SUMMARY

OF

RESEARCH

1996-1997

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BY
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TYPESET BY

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FOREWORD

This Summary of Research presents a listing and description of the research activity and productivity of the faculty, civilian and military, and midshipmen at the United States Naval Academy for the 1996 - 1997 academic year. A total of 3.0 million dollars was devoted to research. The funding categories break down into approximately 80% Navy, 7% non-Navy DoD, and 13% non-DoD federal.

The Chief of Naval Research, Naval Surface Warfare Center, Naval Research Laboratory, and Naval Space Command are the primary Navy sponsors of faculty and midshipmen research. Among non-DoD federal sponsors, the National Science Foundation and the Department of Energy have been the main sources of funding.

Midshipmen activities in research at the Naval Academy continued with students participating in independent research courses and honors projects. Eight members of the Class of 1997 completed the Trident Scholar Program during this academic year. Their research achievements included study of the anisotropic characteristics of the pitting behavior of aluminum; design and construction of a thermophotovoltaic conversion system; inquiry into the usefulness of the addition of a learning component to localization and navigation of robots; analysis of circulation patterns and water destratification in the Severn river estuary; study of the reaction kinetic of nitrous dioxide with nickel, cobalt, scandium, vanadium and chromium; development of new materials that can be used as a source of thermal emitter in a thermophotovoltaic generator; development of a method for speaker-independent speech identification that uses a phonetic classification scheme rather than word identification; and the feasibility of introducing a personal computer in the shop floor of a milling environment to take advantage of the current research in adaptive control in the traditional computer-aided machining process. Some of the projects involved interdisciplinary efforts between two departments. The faculty advisers were comprised from the ranks of both civilian and military faculty members. Midshipman Brett Allen St. George, whose Trident project was supervised by Assistant Professor Louiza Sellami and Instructor Ellen Curran K. Wooten of the Electrical Engineering Department, was awarded the Harry E. Ward Trident Scholar Prize for his outstanding work on the project titled "Speech Coding and Phoneme Classification Using a Back-Propagation Neural Network."

Associate Professor Mark L. Campbell of the Chemistry Department was the recipient of the Researcher of the Year award in 1997. Among Professor Campbell's accomplishments cited by the Selection Committee were his outstanding contributions to the field of reaction kinetics as well as his efforts in introducing the basic tools of research to several midshipmen who participated in joint research projects.

Research at the Naval Academy continues to play a key role in maintaining an atmosphere of scholarship in which midshipmen are exposed to the technical needs of the Navy at the same time they experience problem-solving, an important ingredient of our teaching mission.

WILLIAM C. MILLER
Academic Dean and Provost

REZA MALEK-MADANI
Director of Research and Scholarship

Memorial to Dr. Raouf Ali Raouf

Associate Professor Raouf Ali Raouf (1960-1997)

This year's Summary of research is dedicated to the memory of Associate Professor Raouf Ali Raouf who passed away on 19 April, 1997. Professor Raouf joined the faculty of the Mechanical Engineering Department in 1990 after receiving his Ph. D. from the Virginia Polytechnic Institute and State University and spending a post-doctoral assignment with the Joint Institute for the Advancement of Flight Sciences at the NASA Langley Research Center.

Within a short period after his arrival at USNA, Raouf became an integral part of our institution's focus on teaching, research and service. He will always be fondly remembered for the unselfish sharing of his ideas, whether they related to bringing a new technology into the classroom or applying a novel analytic technique to a research problem. As the Director of the Computer Aided Design and Interactive Graphics (CADIG), Raouf supervised the expansion of this facility to a first-rate computational center where midshipmen and faculty from all disciplines were welcome to conduct research.

In 1996 Raouf's research accomplishments earned him the Faculty Researcher of the Year Award. In a span of six years, Raouf had accumulated a research record that many of us only hope to achieve in a lifetime, several samples of which appear in this year's Summary of Research. Remarkably, based on his record on teaching and service, one could easily imagine that Raouf would have also been the recipient of the Teaching or the Service Excellence Award.

Raouf's approach to research was characterized by his clarity of vision and by his desire to seek direct and simple answers to complex problems. He was an untiring problem-solver whose daily routine displayed a rare combination of self-discipline and sense of humor.

Raouf and his contributions to our community will be sorely missed.

Reza Malek-Madani

CONTENTS

DIVISION OF ENGINEERING AND WEAPONS

Capt. Todd W. Bruner, USN
Director

DEPARTMENT OF AEROSPACE ENGINEERING

CDR Kenneth M. Wallace, JR., USN
Chair

This past year, the aerospace engineering field was brimming with activity ranging from news and key events on programs such as the Joint Strike Fighter, F/A-18E/F, and Unmanned Air Vechiles to company mergers and the tremendous growth in satellite technology and capabilities. The Aerospace Engineering Department strives to stay current in this technology by engaging in research and scholarly activity that keeps the curriculum exciting, provides solutions to government agencies, promotes professional development and sustains the high standards of excellence within the academic program. Despite the challenges of recovering from the loss of a third of the faculty this past year, research stayed on the mainmast to keep the classrooms alive with a "state-of-the-art" academic program. In addition, a considerable amount of effort has also been placed into system development and infrastructure to provide opportunities for future research, classroom integration, publications and presentations in the areas of spacecraft technology and composites. These efforts leverage laboratory assets such as the Composite Structures Facility, the Satellite Ground Station and the Spacecraft Artificial Intelligence Laboratory.

The below descriptions cover a broad spectrum of sponsored and independent research topics, ranging from bio-mechanics and hull-superstructure interaction to general aviation performance issues and the design of a miniature spacecraft. Note that while the capstone design courses were not listed, midshipmen and faculty advisors were involved in projects that were aligned with research in other government agencies. Within the astronautics track, scientists and engineers from the National Aeronautics and Space Administration (NASA) and the Naval Space Command (NSC) view and evaluate midshipman projects. This occasionally leads to follow-on research and midshipmen opportunities.

Support for research is provided primarily by NASA, NSC, the Naval Research Laboratory and the Walter Reed Army Medical Center. Portions of summer research funding were provided by the Naval Academy with matching funds and curriculum development.

