese novelists tend to lack such interests, in spite of or perhaps even because of the attempt by the state to propagate Confucian ethical values among the populace. Unencumbered by such ethical baggage, Japanese novelists exhibit a strong interest in the realistic and vivid depiction of the minute details of urban life that is less apparent in Chinese fiction. Examining and interpreting such differences is the primary focus of this investigation.

Independent Research

Pragmatic Constraints on NP Position in [Se]-structures in Spanish

Researcher: Assistant Professor Penelope M. Bledsoe

This article offers a functional explanation for the existence and special properties of some movement rules for Spanish, in particular, the subject postposing rule which postposes the subject NP to the verb. The researcher argues that positioning of the NP in the [se]-structure responds to discourse factors--presupposed or topical subject NP's are in pre-verbal position and focused NP's being introduced or reintroduced into a discourse are post-verbal. This post-verbal position is the position of prominence in the Spanish clause. The researcher offers an explanation of the extraordinarily high incidence of postposed subject NP's in the [se]-structure as a result of the impersonal pronoun's syntactic function; it changes the valence of a transitive verb from two to one. This remaining NP (the logical object) becomes the new subject, and is free to move around the verb creating a situation similar to that of an intransitive structure where the positioning of the NP in Spanish is determined by the function of the utterance in a discourse.

This article has been accepted for publication in the forthcoming *Proceedings* of the Mountain Interstate Foreign Language Conference.

Chantal Chawaf: Pour une nouvelle éthique de la littérature (Chantal Chawaf: A Plea for New Ethical Values in Literature)

Researcher: Assistant Professor Marianne Bosshard

This project should culminate in a book-length critical analysis of the oeuvre of Chantal Chawaf, one of the better known contemporary women novelists whose literary style belongs to a tradition commonly referred to as "écriture au féminin."

Through her particular thematic and linguistic approach to literature, Chawaf attempts to include on the symbolic level an "interior, affective intelligence." Of particular concern to her are issues in the fields of bipolar and hierarchical thinking with respect to body and mind, and the structuralization process of the female subject which place her at the center of linguistic, psychoanalytic, and philosophical debates that have dominated the French literary and intellectual scene during the last two decades. Though her works comprise no fewer than 15 novels, a script for a play and numerous theoretical texts, no comprehensive critical text is available to date.

During the second part of summer 1991, the researcher will revise and update her dissertation (1988); rewrite a chapter on current linguistic theory that was not included in the previous analysis; analyze the author's stylistic and thematic innovations in the light of "essentialist" and "radical feminist" literary practices; and provide the manuscript with an updated critical bibliography.

During a meeting with the author in Paris, planned for August 1991, the researcher hopes to add an interview pertaining to Chawaf's two most recent, as yet unpublished theoretical and literary endeavours.

Retrato de un poeta: Luis Palés Matos

Researcher: Assistant Professor María E. Castro de Moux

This project is a biography of the well-known Puerto Rican poet Luis Palés Matos (1898-1959). His personal life, political participation, and literary accomplishments are discussed as a way to understand his poetry. The relationship between his poetical ideas at various stages and the kind of poetry he was writing is studied to show both the parallelisms and the contradictions. Although Palés Matos has a sizable bibliography, including information on his life, no biography on this author has been published.

The researcher has finished writing all chapters and the conclusion. The manuscript is presently being revised for content and style, and several chapters have been submitted to readers.

Aspects of Basque

Researcher: Instructor Ana I. Echavarri-Dailey

In linguistics, the theoretical framework which has come to be known as the "principles and parameters approach," introduced by Chomsky in *Lectures on Government and Binding* (1981), concentrates on the general principles, constraints, and parameters that might indicate how language acquisition takes place. The Government and Binding model (G.B.) is based on the belief that language is a cognitive system, which is in large part innate and, as such, part of our biological endowment. This conception of language motivates the quest for the principles on universal grammar (U.G.) that form part of our language faculty.

T'. main topic of this project, the researcher's doctoral dissertation at Cornell, is a study of instances of pronouns and anaphors (reflexive pronouns) in Basque which exhibit peculiar behavior uncommon to other languages and which are therefore difficult to explain within the G.B. model. The analysis of the problematic structures given shows that a slight change in the level of structure in which anaphors and pronouns are interpreted can explain most of the peculiarities of the pronouns and anaphors in Basque. Those structures are then mere parametric variations perfectly explained within the G.B. model.

The researcher is now in the process of applying the modified theory to the so-called "Psyche Verbs" (e.g., think, wish). In Basque, as in many other languages, those verbs exhibit peculiar syntactic behavior, particularly when they appear in conjunction with anaphors. It is expected that the modified theory will explain and predict the structural anomalies of those verbs.

A Different France: Documents from the Minority Cultures of France

Researcher: Associate Professor Audrey Gaquin

A Different France is an anthology of documents from the seven regions of France whose inhabitants are considered "minorités installées," that is, members of a group whose native language and culture are different from those of the French nation. These include Alsace, Basque country, Brittany, Corsica, Flanders, North Catalonia and Occitania. The Mitterrand government has passed laws allowing greater regional autonomy in all of France, including greater freedom of expression for members of cultural minorities. Autonomist and separatist groups in some of these areas, while not attracting many members, receive wide support from the minority population; a member of the Corsican autonomist group UPC, Max Simeoni, is now a delegate to the European Parliament. The regionalist policies of post-Franco Spain have had some effect on the demands of French Basques and Catalans for greater government support of regional languages on their side of the border, and the abolition of economic barriers in the European Economic Community in 1992 is also an important factor in the way minorities respond to the initiatives of the French government.

The regionalist movement in France and its consequences for the minorities have received little attention outside of France. Indeed, it is difficult to obtain even basic information about these minorities in the United States. *A Different France* makes available to students, teachers, and scholars primary

source materials relating to the regional cultures of France. One section of the anthology is devoted to each of the seven minorities, and each section includes a historical introduction, an interview with a minority leader, articles on the political and economic issues concerning the region in question, sample lessons in the minority language, brief literary selections in the minority language, with translations into French, and information about customs, traditions, and folk art in the region.

The Correspondence of Luis Alberto Sánchez

Researcher: Associate Professor Elsa M. Gilmore

The purpose of this project is to produce an edition of the literary correspondence of Dr. Luis Alberto Sánchez. Dr. Sánchez is a well known writer and scholar, a founder of Peru's APRA Party, and a former Vice President of that country. The work is essentially complete, with the exception of some textual problems which are currently being addressed with the cooperation of the Penn State University Library's Hispanic Collections Librarian. The author expects to submit the volume to a publisher some time in fall, 1991.

The Language of Diplomatic Correspondence between Moscow and the Turkic Khanates: 1458-1600

Researcher: Instructor Dudley Hagen

The documents being examined for this doctoral dissertation at the University of California, Los Angeles, are a series of treaties, drafts of treaties, and notes. They were published in the middle half of the last century. All of the documents are in Russian, but about half of them are translations from the Tatar. By comparing the language of the original Russian and translated documents, the researcher hopes to show that at this period, when Muscovite diplomatic language was still taking shape, it was under strong Tatar influence. Recent work by Russian historians has suggested that Moscow's political institutions were shaped in the same way.

The Communicative Function of Stereotypes in the Reception of Toni Morrison's Novels

Researcher: Assistant Professor Monika Hoffarth-Zelloe

This article examines the artistic use of racial myths and Black stereotypes in a selective choice of Black American texts. It shows how stereotypes function as frames of cognitive orientation in the reading process. The researcher focuses on Toni Morrison's novels in which she works with clichés and stereotypes with the intent to deconstruct the Western value system. Her characters--black and white--first depict seemingly "good" and "evil" figures. A close analysis, however, will show that Morrison's characters are not allegorical types. Instead, they symbolize the paradoxical nature of good and evil. The recognition of the "evil of the good" and the "good of the evil" makes the reader examine his own prejudiced world view and leads, eventually, to a reevaluation of his horizon of values.

This article has been accepted for publication in *Text - Culture -Reception: Cross-Cultural Aspects of English Studies*.

The Poetry of Severo Sarduy

Researcher: Assistant Professor Enrique Márquez

This is basically an introductory paper on the Cuban-born French writer, who is mostly known for his post-modernistic fiction and his close links with the *Tel Quel* group in Paris (1960's and 1970's), with Roger Caillois and the critic Roland Barthes. Sarduy is less well known in this country as a poet of note, art critic, and commentator of science, and this researcher seeks to fill that void by offering a more general framework from which to appreciate the contributions of this writer.

Specifically, the essay presents both biographical and critical data: Sarduy's early, formative years in a Cuban province during the pre-revolutionary years; early symbolist poems; his conversion to "lezamismo," a post-modern school of poetry and fiction spearheaded by his compatriot José Lezama Lima in the 1960's; his embrace of Lacanian epistemology in the 1970's in Paris; and the impact of the "new biology" on his literary thinking. While his fiction has grown increasingly cosmopolitan in breadth and scope, his poetry remains intensely intimate and rich with allusions and references to his Cuban adolescent years.

This essay will appear in the collection *Critical Essays on Severo Sarduy*, to be published by the University of California Press in 1991.

Guy Davenport, Poems (from *Eclogues, Apples and Pears, and Thasos and Ohio*)

Researcher: Assistant Professor Enrique Márquez

George Steiner of *The New Yorker* has appropriately singled out Mr. Davenport as among "the truly autonomous voices now audible in American letters." His oeuvre includes distinguished fiction (*Tatlin!*), essays (*The Geography of the Imagination*, nominated for the National Book Award, non-fiction, outstanding classical translations of Archilocus, and a few select volumes of poetry.

The researcher has undertaken to translate into Spanish a selection of poems by Mr. Davenport, mostly known in the Hispanic world of letters by his novel *Tatlin!* and selections of essays published by Peruvian critic Julio Ortega in Mexico's *Vuelta*. Coming out of the American modernistic tradition of Ezra Pound and Wallace Stevens, Mr. Davenport's poetry combines the raw force and spontaneous grace of early, primitive Greek poetry with his own personal wit, creativity, and encyclopaedic mind.

Upon completion, a selection of ten poems will be submitted for publication to Octavio Paz' revue *Vuelta*. Later on, a total of fifteen poems will be sent with an Introductory Study of Mr. Davenport's poetry to Anagrama Publishers in Madrid.

Prophecy and Middle Knowledge: Comparative Libertarianism in Maimonides, Luis de Molina, and José Lezama Lima

Researcher: Assistant Professor Enrique Márquez

This article examines three different approaches for reconciling revelation and reason within a "poetic" mode of knowledge. Notions examined include Maimonides' "creationism" (*Guide of the Perplexed*, ninth century); Molina's "indeterministic" contingency (*Concordia*, Book IV, sixteenth century); and José Lezama Lima's "concurrent randomness" (*Cantidad hechizada*, twentieth century).

Juan de Mena's *Coplas de los Siete Pecados Mortales*: Second and Third Continuations: A Critical Edition and Study

Researcher: Professor Gladys M. Rivera-La Scala

This book includes the first critical edition of the Second and Third Continuations of the *Coplas de los Siete Pecados Mortales*, left unfinished at Juan de Mena's death, and an intertextual analysis of the main poem and its three continuations. The first chapter contains a comparative study of the four works based on themes, imagery, meter, and rhyme. In the second chapter the author gives detailed, firsthand descriptions of the manuscripts and sixteenth-century printings used in establishing the base text and discusses the interrelationships that exist between the many versions of the works. A corrected version of the continuations in modern script follows. Editorial, literary, and linguistic notes make up the next section, which ends with a glossary of medieval Spanish terms and one of proper names. Included in this volume is an extensive bibliography of primary and secondary source materials on Spanish and European fifteenth-century didactic poetry. The book will be published by Studia Humanistica.

Juan de Mena's *Laberinto De Fortuna*: A Critical Transcription and Concordance of ESP.MS 229 of the Bibliotheque Nationale, Paris.

Researchers: Professor Gladys M. Rivera-La Scala and
Assistant Professor María E. Castro de Moux

This work will be published by the Hispanic Seminary of Medieval Studies, University of Wisconsin-Madison, as part of their National Endowment for the Humanities-sponsored project, and the lexicon from the concordance will be included in the first *Dictionary of Old Spanish*, the first volumes of which are scheduled for dissemination in the early 1990's. This thirty-year project, begun in the late 1950's by Professor Lloyd Kasten, has more recently enjoyed yearly support from the National Endowment for the Humanities for 10 years. The project represents the expertise and work of at least two generations of scholars from the national and international communities.

Ueda Akinari and Ji Yun: The Topography of the Netherworld in Eighteenth-Century Japanese and Chinese Fiction

Researcher: Assistant Professor Stephen J. Roddy

Two writers of supernatural tales, Ji Yun (1723-1801), a Chinese, and Ueda Akinari (1734-1809), a Japanese, were almost exact contemporaries of one another. For both of them, such tales have become the main source of their literary fame among modern readers. During their lifetimes, however, both men were known by their contemporaries as scholars of classical learning, and moreover as critics of intellectual trends prevalent in their respective countries. Although the two men were most likely unaware of each other, the parallels in both their intellectual positions and their works of fiction are remarkable.

The paper examines the treatment of supernatural elements in two collections of tales, Ji's *Yuewei caotang biji*, and Ueda's *Ugetsu monogatari*. Ji's stories tend to dwell on the hypocrisy and complacency of latter-day exponents of a rigid Confucian rationality, using supernatural beings and events to shock such characters out of their narrow-minded beliefs. Ueda, on the other hand, while also a critic of the Confucian orthodoxy prevalent among the Japanese elite, presents equally unflattering portraits of exponents of Buddhist and Shinto beliefs. His ghosts and demons defy any rationalistic or moralistic view of them, whether such views deny or, on the other hand, embrace their existence.

Both Ji and Ueda used supernatural tales to comment on the intellectual currents of their day. The differences between them can be attributed in part to the conditions in their respective countries, as well as to the literary traditions from which they sprang.

Rulin waishi and the Portrayal of the Literati in mid-Qing Fiction

Researcher: Assistant Professor Stephen J. Roddy

A revision of the researcher's Ph.D. dissertation, this study examines the Chinese satirical novel *Rulin waishi* in its literary and intellectual context. It places the novel in the context of a group of works of fiction devoted to the theme of the literati as a social and intellectual classification. Moreover, contemporary works of scholarship, literary criticism, and art theory are adduced as examples of a broad trend toward the redefinition of the role of the intellectual in Chinese society.

The revisions focus on expanding the biographical information about the author of *Rulin waishi*, Wu Jingzi (1701-1754). The researcher has already completed most of the research for this task, and expects to write up the results during summer 1991.

"Suoyin pai" and Late-Qing Criticism of the Novel *Hong lou meng*

Researcher: Assistant Professor Stephen J. Roddy

This project, now in its preliminary stages, grew out of a paper delivered at a conference in April 1991. During the last decades of the nineteenth century, when Chinese society entered a period of unprecedented crisis due to internal as well as external causes, some literary critics became acutely conscious of the social and political relevance of certain works of fiction. One of these works, the acclaimed novel *Hong lou meng*, inspired a school of criticism known as "suoyin pai" that was devoted to uncovering topical allusions to political events of the period in which the fiction was written. Although this school fell into disrepute by the early twentieth century, and has generally been ignored or ridiculed by contemporary scholars, it should be reexamined for its significance as a precursor to the development of the political novel, a genre which flourished in the years 1900-1915.

Adjuvancy and Opposition: A Study of Supporting Roles in Pedro Calderón de la Barca (1600-1681)

Researcher: Associate Professor Sharon Dahlgren Voros

This book-length study combines the methodology of semiotics with archival research on Pedro Calderón's secular and religious drama. While supporting or secondary roles are often overlooked in drama studies, they provide keys for interpreting the playtext, since they complement and comment on the action of the main characters. Adjuvancy and opposition, terms from A. J. Greimas' semiotic model, imply actantial functions of characters of subordinate social rank, and hence often marginalized figures. The researcher made a presentation on feminine roles of adjuvancy in the character Flor, an allusion to the Roman goddess Flora of dubious reputation. Flor's intentions are misinterpreted by male leading characters, as they assume her to be an opposant. Flor's self-assertion generates the stage action responsible for the play's structure.

This methodology extends also to minorities. In a forthcoming article, "Discovering Moorish Women in the Spanish Classical Drama," the researcher considers Calderón's history play dealing with the Moorish rebellion of 1570 in the Alpujarras region of Granada. While Moorish men are studied, since they are historical figures, the secondary women's roles are largely fictionalized and in need of investigation. Calderón condemns the greed and brutality of Spanish soldiers who murder Muslim women for their jewels, while he still supports the imperial politics of the Hapsburg reign. Calderón, a supporter of the monarchism of his time, was not, however, uncritical of it.

Research Course Projects

Lyrics of Protest in the USSR in the Last Two Decades

Researcher: Midshipman 1/C Alexander K. Mackenzie, USN
Adviser: Associate Professor Ludmila A. Pruner

The purpose of this research was to analyze the socio-cultural values of Soviet youth as manifested in the music and lyrics of the Russian rock musicians and songwriter, Boris Grebenshchikov, and his group "Aquarium" in particular.

The basic criteria for selecting songs consisted of the researcher's musical influences and personal taste, and intuition based on his level of proficiency in Russian. After having listened to sixteen albums, the researcher made a final selection of twenty songs. All the songs were transcribed in the original language, and translated into English. Manuscripts on the Soviet underground culture, a brief history of Soviet rock movement among them, contributed to the analysis of the songs.

Written criticism regarding cultural and ideological background of the songs, their poetics, and morphological structure were provided in the course of the analysis. The researcher also contributed to the project material from his meetings with Boris Grebenshchikov in Leningrad, U.S.S.R and in Baltimore, U.S.A.

The project significantly enriched the researcher's listening comprehension, vocabulary in Russian, and his understanding of Grebenshchikov's craftsmanship as a poet and a musician. During his work on the project, the researcher also broadened his knowledge of the art of songwriting in terms of basic principles, techniques, imagery, and cohesiveness surrounding a particular theme. Finally, during the project, the researcher composed sixteen original songs.

Publications

FLETCHER, William H., Associate Professor, "Authentic Interactive Video for Lower-Level Spanish at the United States Naval Academy," *Hispania*, 73 (1990), 859-865.

This article describes approaches to interactive video (IAV) foreign language lessons developed at the U. S. Naval Academy. The lessons are based on commercial television from abroad received by a satellite earth station. The initial pedagogical aim of the lessons is to teach students to understand authentic native-speed materials via a medium whose directness and realism ordinary classroom presentations cannot match and to stimulate students' interest in foreign languages and cultures in the process. The USNA IAV team has pioneered an impressive array of techniques which have proven highly successful in enhancing students' comprehension of native-speed language and in helping them develop listening strategies. These techniques are discussed in detail from both practical and theoretical viewpoints.

Of even greater potential interest to educators and courseware developers is the project's goal of evaluating the contribution of interactive video to language learning by college students. This independent evaluation is studying the achievements of three two-year cycles of students learning Spanish who complete a weekly interactive video homework assignment by comparing their performance on standardized listening and speaking tests with that of a control group which has comparable assignments with audio tapes instead. This article also reports on the goals and preliminary evidence provided by this evaluation.

GILMORE, Elsa M., Associate Professor, "Spanish Video Materials: A Resource List," *The Northeast Conference Newsletter*, 28 September 1990, pp. 40-41.

This short article provides Spanish teachers at the high school and college levels with a survey of museums, embassies, and non-profit organizations which offer video materials for rent free of charge or at little expense. Some of these non-commercial materials differ significantly in content and historical or political point of view from the vast majority of materials commonly available for classroom use through commercial sources.

The author lists the sources and describes the tapes, slides, and musical collections in question. She also provides a brief evaluation of the materials and the specific borrowing/rental procedures or the name of a contact person.

HAGEN, Dudley, Instructor, translator for Robert ATWAN and Valeri VINOKUROV, editors, *Openings: Original Essays by Contemporary Soviet and American Writers*, Seattle: University of Washington Press, 1990.

This book contains essays by seven Soviet and seven American writers on the topics of history, geography, art, sports, science, literature and way of life. American authors included Joyce Carol Oates and Barry Lopez. Soviet authors included Yuri Nagibin and Viktor Astafiev. *Openings* is a joint publication in the U.S.A. and the U.S.S.R. Hagen was responsible for translations of Soviet authors.

MARQUEZ, Enrique, Assistant Professor, *José Lezama Lima: Bases y Génesis de un sistema poético*. New York: Peter Lang, 1991.

This book presents an analysis of the inception and development of José Lezama Lima's *sistema poético del mundo*. Its signal contribution lies in its confrontation with the poetic modes generally conceived as typical of modernity, and its revival of pre-modern poetics. Revealed are the ways in which the relationship subject-object is dismantled and taken back to its pre-philosophic, pre-cultural status; a kind of "liberation" is then formulated that exists in the indefinite, concomitant with a form of knowledge that eludes (scientific) deterministic causality. The author traces how different (Western and other) poetic traditions lead Lezama Lima to his explication of an "imagen americana," and its links to natural right and history. The book ends with an inquiry into which type of individual Lezama Lima had in mind, and how this might fit with the changes taking place in revolutionary Cuba.

PRUNER, Ludmila A., Associate Professor, "Russian Feature and Documentary Films in U.S," *The AAASS Editorial Board for Professional Journals Russian Review and Soviet Union*, Spring 1991, pp. 1-12.

The number of Soviet Film Festivals, film-maker exchanges, and Soviet-American co-productions, as well as television series devoted to contemporary and classic Soviet films, have brought to American audiences wider exposure to and appreciation of Soviet cinema. The Aesopian devices are no longer needed; Soviet cinema is undergoing major changes. While the long awaited freedom of expression left many Soviet artists bewildered and silent, others created new schools and initiative groups. The growing interest in Soviet cinema in the United

States encourages a new market for Soviet and Russian video. The present publication provides information regarding the most accessible commercial and non-commercial sources of distribution of feature and documentary films and videos of different epochs, as well as print sources, i.e. film guides, catalogues, and periodicals on Soviet cinema offered to educators, researchers, and the community at large.