Sponsored Research

Biomechanical Testing of Vertebra Fixation Devices in Spondylolysis

Researcher: Professor William J. Bagaria
Sponsor: Walter Reed Army Medical Center

Back pain can be a chronic problem in persons with spondylolysis (a fractured vertebra). The object of this research is to compare three different types of fixation devices. These devices stabilize the defect (fracture) across the pars interacticularis during healing.

Independent Research

Vehicle Center of Gravity Height Measurement Errors

Researcher: Professor William J. Bagaria

Knowledge of the center of gravity height in vehicles is necessary both for performance, and stability analysis. For decades, it has been recognized that the measured values are suspected of containing inaccuracies. Many tests have been conducted in order to determine the source of the error. It was concluded that the vehicle tilt angle was the greatest source of error. From a mathematical point of view, this did not make sense. This research is showing that the actual source of error is due to the measurement accuracies, and the design of the test equipment. The analysis is showing how to redesign the tests, and ways to reduce the error.

Research Course Projects

Use of NASTRAN Finite Element Modeling to Detect Interior Gaps in a Composites Part

Researchers: Midshipman 1/C Brian Hoerst, USN
Advisers: Professor William J. Bagaria and Assistant Professor Colin P. Ratcliffe

Model analysis is a promising method to detect interior gaps in parts fabricated from composite materials. Professor Ratcliffe has been investigating experimental methods to detect the gaps. This project studied the feasibility of using the NASTRAN Finite Element Modeling program to detect the gaps. Preliminary results indicate that both methods can be used to detect internal gaps.

Strain-Gauge Calibration for Measuring Airloads on an F/A-18 Wing Model with Oscillatory Leading-Edge and Trailing-Edge Control Surfaces

Researchers: Midshipman 1/C Nicholas C. Nuzzo, USN
Midshipman 1/C John S. Braddock, USN
Adviser: Associate Professor Gabriel Karpouzian

Summary: Midshipman 1/C Nuzzo and Braddock have expressed to me a great interest in continuing an on-going research in the aerodynamic study of an F/A-18 wing model when the leading-edge and trailing edge flaps are oscillating at various frequencies and amplitudes, and allowing for phase differences between the two modes. The objective of the study is to find the modes that will enhance the aerodynamic response of the wing at take-off and landing speeds appropriate for low-speed wind tunnel testing. The model has already been built with a mechanism to oscillate the flaps. However, in early calibration measurements, the vibrational noise generated by the mechanism affected the loading on the strain gages that, in turn, altered the true measurements of the loading. Both midshipmen will try to rethink the design of the mechanism to alleviate the vibration-induced loadings. If successful, the model will then be placed in the low-speed wind tunnel to generate aerodynamic data for performance analysis. This project will be of great value to the Navy.

Model and Thermal Stress Analysis Procedure

Researcher: Midshipman 1/C Bryan J. Forney, USN

Advisers: Associate Professor Michael D. A. Mackney (Aero Engr Dept)
Assistant Professor Colin P. Ratcliffe (Mech Engr Dept)

The purpose of the research project was to develop a method for the analysis of structures by combining the processes of modal analysis and thermographic stress analysis. Modal analysis is a useful method for identifying the natural frequencies of a system throughout a range of frequencies. Thermographic stress analysis is a useful method for determining the stress concentrations and loads in a structure due to the amplitude of vibration at a specific frequency. It was hoped that by combining the two methods a practical method for determining the loads experienced by a structure when it is being excited at the maximum amplitude could be developed.

At the conclusion of the semester the method has not been completely developed. However, all indications are that with a little trouble shooting the modal and thermographic stress analysis procedure (MATSAP) will prove to be very effective.

Naval Academy Near-Earth Orbiting Satellite (NANOSAT)

Researcher: Midshipman 1/C Jane E. Goodhue, USN
Adviser: Visiting Professor Stephen J. Paddack

We continued the research and design of the Naval Academy Near-Earth Orbiting Satellite (NANOSAT) from last semester's research. The NANOSAT is a hand held satellite that will relay the position and status conditions of Naval Academy ships back to the Naval Academy Ground Station in an inexpensive and effective manner. The main objective of study for this semester is to provide a definitive design and model that has been tested and calibrated for flight. Other objectives include: publishing the results with the American Institute of Aeronautics and Astronautics (AIAA), and maximizing the NANOSAT's communication abilities while maintaining a low budget. We have completed the design, constructed prototypes of various systems, and conducted testing to assure superior performance. The passive attitude control system will be tested to ensure that the magnetic torque induced by the Earth's field will not interfere with the dipole antennas. A model of the satellite will undergo thermal testing to determine what parameters will prevent the satellite from falling below the minimum temperature for the internal components. Also, the electrical power system was analyzed to ensure that the solar arrays provide enough voltage to charge the secondary batteries under various orbital scenarios. The NANOSAT will be an excellent asset to the Naval Academy, since it will not only permit the tracking of Yard Patrol Craft and sailing vessels, it will also act as an instrument for midshipmen training. It has several other possibilities for use, such as communication among other institutions as well.

Study of Tool Material for Fabrication of Composite Structures

Researcher: Midshipman 1/C Tony J. Culic, USN
Adviser: Professor William J. Bagaria

Hard tooling is necessary in order to cure highly accurate composite structural parts in an autoclave. The tooling must also be able to withstand the curing temperatures, typically 350 degree Fahrenheit, but as high as 850 degree F. Traditionally, expensive metal tools have been used. This method is only economical when producing a very large number of parts. This research is studying other types of materials in order to reduce cost. The current materials being investigated are Plaster of Paris, Gypsum Cement, and Casting Investment.

We will make use of Plaster of Paris and Gypsum Cement as materials to make tools from which complicated composite parts could be made. We will experiment with drying times, curing temperatures, and heating rates on these tools to determine what temperatures they can sustain when actually used to fabricate composite parts. Currently industry uses

various metals for their tools; if incorporated correctly, the materials researched here could provide a more accurate and cost-effective method of manufacturing composite parts.

T34 Lift Distribution Wing

Researchers: Midshipman 1/C Michael A. Loeffler, USN,
Midshipman 1/C Abraham N. Younce, USN
Adviser: Professor David F. Rogers

The purpose of this project was to design a lift distribution wing for the Aerospace Engineering Department's low speed wind tunnel. The finished wing is to be used in the EA303 course in subsequent years. The wing uses NACA 23xxx series airfoils. The wing is geometrically twisted. A minimum of six chordwise rows of up to 35 static pressure ports in each row are used to determine the local sectional lift coefficient at each of the six spanwise stations. The resulting experimental wing lift distribution will be compared to the theoretical lift distribution calculated using techniques developed in Aerodynamics II.

The particular challenges of this project were in determining the location of the spanwise stations for optimum comparison with theory, in determining the method for internal routing of the lines from the pressure taps and in determining the actual numerical control manufacturing methods.

The location of the spanwise stations was accomplished. The design of the cavity to hold the lines for the pressure taps was completed. Data for numerically controlled cutting of the interior cavity was generated. Actual cutting of material will be accomplished this summer. Generating data for NC manufacture of the exterior of the wing and NC milling will be addressed in a subsequent research project.

Researchers: Midshipman 1/C Andrew Ring
Adviser: Professor David F. Rogers

The purpose of this project was to add a movable flap to the lift distribution wing for the Aerospace Engineering Department's low speed wind tunnel being designed by Midshipman Loeffler and Younce. The design for partial span slotted Fowler flaps capable of being deflected to a maximum of 40° in 10° increments was accomplished.

The particular challenges of this project was in determining the mechanism for deflecting the flaps and in fitting them to the lift distribution wing without interfering with the structure of the wing. The design was successfully completed. Manufacturing remains to be accomplished in a subsequent research project.

Publications

ROGERS, David F., Professor, "Is There a Step?," World Beechcraft Society, March/April 1996, 10, 34, 36.

The article discusses question of aircraft trim velocity at high altitudes where the power available intersects the power required curve twice. An aircraft will trim at either of two velocities, one above the velocity and one below. Normally one wants to trim at the higher velocity. The article discusses real-world techniques for achieving this.

ROGERS, David F., Professor, "One More Turn," World Beechcraft Society, May/June 1996, 16, 34.

The article discusses the validity of turnback after engine failure during climbout after takeoff studies conducted in a non-motion based simulator as well as a recommended technique based on analytic parametric studies along with real world experiences.

ROGERS, David F., Professor, "Altitude Effects, Part 1," World Beechcraft Society, July/Aug. 1996, 14-15.

The article discusses the effect of increasing altitude on aircraft performance with specific application to a typical light single engine aircraft. Specifically the effect of altitude (density) on the power required to maintain level flight as a function of flight velocity, the minimum power required and the velocity for minimum power required and the power available from a typical reciprocating aircraft engine. The decrease in maximum velocity with altitude and the narrowing of the possible level flight regime are also discussed.

ROGERS, David F., Professor, "Altitude Effects, Part 2," World Beechcraft Society, September/October 1996, 6-7,34.

The article continues the discussion of altitude effects on aircraft performance of Part 1. Specifically, altitude effects on the rate-of-climb clean, with flaps, with landing gear and with landing gear and flaps extended are discussed in the context of a typical high performance light single engine aircraft. The results show that above 10,500 feet with gear and flaps extended this aircraft has a negative rate-of-climb except at one specific velocity. The implications of this result are discussed in the context of operation for a go around at a high density altitude airport.

ROGERS, David F., Professor, "Turbo-normalization," World Beechcraft Society, November/December 1996, 12, 30, 31.

Turbo-normalization maintains sea-level power available in a reciprocating aircraft engine to some critical altitude typically 20,000 feet. In contrast supercharging increases power available compared to a normally aspirated engine. The effects of turbo-normalization on maximum velocity, rate-of-climb and time to climb as well as absolute ceiling are discussed for a typical high performance single engine aircraft.

ROGERS, David F., Professor, "Weight Effects," World Beechcraft Society, January/February 1997, 18-21.

Weight effects on the power required to maintain level flight, the maximum velocity, the velocity for maximum lift to drag ratio, the rate-of-climb and the velocity for maximum rate-of-climb and maximum climb angle are discussed in the context of a typical single engine light general aviation aircraft.

Presentations

KARPOUZIAN, Gabriel, Associate Professor, "Aeroelastic Instability Control of Advanced Aircraft Wings using Combined Feedback Control Laws," AIAA Structures, Structural Dynamics, and Materials Conference, Orlando, Florida, 8-10 April 1997.

ROGERS, David F., Professor, "Altitude Effects on A/C Performance," New England Bonanza Society, Wilmington, Delaware, 31 May 1997.

DEPARTMENT OF ELECTRICAL ENGINEERING

Colonel James F. Kendrick, USAF
Chair

Research and scholarly activity are fundamental to the vitality and viability of any 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 Naval Surface Warfare Center, the Johns Hopkins University Applied Physics Laboratory, and from within the Naval Academy. Research topics supported during the past year included: investigation of various electron transport mechanisms in high electron mobility transistors and multi-instrument sensor fusion for an automated hull maintenance vehicle; exploratory research for development of a drydock painting robot; development of computer simulations of shipboard generator and power circuit breakers systems; investigation of various topics concerned with neural networks; non-invasive testing of microwave circuits fabricated both from semiconductors and organic polymers; and development of satellite laser ranging systems and multiplexed fiber optic systems. This faculty research contributes directly to the fleet's operational capabilities and provides relevant topics which benefit the professional as well as the academic development of our midshipmen.

Sponsored Research

Interface Barrier Height of InAs/AlSb HEMTs

Researcher: Assistant Professor Duane Keye
Sponsor: Naval Research Laboratory

The InAs/AlSb High Electron Mobility Transistor (HEMT) is a good candidate for low-noise low-power application. However, reduction of reverse leakage current must be realized before this material type becomes viable for HEMT applications. Gaining insight to the various electron transport mechanisms will help to improve the transistor characteristics. These transport mechanisms have a strong temperature dependence and they can be isolated by measuring the devices through a temperature range. By inserting the appropriate barrier metal one may be able to drastically reduce the amount of leakage current and thus improve device overall performance.