PRUNER, Ludmila A., Associate Professor, Editor, *Working Group on Cinema and Television: USSR and Eastern Europe (WGCTV) Newsletter*, II, 2 (September 1990)1-8; and 3, 1 (March 1991) 1-8.

The WGCTV *Newsletter* is published twice a year by the Working Group on Cinema and Television, a non-profit, non-political society dedicated to the advancement of knowledge, teaching and research on Soviet and East European cinema and television. The WGCTV is an affiliate of the American Association for the Advancement of Slavic Studies (AAASS) and the Society for Cinema (SCS). The WGCTV *Newsletter* publishes information concerning research, surveys, new film releases, film festivals, joint scholarly projects, and film conferences in the U.S. and abroad. During the 1990-1991 academic year two issues were published. The September 1990 issue presented a detailed outline of the InterUniversity History Film Consortium Conference in London, United Kingdom, and the IV World Congress of Slavists in Harrogate, United Kingdom. The March 1991 issue presented a yearly report of the Executive Committee members. A special section was devoted to professional news and announcements, followed by an updated membership list.

PRUNER, Ludmila A., Associate Professor, "Conferences and Professional News," *Working Group on Cinema and Television Newsletter (WGCTV)*, 2, 2 (September 1990) 3-8.

A detailed report on the InterUniversity History Film Consortium Conference in London, United Kingdom and the IV World Congress of Slavists in Harrogate, United Kingdom revealed a significant contribution by the WGCTV members to both events. The InterUniversity History Consortium Conference discussed issues related to early years of Soviet cinema while the Cinema panel at the Fourth World Congress was devoted to contemporary Soviet cinematic production. The report was followed by an annotated list of conferences on Soviet and East European Cinema and Television in the U.S., Japan, and Western Europe.

PRUNER, Ludmila A., Associate Professor, "Editor's Report," *Working Group on Cinema and Television Newsletter, (WGCTV)*, 3, 1 (March 1991), 3.

The report presented a summary of concerns regarding the preparation of each WGCTV *Newsletter*, the format and the content matter among them. Additional information is provided on the desired software. Suggestions are made for the upcoming WGCTV *Newsletter* publications.

PRUNER, Ludmila A., Associate Professor, "Conferences and Professional News," *Working Group on Cinema and Television Newsletter, (WGCTV)*, 3, 1 (March 1991), 4-5.

This article, a report on American scholars' response to new developments in Soviet cultural and cinematographic scenes, focuses on the first meeting of the Working Group on Contemporary Soviet Culture which was held in Moscow in June 1990. The discussion of the participants centered on three major concerns: the totalitarian nature of Soviet culture, an attempt to establish an "intelligible file" for the interpretation of contemporary culture, and finally, the dual tension between politics and market forces. The forthcoming meeting in summer 1991 will include issues on "Conscious and Unconscious Categories of Discourse in Cultural and Social Life under Perestroika."

PRUNER, Ludmila A., Associate Professor, Translator, *Basic Training School in Quantico*, October 1990.

A seven-page brochure was translated into Russian for the internal use for Russian-speaking official visitors at the School at the request of U.S.M.C. Basic Training School.

VOROS, Sharon Dahlgren, Associate Professor, "La semiótica de los gemelos en *Mujer, llora y vencerás* de Pedro Calderón," *Dispositio*, **8**, 33-35 (March 1988), 179-195.

Appearing in a special issue on semiotics and the theater, this article proposes a pragmatic approach to the analysis of the dramatic function of sign systems. Not all signs contribute to advancing plot or developing characters. The author distinguishes between microsigns with five variables that relate sign to object within specific scenes, and macrosigns that relate larger dramatic segments and account for actantial transformation of characters.

Calderón's *Mujer, llora y vencerás* (Women, cry and you will vanquish) includes the principal microsign, weeping, in its title. Weeping is not gender specific, however, since it also relates to the general macrosign structure, the twin brother relationship. Unlike Shakespeare, who uses two relationships to provide scenarios for mistaken identity, Calderón emphasizes sibling rivalry, which, in the case of this work, escalates into civil war over their love for the same woman. In the analysis of the playtext semiotic codes intersect with performance codes, as the sign of feminine weeping shifts in meaning from being a sign of weakness to a sign of compassion. This approach lays bare the inner workings of verbal and non-verbal signs to provide evidence of Calderón's stage artistry.

Presentations

BLEDSOE, Penelope M., Assistant Professor, "The Pragmatic Exploitation of Impersonal [Se]-structure in Spanish," Mountain Interstate Foreign Language Conference, Radford University, Radford, Virginia, 8 October 1990.

BOSSHARD, Marianne, Assistant Professor, "*L'Eclaircie*: Un nouveau départ dans l'univers chawafien?" ("*L'Eclaircie*: A New Departure in Chawaf's Literary Itinerary?"), Eighth Wichita State University International Conference on Foreign Literature, Wichita, Kansas, 11-13 April 1991.

CASTRO DE MOUX, María E., Assistant Professor, "Tipos de discurso teatral en el entremés de *Los negros* de Simón Aguado," Conference on Literary Criticism of Seventeenth-century Spanish Drama, El Paso, Texas, 13 March 1991.

CASTRO DE MOUX, María E., Assistant Professor, "El escritor, el místico y el loco" and "A Cirilo se le aparece Jesús," Congreso Internacional del Texto Místico, Universita dell'Aquila, Aquila, Italy, 24-30 June 1991.

ECHAVARRI-DAILEY, Ana I., Instructor, "Basque Language and Nationalism," Conference on The Dynamics of Nationalism: European Case Studies, Durham, North Carolina, 8 April 1991.

FLETCHER, William H., Associate Professor, "Interactive Multimedia: Teaching in the Twenty-first Century," George Washington University Television, Washington, DC, 8 May 1991.

FLETCHER, William H., Associate Professor, "Interactive Video with Authentic Materials in Foreign Language Instruction at USNA," Symposium on Technology in Education and Training, U.S. Naval Academy, Annapolis, Maryland, 12-14 March 1991.

FLETCHER, William H., Associate Professor, "Annapolis Interactive Video Project: Development of Pedagogical Model and Software," Interagency Group for Interactive Training Technology, Washington, DC, 29 January 1991.

FLETCHER, William H., Associate Professor, "Applications of Multimedia in Learning the Less Commonly Taught Languages: Rationale and an Outline," American Council for the Teaching of Foreign Languages Conference, Nashville, Tennessee, 16-19 November 1990.

FLETCHER, William H., Associate Professor, "USNA's Interactive Video Authoring Templates," American Council for the Teaching of Foreign Languages Conference, Nashville, Tennessee, 16-19 November 1990.

FLETCHER, William H., Associate Professor, discussant, "Language Pedagogy and Effective Technology Use" by Nina Garrett and "Software for Language Training: Directions and Opportunities" by James P. Pusack, Conference on Improving Foreign Language Teaching through Technology, Defense Language Institute Foreign Language Center, Monterey, California, 29-30 October 1990.

FLETCHER, William H., Associate Professor, "Interactive Video with Authentic Materials in Foreign Language Instruction," Society for Applied Learning Technology's Twelfth Annual Conference on Interactive Videodisc in Education and Training, Washington, DC, 22-24 August 1990.

FLETCHER, William H., Associate Professor, "Choosing and Using Authentic Video for Teaching Foreign Language," National Cryptologic School Symposium "Multimedia Approaches to Foreign Language Comprehension," Linthicum, Maryland, 24 July 1990.

GAQUIN, Audrey, Associate Professor, "Demythicizing and Myth Creation: the French 'minorités installées'," Conference on Cultural Conflict in Contemporary Literature, University of Puerto Rico, Mayagüez Campus, Mayagüez, Puerto Rico, 8 February 1991.

GILMORE, Elsa M., Associate Professor, "Invitación al crimen: *Matatangos*, de Marco Antonio de la Parra" ("An Invitation to Murder: Marco Antonio de la Parra's *Tango-Killer*"), South Atlantic Modern Language Association, Tampa, Florida, 16 November 1990.

GILMORE, Elsa M., Associate Professor, "Morality and the Moral of the Story in *Our Daily Secret Obscenity*," The Kentucky Foreign Language Conference, Lexington, Kentucky, 26 April 1991.

HOFFARTH-ZELLOE, Monika, Assistant Professor, "Resolving the Paradox--An Interlinear Reading of Toni Morrison's *Sula*," Conference on "'Other Voices'; American Women Writers of Color", Ocean City, Maryland, 28-30 May 1991.

HOFFARTH-ZELLOE, Monika, Assistant Professor, "The Notion of Self in Toni Morrison's *Sula*--Paradoxical Twoness in a Unified Soul?," International Conference on Narrative Theory, Nice, France, 12-14 June 1991.

MARQUEZ, Enrique, Assistant Professor, "Analogía y 'ekphrasis', anestoresia e historia: formas de tiempo clásico en la 'polis' de José Lezama Lima," American Association of Teachers of Spanish and Portuguese, University of Miami, Miami Beach, Florida, 9-14 August 1990.

PRUNER, Ludmila A., Associate Professor, "Andrei Tarkovsky's Socialist Realism in Cinematic Work: 'Mirror' and 'Ivan's Childhood'," Fourth World Congress of Slavists, Harrogate, England 21-23 July 1990 .

PRUNER, Ludmila A., Associate Professor, "Report on the Working Group on Cinema and Television:USSR and Eastern Europe Newsletter Activities," Convention of the American Association for the Advancement of Slavic Studies (AAASS), Washington, DC, 16 October 1990.

PRUNER, Ludmila A., Associate Professor, Chair, Panel on "Contemporary Issues in Soviet Cinema," National Convention of the American Association of Teachers of Slavic and East European Languages (AATSEEL),Chicago, Illinois, 26-30 December 1990.

PRUNER, Ludmila A., Associate Professor, "Russian Study Program at the U.S. Naval Academy," 1991 U.S.Navy/Army/Air Force Reserve Russian Training Weekend, Washington Area Group, U.S. Naval Academy, Annapolis, Maryland, 16-17 March 1991.

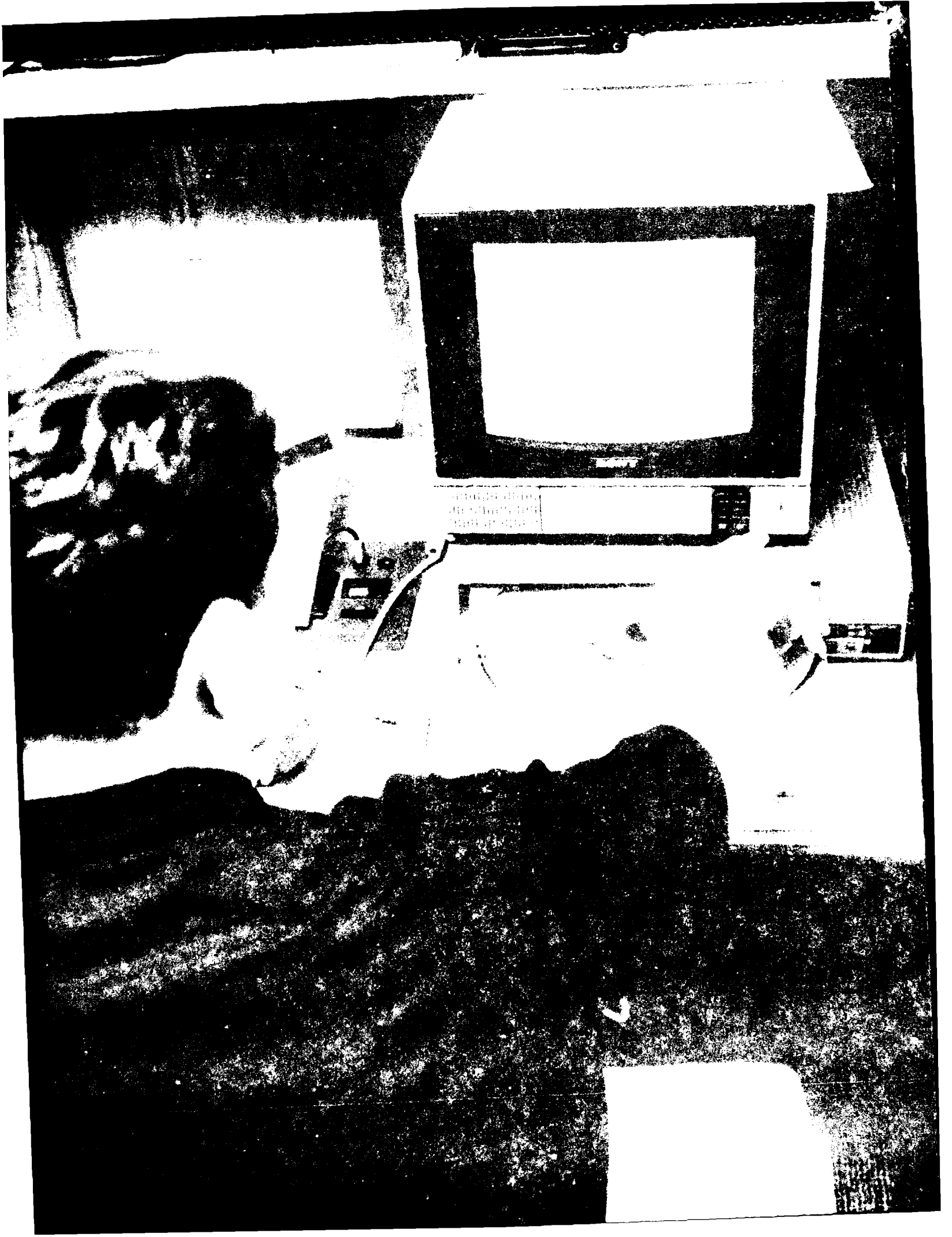
PRUNER, Ludmila A., Associate Professor, "Workshop on the Use of the Interactive Video," 1991 U.S.Navy/Army/Air Force Reserve Russian Training Weekend, Washington Area Group, U.S. Naval Academy, Annapolis, Maryland, 16-17 March 1991.

RODDY, Stephen J., Assistant Professor, "Topicality in Qing Fiction Criticism," Annual Meeting of the Association for Asian Studies, New Orleans, Louisiana, 12 April 1991.

VOROS, Sharon D., Associate Professor, "Integrating Authentic Video into the Foreign Language Curriculum," Annual Meeting of the American Association of Teachers of Spanish and Portuguese, Miami Beach, Florida, 13 August 1990.

VOROS, Sharon D., Associate Professor, "Authentic Video and Interactive Computer Lessons," Mountain Interstate Foreign Language Conference, Radford University, Radford, Virginia, 12 October 1990.

VOROS, Sharon D., Associate Professor, "Flora in Calderón's *De un castigo, tres venganzas*: A Sociosemiotic Approach to Performance," Eleventh Annual International Golden Age Spanish Drama Symposium, University of Texas at El Paso, El Paso, Texas, 13 March 1991.



DEPARTMENT OF

Political Science

Professor Charles L. Cochran
Chair

The 1990-1991 academic year was one of the most productive years ever in terms of research and publication within the Department of Political Science. The department received more competitively awarded grants based upon research design, relevance, and the likelihood of successfully completing the proposed research project than in any other year. One book, seven chapters in books, and one reference document were published, with several more faculty projects accepted for publication in the forthcoming year.

Professor Pope Atkins was invited to the Lyndon Baines Johnson School of Public Policy, where he held the Professor Tom Slick Chair. Professor Arthur Rachwald was a National Exchange Professor at American University; he also made some videotapes for AID and traveled to Poland to lecture on grass roots political involvement in that country. Assistant Professor Stephen Wrage received a Pew Fellowship.

Professors John Fitzgerald, Arthur Rachwald, and Associate Professors Robert Bender and Gale Mattox received Navy Meritorious Civilian Awards for their administrative, research, and general contributions to the department and to the Naval Academy. Associate Professor Helen Purkitt was promoted to full professor in recognition of her scholarly contributions. Particularly satisfying is the fact that three new faculty members were hired last year, and all of them have produced high quality research in their first year and have been active in attending conferences and presenting papers.

The department instituted the required FP130 course and has developed a variety of course materials pertaining to ethics and other topics for the course. Assistant Professor Eloise Malone has been very effective as the course coordinator.

Overall faculty members were funded in a variety of research and projects and presented over 30 papers.

There were twenty-one midshipmen research projects supervised by department faculty in FP490 and Honors projects. There was also one Trident Scholar in the Political Science Department this past academic year. Midshipmen majoring in Political Science participated in the planning and carrying out of the Naval Academy Foreign Affairs Conference and attended conferences at various colleges including the Air Force Academy and West Point.

Sponsored Research

The Constitution and Military Justice

Researcher: Professor John A. Fitzgerald
Sponsor: Naval Academy Research Council (OMN)

The problem explored was the judicial philosophy of the United States Supreme Court in the review of military decisions appealed to it. The Court's posture toward the military is highly deferential today. This trend has become more marked as the Court has become more conservative in philosophy and may be explained by one of two theories. First, the Court is simply recognizing the special needs of the military for discipline and is merely deferring to the expertise of the institution in defining those needs. This, arguably, is consistent with the doctrine of justiciability which calls for non-intrusion into areas committed to the coequal branches of government, in this case the Executive. Second, the Court is reflecting a pro-state conservatism that places the organizational needs of governmental institutions before those of the individual and to this end is willing to sacrifice some modicum of due process and First Amendment freedoms. The researcher's analysis of these decisions is that the latter explanation is the most likely.

The Congressional Game

Researcher: Professor Stephen E. Frantzich
Sponsor: Naval Academy Research Council (OMN)

A number of different perspectives can be used to analyze the U.S. Congress. The game analogy invites the observer to focus attention on the players, rules, strategies, and the winners and losers. This research involves developing a game-based approach to organizing the literature on Congress. It will serve as the outline for a book on the Congress which has been accepted for publication by W. S. Brown publishers. The initial conceptual chapter has been completed, and work is progressing on the substantive chapters.

The Impact of Television on the House and Senate

Researcher: Professor Stephen E. Frantzich
Sponsor: Naval Academy Research Council (OMN)

The arrival of gavel-to-gavel coverage of the House and Senate spawned considerable speculation as to the potential impact on the operations and output of these institutions. This project involved identifying those impacts subject to empirical testing and carrying out the appropriate tests. The researcher concluded that some specific activities such as the length of Congressional sessions and the number of speeches have increased since the coverage began. It is also clear that the availability of video coverage of Congress has affected the press coverage of Congress, and particularly the coverage of Congressional leaders. The results of this research served as the basis for a paper presented at the American Political Science Association.

POLITECH

Researcher: Professor Stephen E. Frantzich
Sponsor: Naval Academy Research Council (OMN)

POLITECH is an interactive database including over 2000 assertions and citations dealing with the impact of technology on politics and government. The database was expanded this year and served as the basis for a paper at the American Political Science Association Meeting and for a presentation to the Netherlands Institute for Advanced Social Science Research (NIAS). The database was accessed by a number of domestic and foreign scholars to support their research, as it served to chart the progress of research in a number of related realms.

The Malayan Emergency--Politicide or Repression?

Researcher: Associate Professor Barbara Harff
Sponsor: Naval Academy Research Council (OMN)

The Malayan Emergency (1948-1956), originally classified as a repressive hegemonial genocide in the investigator's list of 44 cases of genocides and politicides since World War II, turned out to be a repressive strategy designed to fight a Communist insurgency. Initial British policies led to deportations, forced relocation, and detainment. The most controversial policy of forced relocation, initially repressive, led to the establishment of what later became flourishing villages. Designed to cut the life-line of guerilla support, the policy proved to be effective. British strategy was designed to quell the insurgency, but not to kill large numbers of civilians or combatants beyond what was absolutely necessary.

Two Senators and the Quest for the Public Good

Researcher: Professor Karl A. Lamb
Sponsor: Naval Academy Research Council (OMN)

This research asks how the role of the U.S. Senate in the twenty-first century will differ from the role assigned to it in the eighteenth century. The answer is sought by examining the careers and daily lives of two senior senators--Paul Sarbanes (D--Maryland) and Richard Lugar (R--Indiana)--who personify partisan and ideological disagreement within the Senate mainstream. Both serve on the Foreign Relations Committee. While the policy positions taken by Lugar and Sarbanes often represent alternatives between which the nation must choose, the quest for advantage by their separate parties prevents a definitive choice, with policy stalemate the result. In designing the separation of powers, the Founding Fathers sought to prevent tyranny, rather than promote efficiency. But they did not anticipate policy paralysis.

The purpose of the research is to provide a thorough understanding of the Senate, including both its limitationss and its possibilities, by examining the activities of these two senators during the presidencies of Carter, Reagan, and Bush. Recounting their fifteen years in the Senate will lead to a definition of the current relationship between Congress and President Bush. A monograph-length report is indicated.

The Implications of German Unification to East and West Europe

Researcher: Associate Professor Gale A. Mattox
Sponsor: Naval Academy Research Council (OMN)

This project is an attempt to review the events that led to German unification in 1989-1990 and to determine the impact on Western Europe. (Professor Rachwald is undertaking the research on East Europe with collaboration on conclusions, etc.) On the basis of archival and current periodical research, as well as interviews with policy makers, the objective will be to determine the implications of unification on future European and U.S. security. Preliminary results were presented to the International Studies Association on "European Security Arrangements for the Future." Those findings indicate the clear need for a stronger European pillar.

Evaluation of USNA's Language Department's Interactive Audio Video Project

Researcher: Associate Professor Helen E. Purkitt
Sponsor: National Security Agency

This is the final year of a long-term field experiment designed to test the effectiveness of interactive audio video lessons to increase listening comprehension in Spanish at the United States Naval Academy. An interim analysis of four years of data suggested the need for certain changes to ensure further integration of listening comprehension practiced outside of class with in-class activities. The final data analysis is currently being completed. A final report summarizing the results from this longitudinal study of the relative effectiveness of Interactive Audio Video (IAV), when compared to more traditional techniques for mastering listening comprehension skills in a second language, will be circulated before the end of 1991.