Various current (I) and voltage (V) measurements were made on heterojunction transistor structures to determine the interface barrier height of an InAs/AlSb interface. Devices were measured at a temperature range of 4.2 K to over 300 K. Data from the devices has been evaluated for leakage currents, and forward current characteristics to find an activation energy; using an Arrhenius relationship. The activation energy is an indicator of the electron interfacial barrier height. The activation energies calculated to date are only approximations, and are not believed to be very accurate because insufficient data was taken at higher temperatures. Measures are planned for higher temperatures to improve the accuracy and validity of the calculations. This work is on going.

Automated Hull Maintenance Vehicle

Researcher: Assistant Professor K.A. Korzeniowski
Sponsor: NSWC Annapolis

The two major areas of research for the Automated Hull Maintenance Vehicle (AHMV) project at NSWC Annapolis are, first the concept development for the real-time control system for the Automated Hull Maintenance Vehicle (AHMV), an automated underwater vehicle that will be used to monitor the condition of an underwater ship hull and deploy a cleaning head to remove fouling when fouling is encountered. Secondly, the project is concerned with sensor integration, data acquisition, analysis and fusion for the prototype AHMV.

This project is driven by the need to bring the United States Navy's cleaning of ship hulls coated with antifouling, ablative paints in compliance with the Environmental Protection Agency's requirement for limited discharge of environmental contaminants. At present, cleaning of Naval ships is being restricted and it is anticipated that in the future this trend will continue and impose a zero discharge requirement. The focus of the project is to automate the cleaning process so that the cleaning head will be deployed only when necessary, as determined by monitoring of the hull condition, and capture the underwater effluent.

Multi-instrument, sensor fusion for hull inspection was accomplished this fiscal year. Programming for data collection and fusion was accomplished. The program was tested during a fleet deployment with the prototype underwater vehicle for the purpose of electronically monitoring the condition of the underwater hull paint and the impressed current system for the CVN68 USS Nimitz.

This work was continued by incorporating a computer controlled rotator that was mounted on the prototype AHMV. The rotator is used to deploy sensors on the hull surface according to commands received through an RS232 serial port. During a fleet trial, it was determined that this system addition improved the operator ontrol of the underwater instruments.

Dry Dock Painting Robot

Researcher: Assistant Professor K.A. Korzeniowski
Sponsor: NSWC Annapolis

This work consisted of a co-authored 6.2 (exploratory research) proposal for developing a dry dock painting robot. This project was reviewed and accepted by ONR. It will be funded in FY97.

The current method of spraying paint in dry dock creates a hazardous environment for the painter. The painter is being exposed to volatile organic compounds (VOC's) that are used to propel the paint particles as well as being exposed to paint overspray. The current method of paint application is also inexact. During the application process, it is not possible to determine the exact thickness of each coat of paint and thus the overall paint system can vary by five millimeters or more (a whole coat thickness) from one area to another. This translates to wasted paint product and a considerable financial loss for the U.S. Navy as well as adversely affecting the wearing of the ablative paint system while the ship is underway. The project will be driven by two goals, to increase the accuracy of paint application on ship hulls and to decrease environmental pollutants created by introducing paint overspray into runoff water and introducing VOC's into the atmosphere.

The proposal described a dry dock painting robot that would be able to maintain a constant distance from the hull while accurately controlling the amount of paint sprayed. The system included a device that would be responsible for the capture and containment of the overspray and the VOC's.

Simulation of a Shipboard Six phase Generator, Rectifier, Regulator System

Researcher: Professor Richard L. Martin
Sponsor: NSWC Carderock (Annapolis Detachment)

Various computer models and simulations have been provided to NSWC by outside consultants, written in ACSL (Advanced Computer Simulation Language), to allow analysis of proposed shipboard power distribution systems.

The objective of this project has been to implement one such set of models, a six phase generator simulation package, in a form to be run with a turbine simulation to be provided at a later date.

Methodology and Results: The documentation was reviewed, and the system was found to consist of a six phase ac generator and rectifier, its exciter, its voltage regulator, and a load. Input to the present simulation is the desired DC voltage at the load. Primary outputs of the simulation are the voltage actually provided to the load and the torque required from the turbine (prime mover). The majority of the effort expended was in the implementation of the voltage regulator simulation. The original regulator model, a generic controller which used proportional plus integral control, was found to be unstable with the gains as provided. Literature from the controller manufacturer indicated a variation in the controller's configuration plus the inclusion of a derivative control signal. After the controller has reconstructed and the gains for the proportional, integral, and derivative signals were adjusted, a stable system was established. Results of several computer simulation runs have been provided to NSWC.

Modeling and Simulation of A Power Circuit Breaker

Researcher: Professor Tian S. Lim
Sponsor: NSWC

This project is a continuation of last year's project. The purpose is to develop a model that simulates a dc power circuit breaker. The circuit breaker can withstand a maximum voltage of 800 Volts and a maximum current of 75,000 Amperes. The circuit breaker arc voltage can rise to 1650 Volts during the time of contact separation, or 32 msec., and then drops to 800 Volts during the arcing time, or 30 msec., across open contacts.

An Optical Distributed Processing Network (summer 1996)

Researcher: Assistant Professor R. Brian Jenkins
Faculty Advisor: Prof. Jon Sauer, University of Colorado
Sponsor: U.S. Army

The goal of this project is to design and implement a fiber optic interconnect, with a ShuffleNet topology, for use in shared memory multi-processors. Nodes in the interconnect network use deflection routing to resolve contention, where each node consists of a processor, memory, a photonic 2×2 switch, and a packet routing processor. Each host processor is a commercial workstation with FIFO interfaces between its bus and the photonic switch. Hence, data payload remains in an optical format as it traverses the network from source to destination. When coupled with the latency minimization achieved at the FIFO bus interface, the interconnect provides very low-latency communications to remote memory locations in the network. The resulting system could be useful as a general purpose radar image processor, scalable in both computing power and geographical separation between network nodes. Such an interconnect might be used for real-time battle management or simulation. Other applications include medical imaging or airline reservation systems. The architectural design was nearly complete as of Aug. 1996, and fiber optic

transceivers, electronic FPGAs, and other required components were on hand to begin the implementation of an electronically switched version of the interconnect. The implementation of a practical network including real host computers distinguishes these efforts from previous theoretical and experimental work.