The Search of Poland

Researcher: Professor Arthur R. Rachwald
Sponsor: Naval Academy Research Council (OMN)

An international event, the appearance in Poland of Solidarity--the first independent and self-governing labor union in the Soviet bloc--met strong reactions in the East and West. Moscow perceived Solidarity as the most destabilizing challenge to its imperial order in Eastern Europe since Titosim in 1948. This book details the extraordinary events that led to the June 1989, semi-free elections, which placed the government of Poland in the hands of a Solidarity-led coalition, and culminated in the self-dissolution of the Polish Communist party.

The author documents and examines the pressures applied by the Kremlin to Solidarity and the Polish government through ideological and political harassment, economic sanctions, and thinly-veiled threats of armed intervention. This important study examines the sequence, intensity, and temporary effectiveness of Soviet opposition to the Solidarity-led social and political movement in Poland. The analysis of the lengthy and involved encounters and confrontations between the governing authorities and the labor union after the imposition of martial law on 13 December 1981 demonstrates the Soviet failure to crush or contain the political aspirations of the Polish people.

Using documents and reports in Polish, Russian, and English, this study compares U.S., Soviet, and Polish authorities' reactions to events in Poland during the 1980's as well as analyzes U.S.-Polish relations and their effect on the Polish government's domestic and foreign policies. The author gives careful attention to the complex relations among the political players, particularly the communist authorities and the Roman Catholic church. The project explores one of the most critical political developments of our time in discussing the pivotal position, politically and geographically, that Poland occupies in Eastern Europe.

Polish Transition from Communism

Researcher: Professor Arthur R. Rachwald
Sponsor: Naval Academy Research Council (OMN)

The country profile includes a comprehensive analysis of emerging democratic institution in Poland, including the first totally free elections to local governments and presidential elections at the end of 1990. Discussion of social problems focused on economic stratification of society, consequences of unemployment and other economic dislocations, as well as on the enormous power of the Roman Catholic church. Finally, examination of the Polish economy was designed to identify basic elements of the so-called Balcerowicz plan of transition from a socialist to a market economy: anti-inflationary measures, privatization, convertability and de-monopolization of heavy industry.

In this area of foreign affairs, this study focused on new patterns in Polish-German and Polish-Soviet relations. Such new developments as the November 1990 Polish-German treaty, and the emerging bilateral relations between Poland and Western republics of the Soviet Union, especially, Lithuania and Ukrania, were discussed in detail to show new trends in regional politics.

The Soviet Perception of German Unity

Researcher: Professor Arthur R. Rachwald
Sponsor: Naval Academy Research Council (OMN)

The revolutionary explosion that was symbolized by the fall of the Honecker regime and his Berlin wall, accelerated the peaceful revolution in Central-Eastern Europe and the Soviet Union. In the absence of communism, new political forces began to play major roles in European polities. Two most consequential of them were the desire of the German people to unify as soon as possible and a pan-European process of rapprochement in the spirit of the Helsinki accord. Soviet approach to these developments can be outlined in three points: First, unable to stop or delay peacefully the process of unification, the Soviets adopted an "if you can't beat 'em join 'em" policy and incorporated German unity among the ideas of the "new political thinking," namely Gorbachev's policy conceived to overcome the East-West confrontation and to reduce tensions in Europe. Second, the Soviet leadership reevaluated its attitude toward the security arrangement in Europe, concluding that the policy based on the premise of "German menace" and the ideological enemy was both antiquated and counterproductive. The time has come for Moscow to accept the idea of a collective security in Europe, an expectation that the CSCE will gradually evolve into an effective collective security system. Third, the Soviets concluded that the Cold War and the division of Germany was a historical plot framed by the United States to deplete the military and economic potential of the USSR. The Bipolar structure of the regional system in Europe and on the global level imposed excessive responsibilities, accelerated exhaustion of the Soviet state, and ensured a concurrent collapse of Moscow as a regional and global power. (Associate Professor Gale Mattox wrote the second half of the paper advancing the Western reaction to German unity.)

Monitoring WEIS Events Data in Three Dimensions

Researcher: Professor Rodney G. Tomlinson
Sponsor: Naval Academy Research Council (OMN)

In 1972 the WEIS project developed metric scales for the twenty-two combined event categories of international behavior. In 1977 a final set of values was determined using professional diplomats for judges. Additionally, exponential smoothing looked very promising as the basic computational model for event monitoring. The techniques are re-introduced and their use illustrated using behavior pairs for the USA-USSR, USA-United Kingdom, and USSR-Czechoslovakia. The two-dimensional composite 'constructive - deconstructive' scale is introduced. The gaps between the actors' plot lines appear related concepts of reciprocity. The notion of 'response-demand' is suggested. A three-dimensional behavior model is shown using moral and power as underlying concepts, with time as the third axis. The moral and power constructs are shown to be inversely related. Stable relationships appear to have events GRANT, REWARD, PROPOSE, and AGREE regularly mingled among more assertive event types. Additional directions for research are proposed, and the work of two scholars pursuing related objectives is cited, and the connections noted.

The Structure of International Events - Testing a Theoretic Model of World Political Behavior

Researcher: Professor Rodney G. Tomlinson
Sponsor: Naval Academy Research Council (OMN)

Rules and norms circumscribe international political behavior. The vast majority of national leaders conform to customs of diplomatic practice. They tend to ascribe to similar perceptual constructs as to the meaning and impact of certain actions. This case study and analysis effort identified patterns of conduct indicative of stable, problem solving relationships and found evidence to characterize non-problem solving behavior. The presence or absence of the patterns provides clues to the general outcome of a situational issue. These findings independently corroborate work of other scholars, thereby lending credence to some general theories of conflict. The results of this research were presented in a paper at the International Studies Association annual meeting in March 1991.

Charting the Course of the VOYENNO-MORSKOY FLOT: Soviet Naval Strategy Towards the Year 2000

Researcher: Midshipman 1/C Stephen F. Murphy, USN
Adviser: Professor Arthur R. Rachwald
Sponsor: Trident Scholar Program

This purpose of study is to examine the implications of changes in Soviet military doctrine for the strategic employment of the Soviet Navy towards the year 2000. President Gorbachev's Perestroika reform program has brought fundamental changes to official Soviet military doctrine, namely the requirements for "reasonable sufficiency" and a "defensive doctrine." The former requirement calls for a reduction in the size of the armed forces, while the latter is intended to alter their character. Soviet naval expansion of the 1970's and early 1980's has been checked by the implementation of new doctrinal requirements. However, the degree to which the course of the Soviet Navy will change in the 1990's is unclear.

A system approach is employed to analyze the domestic and international factors that have affected the Soviet Navy thus far, and that will determine its strategy in the future. Economic stagnation, political polarization, and national unrest account for a new perception of Soviet national security. Under the banner of New Political Thinking, the Gorbachev leadership has sought a stable international environment through diplomacy unaccompanied by the aggressive naval presence of the Brezhnev era. So far, the Soviet Navy has managed to avoid major reductions in its budget that would degrade its war fighting potential. This

has been done through the scrapping of obsolete vessels and a sharp reduction in out-of-area deployments. Current trends indicate that the Soviet Navy of the year 2000 will be a smaller, but more potent force because of expected technological improvements.

This study compares the legacy of Admiral Gorshkov, Commander-in-Chief (CINC) of the Soviet Navy from 1956 to 1985, to the strategic views of Admiral Chernavin, the current CINC. Soviet naval strategy in the 1990's will be influenced by Chernavin's greater emphasis on combat readiness and the integration of the Navy's missions with those of other services. Despite historic improvements in U.S.-Soviet relations, the Soviet perception of the U.S. naval threat has intensified in the absence of naval arms control agreements and focuses on the strike potential of sea-launched cruise missiles and aircraft carriers. The construction of large-deck aircraft carriers is addressed as a crucial factor in judging the direction of Soviet naval strategy.

This analysis culminates in a projection of the vital and alternative missions of the Soviet Navy towards the year 2000 and an evaluation of each mission according to the relative emphasis that the Soviets place on both offensive and defensive options. The central conclusion of this study is that it is structurally inconceivable that the Soviet Navy will transition to an exclusively defensive strategy under new doctrinal requirements.

Independent Research

The Design and Redesign of the Rule of Exclusion: Search and Seizure Law in the United States and Canada

Researcher: Assistant Professor Priscilla H. Machado

Balancing the rights of the accused with the government's concern for security and the rights of the whole is a timeless challenge which all democratic societies face. Using Herbert Packer's models of the criminal justice process, this project compares the changes in search and seizure law which have occurred in the United States and Canada. The issue of what to do with evidence tainted by an illegal search and seizure clearly illustrates the tradeoffs countries are willing to make concerning citizen-police encounters. The alterations noted comprise more than a shift in policy; they reveal changes in the basic premises of the respective criminal justice systems. This research is currently being reviewed for publication by the *Canadian Journal of Law and Society*.

Reaction to the Naval Academy Experience: 1989 Follow-up of 1985 Plebes

Researcher: Assistant Professor Eloise F. Malone

Plebes who entered the Naval Academy in the summer of 1985 (class of 1989) participated in a project of the Cooperative Institutional Research Program's (CIRP) continuing longitudinal study of American higher education, sponsored by the American Council on Education (ACE) and the Graduate School of Education at the University of California, Los Angeles. This project generates significant data from various institutions of higher learning around the country. Results from the survey instrument administered to Plebes, the Student Information Form, provide initial information for longitudinal research. Follow-up surveys of individual students from the entering cohort in 1985 were conducted in 1989.

The normative data are reported separately for men and women, and for various groupings of institutions. The major institutional characteristics are race (predominantly black versus predominantly white), control (public, private-nonsectarian, Catholic and Protestant), and the "selectivity level" of the institution. This permits an analysis of the data regarding how entering Plebes compare in achievement and attitudinal characteristics with students from other institutions.

In 1989 a follow-up questionnaire was mailed to those students matriculating in 1985. The follow-up survey permits an analysis of how students react to their educational experience at the Naval Academy, and how they react and relate to the Academy experience when compared to students at other four-year institutions.

Models, Ethics, and Budgeting on Local Level in the United States

Researcher: Professor Arthur R. Rachwald

This paper on "Models, Ethics, and Budgeting on Local Level in U.S." was prepared for delivery at five Polish cities during June of 1990. The essay is a general overview of three basic models adopted by local governments in the United States; namely, city council-city administrator, city council-major, and the commissary council arrangement preferred by small administrative units. The ethical standards followed by local governments in United States were discussed using the case study approach. Fiscal policies of local governments include examination of revenue sources as various taxes (sales tax, property tax, income tax, and special taxes), grants, bonds, loans, and revenue of expenditures. Strong emphasis was placed on practical matters such as budget development and its execution.

Research Course Projects

American Education Policy and the Development of Students: An Important Relationship for the Next Decade

Researcher: Midshipman 2/C Jonathan W. Barney, USN
Adviser: Assistant Professor Eloise F. Malone

The researcher looked at the likelihood of achieving the Bush administration goals for improving the American educational system. The researcher presented an historical overview and then based his analysis on a comparative study of the United States, German, and Japanese educational systems. Work involved extensive library research, along with analysis of empirical data.