Wavelength-Division Multiplexed Solitons for Fiber Communications

Researcher: Assistant Professor R. Brian Jenkins

ABSTRACT: The primary goal of this ongoing research project is to analyze the feasibility of using wavelength-division-multiplexed solitons for optical fiber communications. Such a communication system is unorthodox since the propagation of data, represented by soliton pulses, is inherently dependent on nonlinear phenomena in the fiber. As a result, nonlinear interactions between solitons cause frequency/timing shifts which may distort data in ways atypical of linear communication systems. The analysis accounts for practical system issues such as loss, amplification, and filtering. In addition, four-wave mixing is known to have a significant impact in many wavelength multiplexed communication systems, but its effect on soliton communications is not yet well understood. Initial results indicate its importance is greater than originally expected.

Laser Testing of High Speed Microwave and Packaged Circuits

Researcher: Assistant Professor Deborah Mechtel
Sponsor: Johns Hopkins University/APL

Laser probing of circuits is a technique for noninvasive testing of high speed microwave circuits and packaging. The technique, called electro-optic probing, allows point-by -point evaluation of the electric field internal to circuits instead of limiting testing to external port measurements. We have built a laser probing system that we use to characterize high speed circuits.

Several technical issues for the laser probing system have been addressed including the theoretical basis for a calibration method that would be used with a continuous wave laser. The next step will be experimental results to support the theory. In addition, the system is being extended to become optical fiber based at speeds of 40GHz.

Electro-optic probing has been demonstrated on semiconductor substrates, such as InP and GaAs, that exhibit the electro-optic effect. We have extended electro-optic probing beyond these conventional substrates to probe circuit structures on organic polymer substrates that would be used for high density packaging such as multichip modules (MCMs). An organic polymer, with its low dielectric constant, is popular in advanced packaging applications. Our test results demonstrate the potential to probe circuits structures that are buried in the center layers of an MCM.

A Distributed Code Division Multiplexed Fiber Optic Sensor System

Researcher: Professor Antal A. Sarkady
Sponsor: NSWC, Annapolis, Code 853, Henry Whitesel

Advanced diagnostic fiber-optic sensor are currently being developed at Naval Surface Warfare Center, Carderock Division at Annapolis. These sensors could be used for damage control applications in naval ships if a cost effective way is found to distribute, multiplex and network them. Currently we are developing a single strand optical fiber link connected to 32 sensors with 100 ns time delay between them. This system operates on the principle of a time-domain reflectometer (TDR) where each sensor value is

obtained at a different delay time. An optical source, driven by a pseudorandom bit sequence generator produces the “main bang”; matched filters and correlation techniques are used to recover the senor values.

In this year, we built and tested a prototype of this fiber-optic sensor system at NSWC Annapolis Lab. The results of this tests were extremely promising and now we are preparing a robust version system that can operate on US ships. A technical paper was presented and published in the SPIE Proceedings (at the annual meeting of The international Society for Optical Engineering, 10-11 February 1997, San Jose, California) describing the operations and performance of this system. In addition, an NSWC Technical Report (NSWCCD-TR-85-96/20, Dec. 1996) was published on this topic.

Research Course Projects

Speech Coding and Phoneme Classification Using a Back-propagation Neural Network

Researcher: Trident Scholar- Midshipman 1/C Brett A. St.George
Faculty Adviser: Instructor Ellen C. Wooten and Asst. Prof. Louiza Sellami
Sponsor: U.S. Naval Academy

Speech is a natural, unspecialized method of communication that is perhaps the ultimate machine interface. Previous attempts to provide such an interface, however, have been limited to pre-defined vocabularies of an artificial syntax. This paper presents a method for speaker-dependent speech identification that uses a back-propagation neural network to determine the phonemes present within a voice signal. The vocal tract changes slowly in time and can be modeled using the pitch and format frequencies of the voice. These frequencies relate the position of the vocal tract to specific pronunciations and are obtained by using a homomorphic filtering process that separates the vocal tract's impulse response from the excitation source. The frequency representation of this response is concatenated with the excitation containing the pitch frequency and applied to the input layer of the neural network. From this information, the network selects combinations of features that identify the phonemes which are present. This network was trained on a set of speaker dependent phonemes, and now phonetically classifies new speech input.

This classification scheme could be used to translate linguistic messages into machine code with a very high data rate. This benefit would allow for real-time interaction with machines with no specialized training. Applications could be as simple as providing quick voice to text processing or as diverse as implementing a control system with response time tied to specified voice patterns.

Sonar Demonstrator

Researcher: Midshipman 1/C Brian Blair
Faculty Adviser: Assistant Professor K.A. Korzeniowski
Sponsor: Department of Electrical Engineering

The purpose of this project was to build a sonar instrumentation device that is capable of determining the distance to an object. Midshipman Blair successfully integrated the necessary IC hardware along with the signal processing hardware to output a high frequency chirp and receive the echo. The time differential between the chirp and the echo is related to the position of an object. The system consisted of a single transducer, electronic hardware and an oscilloscope. A next step to this project would be to increase the number of transducers, remove the oscilloscope and automate the data acquisition. This is an excellent topic of study for a future Navy officer. The Electrical Engineering Department may also use this project to demonstrate the electronic systems involved in sonar detection.

Publications

WOOTEN, Ellen C., Instructor, "Design of a Coordinated Controller Based on a Neuron Modeh of Flight", *Locomotion in a Locust, Univ. Of Md., PhD Dissertation*, May, 1997.