The Search for a Malaysian Identity

Researcher: Midshipman 2/C Erik P. Bethel, USN
Adviser: Professor Robert L. Rau

Malaysia suffers from an identity crisis that hinders the country's socio-economic and political stability. In order for Malaysia to progress into the twenty-first century and become a viable economic contender in the global market, she must resolve the ethnic and racial barriers that hold back progress among the fourteen million Malays, Chinese, and Indians in the country.

The researcher analyses the cultural and historical influences of each of these groups within Malaysian society, as well as their present political and economic leverage.

Something must be done soon to meld the ethnic groups into a homogeneous identity. Although many projects have been undertaken to further these goals, none has been particularly successful. Without an identity, Malaysia will continue on its present, unsteady course and will never reach its full potential as a politically stable economic power.

East Europe and the Baltic Republics: Historical Parallels and Future Prospects

Researcher: Midshipman 2/C Laura L. Christman, USN
Adviser: Commander Gregory D. Young, USN

Based on the hypothesis that recent events in the Baltic Republics of the Soviet Union closely parallel the events in Eastern Europe over the last 45 years, the researcher studied the likely prospects for the future of the Baltic Republics. Much of what has occurred in the Baltic Republics since the collapse of communism was inspired by that collapse, and many of the protests and public initiatives bear a striking resemblance to similar happenings in Eastern Europe during the Cold War. Because these events are so similar in many respects, and because many of the Soviet's security interests remain the same as they have always been, the researcher came to the conclusion that the Baltics must also undergo a period of repression and domination before they are allowed to go on their own course.

Using the method of comparative case study, the researcher examined the historical aspects of the collapse of communism in Eastern Europe in order to draw parallels between the nations of Eastern Europe and the Baltic Republics. An analysis of past events is necessary to understand the pattern of Soviet foreign policy and how this pattern of behavior now applies to the Baltics.

The Culture of American Political Parties

Researcher: Midshipman 1/C Dominic P. Delpozzo, USN
Adviser: Professor Stephen E. Frantzich

Political parties serve as key mediating groups in American society, playing an important role in recruiting candidates and supporting the electoral process. The parties differ not only in terms of ideology, but also in terms of their internal culture and organization. The Democratic party views itself as a coalition of constituent groups and avoids hierarchical structure as much as possible. The Republican party views itself more as a corporation which harnesses the efficiencies of hierarchical control. These conflicting cultures not only lead to different organizational structures and decision-making procedures, but also grant differing advantages and disadvantages in the electoral process. The Democratic culture is better designed for success in constituency-related elections such as those for Congress, while the Republican party has an inherent advantage when it comes to contests for the presidency.

Seeking Legitimacy: Taiwan Shifts to a Regional Focus

Researcher: Midshipman 2/C Peter D. Eisenhauer, USN
Adviser: Professor Rodney G. Tomlinson

The problem of legitimacy of the government of the Republic of China (ROC) on Taiwan is no longer an issue to be decided in the People's Republic of China (PRC) - United States - Soviet Union continuum. The Kuomintang has shifted its policies and efforts accordingly, while maintaining the old anti-PRC rhetoric for internal political and propaganda reasons. Thus a new model has to be developed for behavior in this new regional balance. It appears that the regional powers have decided to recognize a de facto independent Taiwan. They seem to be following a two-China policy without saying so. The ROC government has moved to accommodate this reality and gain further acceptance without confronting these nations with choices of "them or us." The spectacular growth of the Taiwan economy makes the island a regional economic power. Prudent policies by the KMT should lead to official recognition. Economic and human rights problems in mainland China benefit the Taiwan cause. It appears that no government is prepared to champion re-unification with China after the bloody smashing of the students in Tiannamen Square.

Domestic Terrorism: Recent Trends and Future Prospects

Researcher: Midshipman 1/C Maureen Fox, USN
Adviser: Captain Steven M. Zotti, USMC

The researcher analyzed the disparity between domestic and international terrorism as a reflection of successful anti-terrorism policies. The researcher analyzed several factors, including the location of terrorist infra-structures, geographic isolation of the continental United States, and the global scope of American interests. Americans can be found all over the world, and the American media are very sensitive to terrorist acts involving Americans anywhere. Consequently, the motivation to attack within the United States has been subdued.

The researcher postulated that the American public should not be lulled into thinking that the United States is immune to violence by political extremists within its own borders. Rather, recent developments indicate probable increases in domestic terrorism.

The researcher examined recent trends and future prospects of domestic terrorism within the context of current political events. The study included extensive research into the motivations of international terrorists, the history of domestic terrorism by foreign agencies, the effectiveness of anti-terrorism policies, and the effect of specific international events on terrorist's activities.

A Decision-Making Analysis of the Deployment of U.S. Troops in Saudi Arabia

Researcher: Midshipman 2/C Shaun C. Francis, USN
Adviser: Associate Professor Barbara Harff

When implementing foreign policy action, the President alone has the ability to commit the resources of the government. The decision participants of the researcher's model act as both the internal and external forces that influence his final decision. Each participant has a certain degree of influence on the other, however, it is their combined influence on the President at the center of the model that is the main concern. The model has three conditions: (1) determining those decision participants that can be analyzed through the President's perspective; (2) determining what the President's perception of that participant would be; and (3) determining the extent to which that participant influences the President's final decision. The basic premise is that the President is the supreme decision maker and that his final decision is influenced by his perceptions of the other participants who have already been identified.

Congressional Oversight of Covert Operations

Researcher: Midshipman 1/C Michael J. Hannan, USN
Adviser: Assistant Professor Stephen D. Wrage

As the result of various abuses, Senator Church ordered an investigation in 1974 into the operations branch of the Central Intelligence Agency (CIA). In order to create a system of legislative oversight with regard to covert operations, both the Senate and the House established permanent committees tasked to monitor intelligence activities (the House Permanent Committee on Intelligence and the Senate Select Committee on Intelligence). The record since 1974, especially the exposure of the Iran/Contra Affair, shows that this method for oversight does not work well. The Executive circumvents the rules by failing to notify Congress and by hiding behind plausible deniability for the President. The Congress neglects to maintain a charted course with intelligence issues and fails to eliminate the causes of information leaks.

The Intifada as a Model of Revolution

Researcher: Midshipman 1/C Peter K. Malecha, USN
Adviser: Associate Professor Barbara Harff

The intifada is an ongoing revolution in which the Palestinian people are attempting radically to alter the situation in which they live. As a revolution, it provides a case study on which various bodies of theory can be tested to determine their validity and applicability.

The Gurr model does in fact provide a useful and realistic predictive framework concerning both the outbreak of revolution and the events which create the climate in which a revolution can develop. In conclusion, it is obvious that the body of literature which deals with revolutions will have an additional, verified, and applicable member.

Population Growth in Mexico: Implications for U.S. Security

Researcher: Midshipman 2/C Martin L. McMahon, USN
Adviser: Associate Professor Helen E. Purkitt

When Mexico's former President Luis Echeverria Alvarez took the first steps toward initiating a government-run family planning program in 1972, it marked the end of an era. In Mexico, the new government policies were a complete reversal for the predominately Catholic country in which the traditional attitudes of "machismo" and fertility prevailed over the use of contraceptives. Why, after more than fifty years of encouraging population growth, did the Mexican government alter its position? An analysis of the effects of Mexico's growing population on the standard of living and prospects for future stability within Mexico helps answer the question.

This paper discusses the demographic problem in Mexico and the efforts that both countries have undertaken to improve the situation through family planning and implementation of the Free Trade Agreement (FTA). In addition, the paper examines the severe implications of Mexico's rapid population growth for the United States and Mexico. At stake is Mexico's continued stability and the threat that a potential Mexican revolution could pose to U.S. national security through immigration and possible hostility.

In this study, the researcher addressed the factors contributing to the problem and attempted to demonstrate that the crisis developing in Mexico must be resolved if the United States and Mexico are to continue pursuing their relatively beneficial and non-belligerent relationship.

The Anti-Terrorism Policy of the United States

Researcher: Midshipman 2/C Donovan A. Martinez, USN
Adviser: Captain Steven M. Zotti, USMC

The researcher's topic was an examination of the specific approaches that France, Israel, and the United States use to deal with terrorism. Also included are recommendations that the United States take in order to improve its preparedness to deal with the problem of terrorism.

Israel is currently viewed as following a "no negotiations" policy in response to terrorism and is not hesitant to use force when it can be applied to a situation. This policy is then examined as to why it would or would not be an effective policy for the United States to follow.

France is characteristically viewed as being mild in its approach to terrorism. It is extremely reluctant to deal with other nations when terrorism is the subject, and extradition from France is all but impossible. This policy hampers international efforts to combat terrorism which are needed to counter the problem effectively. France does, however, have a very effective domestic policy regarding the handling of terrorists. A recent advancement in the area of justice is France's use of special "Terror Judges" to investigate and prosecute persons accused of crimes of terrorism. Certain aspects of each policy are reviewed and their applicability in the United States is discussed.

When examining the current policy the United States follows, one can see that there really is none. The researcher examines four distinct phases of different approaches to terrorism that the United States has employed since the late 1960's, and considers the current status of U.S. policy and the present structure used to investigate, prevent, and prosecute terrorism.

Finally, the paper covers some specific recommendations that the United States could follow to improve its ability to prevent or respond to a terrorist threat. Some areas discussed are: a shift to a more uniform domestic chain in the investigation of terrorism, continuation and/or implementation of policies to foster international cooperation, and the roles of the legislative and executive branches of government.

American National Security and Soviet Political Transformation in the 1990's

Researcher: Midshipman 2/C Sean G. Owens, USN
Adviser: Associate Professor Gale A. Mattox

In 1985, the Bi-Polar world balance of power began to change after a 40-year virtual stalemate. As Soviet President Mikhail Gorbachev ascended to power, he instituted a number of policies that would forever alter the composition of the world order. It appears that he had concluded that, while the Soviet Union possessed one of the two most awesome military complexes, the "real power" of his country had dropped to an alarming level. Glasnost and Perestroika were the results. The effect on Eastern Europe was a "loosening of the reigns" of power that the Soviets held for decades. This culminated in the unification of Germany and the democratization of the other members of the Warsaw Pact.

The implications of these changes on the United States and the West are still quite uncertain and the future of East-West relations, given the changes in the East Block, is yet unclear. The character of Soviet-American relations and security arrangements will inevitably undergo change in the next decade. The researcher believes that it is in the United States' interest that many of the previously established security arrangements, although evolving with time, remain in place. The researcher examined the content and rationale for current Soviet political movements, possible Soviet security options, and potential American responses to the recent and ongoing upheavals in the East.

The Proliferation of Weapons to the Third World: The Creation of Instability

Researcher: Midshipman Mark T. Palmer, USN
Adviser: Associate Professor Gale A. Mattox

Over the years major powers have sold arms to many Third World nations in an attempt to support national interests. This proliferation of arms has increased to drastic levels. At first, small conventional arms were supplied in a controlled manner. However, the transfer of arms now runs rampant and is extremely hard to limit. Arms sales no longer just involve small scale weapons but also include mass destruction conventional weapons, chemical and biological weapons (CBW's), and technology for nuclear weapons. The potential for prolonged and large scale conflicts involving multiple nations increases with the proliferation of arms to the Third World.

The proliferation of weapons to the Third World produces both regional and global instability. The author examines the problems related to the proliferation of arms, with an emphasis on CBW's. The history of proliferation, why the Third World wants mass destruction weapons, why major powers sold these arms, and how proliferation affects the major powers are discussed. Past negotiations and current agreements are analyzed in an attempt to formulate an effective policy for the United States to follow.

In general, the proliferation of mass destruction weapons must be stopped in order to increase both regional and global stability. The United States needs to work with the major powers and enter negotiations to stop the transfer of these arms. Allowing rival Third World nations to join in the talks is absolutely necessary to achieve lasting regional stability. The U.S. should also continue to monitor itself to ensure it is not contributing to the proliferation problem. The more nations involved in the Non-proliferation Talks, the more it will help ensure both regional and global stability. The United States and other major nations need to follow these ideas to create a more stable world.

Contracting Out: The Effects on Military Capabilities

Researcher: Midshipman 1/C Mark T. Palmer, USN
Adviser: Professor Charles L. Cochran

The implementation of privatizing government functions has been around since the middle of this century. The basic reasoning behind "contracting out" is to decrease government waste, increase efficiency, and boost the role of the private sector. Currently, the government contracts out some of its goods and services to the private sector. The author analyzes both the advantages and disadvantages of privatization, the criteria for "contracting out," and the history of privatization.

Costs play an important role in the contracting process. However, when dealing with national defense, it is equally important to examine the capabilities provided. There is no benefit in having a cheaper defense that can not adequately perform its mission. Two case studies were used to examine the effects of "contracting out" on military capabilities. Military Sealift Command, and Air Force trainer aviation maintenance (Columbus Air Force Base) were examined.

"Contracting out" had different effects on both case studies. Capabilities were not affected for Maritime Sealift Command (MSC) contracts. In fact, contracting out decreased costs and increased military performance. "Contracting out" had negative effects on Columbus Air Force Base. Costs decreased slightly, yet military capabilities decreased drastically. The problems with Columbus Air Force Base were due to poorly-written contracts and improper implementation of the contracts. Recommendations are given to improve contracts for both MSC and A.F. trainer aircraft maintenance.

Combat and Crisis Resolution: The Relationship Between Presidential Military Background and the Conduct of Foreign and Domestic Policies

Researcher: Midshipman 1/C Paul B. Quimby, USN
Adviser: Professor Stephen E. Frantzich

The study tested the correlation that exists between a President's military background and his performance in crisis management. Specifically, it is hypothesized that Presidents who have been in combat are less likely to utilize the armed forces to resolve crises.

The measure of association between the variables of presidential background and applications of force in crises was determined for the Presidency as a whole and for chronologically divided groups of Presidents. This measure was analyzed to discover the strength and direction of the relationship. Other elements that influence presidential decision-making--public and Congressional support, national security risks, economic well-being, and the international situation--were discussed to focus on the fact that the presidential decision-making process is not limited in structure or scope by one aspect of a President's background.

The results of this study demonstrate that there is a very weak relationship between presidential military background and presidential propensity to use the armed forces in crisis resolution. From this, one is also able to conclude that Presidents who have seen combat are as willing to deploy the military as Presidents without combat experience.

How Can the United States Defeat Japan in an Undeclared Trade War?

Researcher: Midshipman 1/C Sean A. Rach, USN
Adviser: Professor Robert L. Rau

Presently, the United States finds itself at a critical period of development as a world power. In the post-Cold War/post-Persian Gulf War era, America must set various long term goals to determine the future of the country and the resultant effects on the global economy. At all costs, the United States must retain its economic and political independence.

The United States-Japan relationship has recently come under stress with many issues such as unfair competition and trade, racism, and the use or misuse of technology surfacing as areas of growing concern.

Japan has emerged from the destruction of World War II to challenge all other countries, economically. The United States must respond to this challenge with firm and controlled action. Whether by trade negotiations or by direct trade retaliation, the United States must protect its investments abroad and remain an economic leader in the world.

This paper studied this important political/economic relationship by reviewing the relevant history of the relationship, the foundations of the present conflict, and the issues involved on both sides. This paper recommended several steps to be taken by the United States in order to emerge victorious over Japan in an undeclared trade war.

Independent Latvia. Can It Last?

Researcher: Midshipman 2/C Karl W. Riebs, USN
Adviser: Professor Arthur R. Rachwald

This examination of the Latvian road to independence involved critical discussion of relations between Moscow and Riga, and assessment of Latvia's prospects for sovereignty and economic prosperity without Soviet assistance. This study concluded that Latvia has a very good chance to survive as a fully independent state. Its human resources and easy access to Western markets, especially in Scandinavia and Germany, provide a solid guarantee for economic, and consequently, political success. In addition, the Soviet Union would always be interested in Latvia's computer technology and willing to trade its natural resources for the Latvian high-tech.

Modeling of Gorbachev's Choice: Will the USSR Survive Perestroika?

Researcher: Midshipman 1/C Daniel R. Wagner, USN
Adviser: Professor Arthur R. Rachwald

This model measures neutral interdependence between economic and political changes in the USSR.

The Soviet economic system cannot be reformed unless a certain degree of power is devolved from the center to the republics. However, too much authority granted to the periphery can result in the disintegration of the union, if these republics use their power and authority to declare themselves independent and separate from the center.

In this analysis, the researcher constructed a model to evaluate Gorbachev's options in this difficult situation. This model highlights both the economic and political aspects of "Gorbachev's Choice." This model was applied to the current realities of the Soviet situation toward the end of 1990 and in the first few months of 1991. Will Gorbachev choose to implement free-market reforms within his collapsing economy within a democratic political framework? Or, will

Gorbachev initiate the option of maintaining his hold upon the republics and maintain the present command economy within a more centralized, neo-Stalinist political framework? If Gorbachev fails to devote his country to either course of action, can it mean the ultimate failure of the entire economic and political system? This analysis evaluates these various options. Finally, only the test of time will dictate the true consequences of "Gorbachev's Choice."

The Economic Underpinnings of Instability in the USSR

Researcher: Midshipman 1/C Daniel R. Wagner, USN
Adviser: Professor Arthur R. Rachwald

This analysis involved the research and evaluation of various sources of instability within contemporary Soviet politics. Since early 1990, President Gorbachev has fluctuated in this commitment toward a specific course of reforms within the Soviet Union. As the events of the past year (from early 1990 to April of 1991) indicate, President Gorbachev has been unable to support the policies advocated by either the liberal, democratic left, or the conservative, hard-line right wing. His indecision has proven disastrous for both the political and economic institutions within his country.

Utilizing the techniques of deductive and intuitive analysis, the researcher evaluated Gorbachev's actions and initiatives as President of the Soviet Union. Sources of instability in both the political and economic sectors of the country were also defined. Such events as the rejection of the Shatalin Plan in November 1990, the violent repression of democracy in the Baltics in January of 1991, and the recent workers' strikes throughout key industrial regions are representative of such sources of instability.

This analysis sought a method or model to evaluate Gorbachev's chances of success as he attempts perhaps the greatest political feat of any present political leader. This mission involves reversing the cancerous inertia which has devastated both the economic and political institutions of the Soviet Union for the past seven decades. Although this appears to be an impossible task, Gorbachev has demonstrated an ability to maintain power as President. However, how much longer can he afford to waiver between the liberal and conservative forces and deny his commitment to a specific political and economic agenda to stabilize his country?

Jordan: Analysis of Revolution Potential

Researcher: Midshipman 1/C John M. Wiese, USN
Adviser: Lieutenant Commander Donald S. Inbody, USN

The Hashemite Kingdom of Jordan rests precariously on the verge of revolution. Social, political, and economic developments within the past five years have pushed it continually closer to what seems to be a violent and unavoidable end. Using Ted R. Gurr's theoretical model of the revolution process as a framework, the author analyzed the probability of revolution occurring within Jordan. Included in the analysis was discussion of factors promoting stability. These included Hussein's political skill, the Hashemite legacy, a loyal military, and Hussein's charisma.

The Gurr model proved to be particularly applicable to Jordan. This was largely a result of the flexibility inherent in the Gurr model which allowed for adjustment to the very complex revolutionary scenario in Jordan.

From the Gurr model, the author concluded that while the situation in Jordan is desperate and likely to get worse due to a dismal economic forecast and increasing religious fundamentalist sentiment, revolution is unlikely to occur in the immediate future. King Hussein, through manipulations of the political system, including democratic concessions and appeals to majority demands, seems to have diffused revolution potential. Moreover, the military remains tightly under the King's control, which indicates that he will possess the coercive control necessary to suppress any uprising.

Revolutionary Unrest in Egypt

Researcher: Midshipman 1/C Waleed A. Yousif, USN
Adviser: Associate Professor Barbara Harff

Gurr's theoretical model of revolution was applied to Egypt. The model specifies conditions leading to revolution. Using several resources, such as scholarly journals, news sources, books, and United Nations statistics, the model was tested. In addition, conditions were specified in the international system which may contribute to internal instability. It was concluded that Egypt is unstable, but is not likely to experience another revolution for at least 20 years. It was especially difficult to determine which particular factors and in which combinations determine the timing of a revolution.

Publications

ATKINS, G. Pope, Professor, "General Patterns in International Relations Research," *Handbook of Political Science Research on Latin America*, ed. David W. Dent. New York: Greenwood Press, 1990, pp. 285-306.

The past three decades are an appropriate time period for identifying and appraising the trends in political science research on the international relations of Latin America. Thirty years ago the field was still largely restricted to a handful of academic pioneers in a few institutions in the United States, Europe, and Latin America; coverage of the varied components of international relations was relatively scarce and of uneven quality. The expansion of scholarly attention that began in the early 1960's has continued over the past three decades, so that today the volume and scope of the literature has expanded and is accompanied by more sophisticated methodological techniques. Diversity today characterizes the literature, reflecting the complexity and dynamism of Latin America's international relations, the variety of academic approaches, and the caliber of the scholarly work in the United States, Latin America, and Western Europe.

The appraisal in this chapter surveys some of the literature but does not include a detailed inventory--it has become too voluminous to mention even all of the most important works that have appeared, and only a representative sampling is cited. It first offers a broad assessment of the expansion of research in the field since 1960, followed by identification of major trends in the analysis of the foreign policies of the principal actors and of the international structures in which they operate. Some reference to specific instrumentalities, interactions, and issues is included in the larger contexts but not dealt with directly or extensively.

ATKINS, G. Pope, Professor, "The United States and the Caribbean Basin," *Regional Hegemons: Threat Perception and Strategic Response*, ed. David W. Myers. Boulder: Westview Press, 1991, pp. 31-62.

This chapter analyzes U.S. threat perceptions in the Caribbean Basin and the strategic responses to those threats as the United States sought to play the role of regional hegemon. While the region has continuously been the object of great power rivalry, pressure, intervention, and domination, throughout the twentieth century the U.S. presence has been one of the clearest cases of hegemony in the international political system. That hegemony, however, has not been total, constant, or simple, and has had numerous challenges to its assertion. The chapter explores the decisional and perceptual bases for U.S. policies over time; particular attention is paid to the Central American crisis in the decade dating from the Nicaraguan Revolution of 1979, and the subsequent attempt on the part of U.S. decision makers to reorient policies toward the Caribbean in terms of the post-Cold War world and a new set of nontraditional security issues. The aspirations and strategies of certain challengers, bargainers, and dependents are evaluated, including the degree to which they seem to have conformed or not to U.S. perceptions.