The purpose of this dissertation is to develop a design of a neural network capable of providing simulated output comparable to the intact flight neural control behavior of the locust. The basis of this network is the proposed structure, including neuron properties and interconnections, of the actual neurons found from many biological and physiological experiments. A series of software models of portions of the flight system is developed using these "biologically-realistic" neuronal compartments for each neuron and its connections. Most of the parameters chosen to characterize each of the 24 "neurons" representing flight interneurons were determined by using information from other invertebrates initially. The parameters were then changed for each cell so that the model output pattern matched that of the actual cell in the network. By experimenting with the models and running simulations on them, while comparing the outputs against the actual data from the locust, the final design for a sensori-integrated flight controller is provided. The analysis of these models at a detailed level leads to a better understanding of the structure of the insect and provides a means of looking at the structure of other invertebrate and vertebrate motor systems. This analysis leads to a determination of the unique contribution of each neuron in the control of the complete flight behavior. The final model which incorporates sensory control of the system may also lead to design of artificial motor controllers for robotic flying insects.

To be able to answer some of the physiological questions posed by the experimentalists, different hypotheses of neuronal control of flight were tested in the modeling process. The results of the design of the final model show that a synaptic network consisting of a stable three-neuron inhibitory loop can provide the basis of alternating control or central rhythm generation (CRG) for the two sets of outputs to control the forewing and hindwing on one side. The other side is controlled by an identical "distributed" controller and it is synchronized by the same initiating input, and coordinated by sensory feedback from the other side. The simulated mechanical sensory inputs integrate with the alternating inhibitory control, such that they entrain the output pattern. The simulated exteroceptive inputs provide peripheral parallel loops to control the outputs, but these inputs are synchronized to the pattern determined by the sensory adapted CRG.

ST.GEORGE, Brett A., Wooten, Ellen C., and Sellami, Louiza, "Speech Coding and Phoneme Classification Using MATLAB and NeuralWorks," proceedings of the *Frontiers in Education Conference*, Pittsburg, Pa., (Nov 5-8, 1997) p. 12.

Applications involving speech coding and phonetic classification are introduced as educational tools for reinforcing signal processing concepts learned in senior level communication classes at the U.S. Naval Academy. These applications utilize the software packages MATLAB and NeuralWorks and are used here to explore the concepts of impulse sampling, Fourier transforms, data windowing, and homomorphic filtering.

SELLAMI, L., R. W. Newcomb, and R. J. De Figueiredo, "Examples of Optimal Interpolative Functional Artificial Neural Networks," Technical Report No. 717, Electrical Engineering Department, State University of New York, Stony Brook, New York, (June 1996) pp. 1-4.

This paper presents examples of a class of optimal interpolative (OI) functional artificial neural networks which process continuous multidimensional signals. These networks embody for the present case the structure of OI networks previously derived in the literature, which best approximate a nonlinear dynamical system in a Generalized Fock Space (GFS) under input-output training data constraints. Among other applications, these networks are useful in the modeling and identification of the degradation process of image signals occurring while propagating in nonlinear media.

SELLAMI, L. and R. W. Newcomb, "Lossy Synthesis of Digital Lattice Filters," *IEEE Transactions on Circuits and Systems II, submitted July 1996*, accepted for publication April 1997.

A new method for converting a lossless cascade lattice realization of a real, stable, single-input, single output ARMA(n,m) filter, with a lossy terminating one-port section, to a lossy realization is proposed. The conversion process is carried out through the

factorization of the transfer scattering matrix of the terminating section and the distribution of the loss term, embedded in this matrix, among the lossless lattice sections according to some desirable pattern. The cascade is then made computable through the extraction of right-matched J-unitary normalization sections. The technique applies to both degree-one and degree-two lattice sections and is rendered systematic owing to the particular lossless lattice structure used. The motivation for this work lies in the synthesis of a pipeline of digital cochlea lattices with loss suitable for hearing impairment diagnosis via Kemp echoes.

SELLAMI, L., K. Wong, and R. W. Newcomb, "Semi-State Models for VLSI Hair-Cell Circuits," *International Journal of Circuits, Systems, and Computers, vol 7, no. 5 pp. 505-516,* 1997.

Cochlea hair-cells act as neural interfaces of sound signals and, therefore, circuit representations are important to signal processing systems based upon characteristics of the ear. Here nonlinear semi-state equations for a bidirectional circuit representing a generic cochlea hair-cell are presented. The circuit can be specialized to inner or outer hair-cells depending upon the choice of circuit parameter values. Also developed are a canonical semi-state description for the hair-cell potassium and sodium channels and circuits suitable for a transistorized hardware implementation. Circuit simulations are run with numerical data to correlate with the Howard-Hudspeth experiments.

SELLAMI, L. and R. W. Newcomb, "A Pipelined Synthesis of Cochlea DSP Lattice Filters," proceedings of the *International Conference on Information, Communications and Signal Processing,* Singapore (Sept. 1997) pp. 1163-1167.

A pipelined lattice realization of a digital scattering model of the cochlea is presented, based on real, lossless lattice synthesis of ARMA filters. The structure is recursively designed and each lattice is precisely implemented by a pair of complex conjugate transmission zeros via Richard's function extractions. In addition to being suitable for VLSI implementation, the structure leads to a systematic cochlea parameter estimation, owing to the scattering nature of the model.

R. W. Newcomb and L. SELLAMI, "Multivibrator Circuits," (invited paper) *Wiley Encyclopedia of Electrical and Electronics Engineering* (John Wiley and Sons, Inc.), accepted for publication Oct. 1997.

A multivibrator is a device which transitions (vibrates) between several (multi) fixed output levels. Besides their use for timing, they are commonly used for either storage of for clocking of data in digital computers using binary numbers where the number of levels is generally two. There are several types of multivibrators, and several classification schemes. One classification is into (A) triggered or (B) free-running, while another more frequent classification is in terms of their stability properties for which, in the two-case level, there are (a) monostable, (b) bistable, or (c) astable multivibrators. The bistable multivibrator has an output which remains in either one of its two stable states; consequently, the name flip-flop is frequently ascribed to it. The monostable multivibrator remains in its one sable state until triggered into its unstable state; an alternate name of one-shot is frequently used for it. The astable multivibrator acts as a nonlinear oscillator as it oscillates periodically between its two unstable states, often in an asymmetrical manner, giving different resting times in the different states.

KORZENIOWSKI, Kelly A., Assistant Professor, "Practical Electronic Instrumentation for All Engineering Disciplines", *Proceedings of the American Society for Engineering Education Conference - ASEE 1996*, Washington, DC, (June 1996).

True engineering is a multi-discipline field and commonalities exist among all types of engineers. Engineers work within their environment and control processes by using instrumentation in order to sample surrounding physical phenomenon such as light level, temperature and pressure. Electronic Instrumentation Systems are concerned with data acquisition, signal processing and computer control. In these systems, data acquisition circuits use sensors and signal conditioning electronics in order to convert physical environmental changes into electric signals that can be processed with a computer.

Gaining experience with practical electronic instrumentation is an important experience for any engineering student and should be a part of a rounded engineering education. Design is a major component of the course described in this paper, therefore the course complies with the American Board for Engineering Technology (ABET) requirement that the design process should be an integral part of the engineering curriculum. The material learned in this type of course can be immediately applied to independent design projects and these skills can later be used in professional work. This paper describes the

process of introducing practical electronic instrumentation to non-Electrical Engineers.

KORZENIOWSKI, Kelly A., Assistant Professor, "Using Supervised Learning to Fuse Sensor Data for Surface Tracking in Complex Environments", *Proceedings of the International Society for Optical Engineering* ,Vol. 2911, Boston, MA, (November 1996), pp. 2-8.

This paper is concerned with the problem of optimizing surface following control in automated systems. Tracking a surface is an integral task for many autonomous systems. It can be used for navigation, surface preparation or object recognition. There are two types of control for surface following, continuous and discontinuous. The robot may maintain contact and continuously track the surface or touch the surface at discontinuous points. A balance is sought between each surface tracking method in the path planning phase, in order that the whole process be optimized in terms of time to complete the task and the amount of data collected. The tracking method is computed by the tracking algorithm using the partial data sets provided by sensors. It is common practice to outfit automated systems with the ability to gather data from many sensors. As the environmental conditions change, sensor reliability changes. Thus, the system's reliability on sensor data must also change. This work focuses on the addition of the supervisory learning module for choosing the method of surface tracking.

KORZENIOWSKI, Kelly A., Assistant Professor, "Collision-Handling Control in an Automated Environment", *International Journal for Advanced Manufacturing Systems, Vol. 1, pp. 13-23.*

Obstacle avoidance is an important safety component in any system that relies on gross mechanical movement in order to complete a task. The collision-handling controller described in this paper has been designed to function as an independent module, therefore it can be incorporated into an existing control loop without compromising the functionality of the system. The objective of the collision-handling controller is to enable an automated system to adapt to a changing environment and recover from an unavoidable collision with a moving obstacle. This paper presents the motivation behind the development controller, the actual control law and experimental results.

LIM, Tian S., Professor, "Modeling and Simulation of A Power Circuit Breaker," 1997 ASEE Annual Conference Proceedings, June 1997, CD-ROM.

This paper describes modeling and simulation of a dc power circuit breaker. The circuit breaker can withstand a ma|imum voltage of 800 Volts dc and a maximum current of 75,000 Amperes. The circuit breaker arc voltage can rise to 1650 Volts during the time of contact separation, or 32 msec., and then drops to 800 Volts during the arcing time, or 30 msec., across open contacts. It necessitates the solving of a non-linear differential equation using ACSL (Advanced Continuous Simulation Language). .

ABLOWITZ, M.J. and Biondini, G. and Chakravarty, S. and JENKINS, R.B. and Sauer, J.R., "Four-wave mixing in wavelength-division-multiplexed soliton systems: damping and amplification", *Optics Letters*, Vol. 21, No. 20, October 15, 1996 pp. 1646-1648.

Four-wave mixing in wavelength-division-multiplexed soliton systems in optical fiber with damping and amplification is studied. In ideal fibers without loss, four-wave mixing energy created during soliton collisions quickly decays to zero after a collision. In a practical fiber with loss and amplification, the four-wave mixing energy reaches a finite steady-state value. An analytical model is introduced that explains the dramatic growth of the four-wave terms in fibers with lumped amplifiers. The model yields a resonance condition relating the soliton frequency and the amplifier spacing. It correctly predicts all essential features regarding the resonant growth of the four-wave mixing energy, which could degrade fiber optic communications when data is carried on wavelength multiplexed solitons.

MECHTEL, Deborah M.., Assistant Professor and Charles Jr., Harry K. and Francomacaro, Shaun A. "Electro-optic Probing: A Laser Based Solution for Noninvasive High Speed Testing of MCMs", Accepted for publication in *IMAPS Proceedings of the 30th International Symposium on Microelectroncs.*

Electro-optic probing is a proven technique for testing high speed microwave circuits on substrates such as GaAs and InP by making point-to-point electric field measurements directly in the substrate. We have extended this technique to probe circuit structures on polyimide substrates that would be used for high density packaging such as multichip modules (MCMs).

Test results demonstrate the potential to probe circuits structures that are buried in the center layers of an MCM.

WHITESEL, Henry K. , and John K. Overby, NSWC Carderock Division Annapolis Center; Prof. Antal A. SARKADY, US Naval Academy EE Dep.; and Carl P. Jacobson, Naval Sea Systems Command, "Code Division Multiplexing of Fiber Optic Sensors with LED Sources", Proceedings of SPIE, The International Society for Optical Engineering, Laser Diode and LED Applications II, Volume 3000, 10-11 Feb. 1997, pp. 9-16.

Code division multiplexing can be used to increase the number of sensors operated on one light emitting diode (LED) and thereby reduce the unit sensor cost of the complete sensor system. We have successfully designed a system to multiplex 32 sensors on one LED with output power of approximately 0.4mW, at 850nm wavelength. The LED is modulated with a pseudorandom pulse sequence distributed through a 2 X 32 coupler to reflective sensors. Sensor response is measured by computing the cross correlation of the transmitted code and the sensor reflection. The response is separated in time by varying the length of the sensor fiber. Sensor noise is reduced by averaging and cross correlation of the sensor response with the transmitted code sequence. All processing is done by microcomputer and a digital oscilloscope. The system was demonstrated with multimode fiber connected to 2 Fabry-Perot sensors and 1 amplitude sensor. Noise values on each sensor imply that more than 32 sensors can be monitored with code division multiplexing technology.