HARFF, Barbara, Associate Professor, "Humanitarian Intervention in Genocidal Situations," *Genocide: A Critical Bibliographic Review*, Vol. II, ed. Israel W. Charny. New York: Facts on File, 1991, pp. 146-153.

This chapter gives an overview of the literature on humanitarian intervention. It traces the doctrine of the just war to its modern application under international law. The principle of state sovereignty emerges as the preeminent stumbling block against the protection of individual rights.

HARFF, Barbara, Associate Professor, co-author, "Bibliography of Law and Genocide," *Genocide: A Critical Bibliographic Review*, Vol. II, ed. Israel W. Charny. New York: Facts on File, 1991, pp. 154-172.

This chapter is an annotated bibliography that lists 135 abstracts of books, chapters, and articles on humanitarian intervention. The author cited above is responsible for writing over 100 of these abstracts.

MATTOX, Gale A., Associate Professor, "The Bundeswehr and Arms Control," *The Bundeswehr and Western Security*, ed. Stephen F. Szabo. London: MacMillan Press, 1990, pp. 71-90.

The authors in the book look back at the development of the Bundeswehr in the Western Alliance and ahead to the implications of the changes for its Bundeswehr's future role in NATO. In the chapter the issue of arms control in the

Federal Republic as a political issue foremost (and only secondly as a military issue) is specifically addressed. After tracing the history of arms control and the German armed forces, arms control efforts in the area of conventional forces and intermediate-range nuclear forces are considered more closely. Initially submitted for publication in October 1989, the book has become more historical than relevant at present for united Germany.

MATTOX, Gale A., Associate Professor, "The United States Perspectives on the Growth of a European Pillar," *European Defense Co-Operation: America, Britain, and NATO*, ed. Michael Clarke and Rod Hague. Manchester, England: Manchester University Press, 1990, pp. 121-131.

The chapter contends that the Europeanization of security affairs and the strengthening of the so-called "European pillar" of NATO are not only important elements of a broader European consensus on defense, but have also the potential to reinforce more generally U.S.-European relations and more specifically a U.S.-European consensus on security policy.

PURKITT, Helen E., Associate Professor, "Artificial Intelligence and Intuitive Foreign Policy Decision Makers Viewed as Limited Information Processors: Some Conceptual Issues and Practical Concerns for the Future," *Artificial Intelligence and International Politics*, ed. Valerie M. Hudson. Boulder: Westview Press, 1991, pp. 35-56.

This study reviews recent efforts to model foreign policy processes using artificial intelligence techniques and identifies the key questions and issues which must be addressed if future efforts to construct Artificial Intelligence models of political decision making are to succeed. Insights from information processing research are used to illustrate how descriptive research from both experimental and case studies can be used to guide future AI research efforts.

PURKITT, Helen E., Associate Professor, co-author, "Foreign Policy Decision Making Under Varying Situational Constraints: An Information Processing Perspective," *Contemporary Issues in Decision Making*, ed. K. Borcherding, O.I. Larichev, and D.M. Messick. North-Holland: Elsevier Science Publishers, B.V., 1990, pp. 353-366.

This study compared the decision-making process of President Kennedy and his advisers during one day of the Cuban Missile Crisis with the process used by experimental subjects assigned the task of trying to balance the United States budget. The major finding of this study was that the intuitive decision makers both in the laboratory and real world are limited information processors who used the same basic problem-solving logic in their efforts to make decisions about complex political problems. This finding calls into question the widespread assumption in past studies of political decision making that decisions made during foreign policy crises are different from the process used to make routine or recurring political decisions. Instead, the data presented in this study support the view that political decision makers are limited information processors who use the same "low effort judgmental metaheuristic" in their efforts to "solve" political problems. Makers in both the laboratory and real world were using remarkably similar limited information.

RACHWALD, Arthur R., Professor, *The Search of Poland*. Stanford: Hoover Institution Press, November 1990.

An international event, the appearance in Poland of Solidarity--the first independent and self-governing labor union in the Soviet bloc--met strong reactions in the East and West. Moscow perceived Solidarity as the most destabilizing challenge to its imperial order in Eastern Europe since Titosim in 1948. This book details the extraordinary events that led to the June 1989 semi-free elections, which placed the government of Poland in the hands of a Solidarity-led coalition, and culminated in the self-dissolution of the Polish Community Party.

The author documents and examines the pressures applied by the Kremlin to Solidarity and the Polish government through ideological and political harassment, economic sanctions, and thinly-veiled threats of armed intervention. This important study examines the sequence, intensity, and temporary effectiveness of Soviet opposition to the Solidarity-led social and political movement in Poland. The analysis of the lengthy and involved encounters and confrontations between the governing authorities and the labor union after the imposition of martial law on 13 December 1981, demonstrates the Soviet failure to crush or contain the political aspirations of the Polish people.

Using documents and reports in Polish, Russian, and English, this study compares U.S., Soviet, and Polish authorities' reactions to events in Poland during the 1980's, as well as analyzes U.S.-Polish relations and their effect on the Polish government's domestic and foreign policies. The author gives careful attention to the complex relations among the political players, particularly the communist authorities and the Roman Catholic church. As he explores one of the most critical political developments of our time, the author discusses the pivotal position, politically and geographically, that Poland occupies in Eastern Europe.

RACHWALD, Arthur R., Professor, "Polish Transition from Communism," *Yearbook on International Communist Affairs*. Stanford: Hoover Institution Press, 1990, pp. 358-384.

The country profile includes a comprehensive analysis of emerging democratic institutions in Poland, including first, totally free elections to local governments and presidential elections at the end of 1990. Discussion of social problems focuses on economic stratification of society, consequences of unemployment and other economic dislocations, as well as on the enormous power of the Roman Catholic church. Finally, the examination of the Polish economy was designed to identify basic elements of the so-called Balcerowicz plan of transition of socialist to a market economy: anti-inflationary measures, privatization, convertability, and de-monopolization of heavy industry.

In this area of foreign affairs, this study focused on new patterns in Polish-German and Polish-Soviet relations. Such new developments at the November 1990 Polish-German treaty and the emerging bilateral relations between Poland and Western republics of the Soviet Union, especially, Lithuania and Ukrania, were discussed in detail to show new trends in regional politics.

TOMLINSON, Rodney G., Professor, *Reference Guide to the 45th (1990) United Nations General Assembly Rollcalls*. Washington: United States Department of State, March 1991.

This is a reference document that summarizes voting records of the members of the United Nations for the 1990 General Assembly. All rollcalls are studied and cataloged according to agenda, date, location, major and minor subjects, and important related incidents and issues in world affairs. A short descriptive passage is prepared, and rollcall votes for each member are appended. A series of cross-reference indexes are prepared to provide quick look by dates, resolution number, agenda number, location, and topical keywords. This document is published for use by members of the U.S. Diplomatic Corps and U.S. missions abroad to facilitate research into positions taken by the nations to which they are accredited.

Presentations

ATKINS, G. Pope, Professor, "The United States and Latin America: Opportunities and Obstacles in the Post-Cold War World," The Tuesday Club (University of Texas-City of Austin "Town and Gown" organization), Austin, Texas, 16 October 1990.

ATKINS, G. Pope, Professor, "Redefining U.S. Purposes in Latin America in the Post-Cold War World," Koeppler Lecture, Baylor University, Waco, Texas, 7 February 1991.

ATKINS, G. Pope, Professor, "A New Era for U.S. Latin American Policies," Rotary Club of Austin, Austin, Texas, 19 February 1991.

ATKINS, G. Pope, Professor, "The United States and Latin America in the Post-Cold War World: Introduction to the Conference," Conference on United States and Latin America: Redefining U.S. Purposes in the Post-Cold War Era, Lyndon B. Johnson School of Public Affairs, University of Texas at Austin, Austin, Texas, 28 February 1991.

ATKINS, G. Pope, Professor, "Reorientation of U.S. Policies in Central America," Pan American Round Table of Austin, Austin, Texas, 5 March 1991.

ATKINS, G. Pope, Professor, "Redefining U.S. Policies Toward Latin America," University of Texas at Austin, Learning Activities for Mature People (LAMP), Austin, Texas, 9 April 1991.

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FRANTZICH, Stephen E., Professor, "Using C-Span in the Classroom," C-SPAN Seminar for Professors, Washington, DC, 2 July 1990.

FRANTZICH, Stephen E., Professor, " Technology and Congress," The Carnegie Commission, Aspen, Colorado, 8 July 1990.

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MATTOX, Gale A., Associate Professor, "European Security Structures: NATO in Transition?" Women in International Security (WIIS) Summer Symposium, St. Mary's College, St. Mary's City, Maryland, 30 June 1990.

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MATTOX, Gale A., Associate Professor, "Teaching International Relations," Anne Arundel Board of Education for Teachers of Gifted High School Students Program, Annapolis, Maryland, 31 October 1990.

MATTOX, Gale A., Associate Professor, Chair/Discussant and Organizer, "The Fall of the Wall: German Unification and Future European Security," One Washington Circle, Washington, DC, 8 November 1990.

MATTOX, Gale A., Associate Professor, "Germany and Its Security after Unification," Senior Seminar on National Security, Foreign Service Institute, Rosslyn, Virginia, 28 November 1990.

MATTOX, Gale A., Associate Professor, "German Unification and Security in Europe," Washington Semester, American University, Washington, DC, 22 February 1991.

MATTOX. Gale A., Associate Professor, Chair, "Implications and Challenges of German Unification to East and West," presenter, "European Security Arrangements in the Future" Annual Conference of International Studies Associations, Vancouver, Canada, 21 March 1991.

MATTOX, Gale A., Associate Professor, "German Security Options," Annual NATO Conference at National War College, Washington, DC, 18 April 1991.

MATTOX, Gale A., Associate Professor, "The Future of European Security, American Friends of Wilton Park, American University, Washington, DC, 20 April 1991.

PURKITT, Helen E., Associate Professor, "Regional Security Issues: Africa," Women in International Security (WISS), St. Mary's College, St. Mary's City, Maryland, 29 June 1990.

RACHWALD, Arthur R., Professor, Fifteen presentations on three topics: Models, ethics and budgeting on local level in U.S., delivered on behalf of the U.S. Information Agency in five Polish cities (Warsaw, Gdynia, Gdansk, Bydgoszcz, & Szczecin), 1-21 June 1990.

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RACHWALD, Arthur R., Professor, "Security Implication of German Unity," Brandeis University, Boston, Massachusetts, 6 December 1990.

RACHWALD, Arthur R., Professor, "Soviet Perception of German Unification," International Studies Association Conference, Vancouver, Canada, 24 March 1991.

TOMLINSON, Rodney G., Professor, "The Structure of International Events - Testing a Theoretic Model of World Political Behavior," International Studies Association, Vancouver, Canada, 20 March 1991.

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This annual report summarizes the research work of the Naval Academy faculty and midshipmen for the period July 1990 through June 1991. 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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