Presentations

KORZENIOWSKI, Kelly A., Assistant Professor, "Practical Electronic Instrumentation for All Engineering Disciplines" ASEE 1996, Washington, DC, June 1996.

KORZENIOWSKI, Kelly A., Assistant Professor, "Using Supervised Learning to Fuse Sensor Data for Surface Tracking in Complex Environments", SPIE 1996, Boston, MA, November 1996.

KORZENIOWSKI, Kelly A., Assistant Professor, "Collision-Handling Control in an Automated Environment", ICAM 1997, Lafayette, LA, Feb. 1997.

LIM, Tian S., Professor, "Modeling and Simulation of A Power Circuit Breaker," 1997 ASEE Annual Conference, Milwaukee, WI.

MECHTEL, Deborah M.,Assistant Professor, "Electro-optic Probing: A Laser Based Solution for Noninvasive High Speed Testing of GHz Circuits," Sigma Xi Chapter Meeting, USNA, 25 September 1996.

HYDROMECHANICS LABORATORY

Associate Professor David L. Kriebel
Director

The Naval Academy Hydromechanics Laboratory supports a broad range of Midshipmen and faculty research in the areas of naval architecture and ocean engineering.

The laboratory facilities include one of the largest academic towing tanks in the world (380 ft long, 26 ft wide, and 16 ft deep), a small towing tank (120 ft long, 8 ft wide, and 5 ft deep), a coastal engineering wave basin (52 ft long, 48 ft wide, and 2 ft deep), a circulating water channel, a stability and ballasting tank, and computer workstations used for hull-form design. The laboratory is operated by multi-talented staff of five graduate engineers/naval architects, three engineering technicians, and an office manager. Liaison with the Naval Academy faculty is maintained by the Laboratory Director who is a member of the teaching faculty.

The primary role of the laboratory is to provide classroom lab support. In addition, however, the laboratory facilities are used for both basic and applied research by Midshipmen and faculty, as well as other Navy laboratories and government agencies.

Research programs conducted by the laboratory during the past year have included:

- Performance of the USS CONSTITUTION in wind, waves, and under tow (Sponsor: Naval Sea Systems Command)
- Ocean wave group (Sponsor: Office of Naval Research)
- Dynamics of breaking waves (Sponsor: Office of Naval Research)
- Wave interaction with vertical wave barriers (Sponsors: National Science Foundation and Alaska Science and Technology Foundation)
- Breaking wave loads on a submarine periscope (Sponsors: University of Maryland and Naval Underwater Warfare Center)

In addition to supporting Midshipman and faculty research, the laboratory staff is encouraged to pursue independent research and scholarly activities. The results are reflected in journal articles and in presentations given at technical symposia. The Laboratory is actively represented on two technical committees of the International Towing Tank Conference and in the Society of Naval Architects and Marine Engineers, the American Society of Naval Engineers, the American Towing Tank Conference, and the American Society of Civil Engineers.

Sponsored Research

USS CONSTITUTION Model Testing Program

R. H. Compton
Sponsor: NAVSEA Hydrodynamics Division (NAVSEA-USNA MOU)

A 1:25 scale model of the USS CONSTITUTION was fabricated by the Technical Support Department and tested by the Hydromechanics Laboratory to support a planned sailing of the frigate in celebration of her 200th birthday in July 1997. Testing was performed in regular, long-crested beam seas to characterize the resonant roll behavior of the ship with and without sails. Testing was then performed in wind and irregular, long-crested waves at three headings, in three "weather conditions," and with various sail plan configurations, all at zero forward speed.

Except for soft tethers at bow and stern, the CONSTITUTION model was free to respond in all six degrees of motion freedom. Model motions were measured by a non-intrusive 3D video system for all wind/wave testing. Finally, towed testing was performed to simulate the tow to the sailing venue. Only calm water tests were conducted at three slow speeds at each of three towing hawser lengths.

Resistance and Seakeeping Model Tests of a Wave Piercing Hull and a Conventional Hard Chine Planing Hull

Researcher: John J. Zseleczky, Naval Architect (HydroLab)
Sponsor: NSWC Detachment, Norfolk

Small high speed craft have an important role in the mission of the today's Navy. As lighter and more powerful propulsion systems are developed, these craft are being pushed to higher speeds in more extreme wave conditions. In severe conditions their top speed is limited by the endurance of their human occupants. Broken bones and spinal injuries have occurred when operators have exceeded the limits of human endurance.

In an attempt to extend the operating envelope of these craft, the Navy's Combatant Craft Department has been investigating the performance of some unconventional hull forms. One such hull form, referred to as a "wave piercer," has shown potential for operating safely at speeds that are higher than possible with conventional hard chine planing hulls. To evaluate the performance of the wave piercing hull on a relative basis, model tests were conducted using a 1/7th scale model of an existing hard chine planing hull and a modified version of an existing wave piercing hull with similar payload capabilities.

The models were tested side-by-side in the Naval Academy Hydromechanics Laboratory's 380 foot towing tank using new lightweight towing equipment developed by the staff using composite technology. Tests were conducted at scaled speeds up to fifty knots in calm water and up to thirty-two knots in Sea State 3. Resistance, motions and accelerations were measured under identical conditions and are documented in two separate reports.

Measurements of Breaking Wave Loads on a Moving Submarine Periscope Model

Researcher: John J. Zseleczky, Naval Architect (HydroLab)
Sponsor: NUWC - Newport and University of Maryland
Department of Mechanical Engineering

Submarine masts, antennas and periscopes (MAP's) are built to withstand the hydrodynamic loads experienced when cruising at periscope depth in rough weather. Presumably, the highest loads occur when a MAP is struck directly by a breaking wave in head seas. The current design methods used at NUWC-Newport are based on static pressures that are estimated to represent this worst-case scenario.

For this project, fundamental experiments were conducted in the 380 foot towing tank using a 3.5 inch diameter partially-submerged cylinder as a model periscope. The stiffness properties of the cylinder were scaled to represent those of the full scale counterpart and loads were measured using strain gages mounted on the surface of the model. The model was supported at its base and towed at a constant speed into an approaching breaking wave. Tests were conducted with one repeatable breaking wave, one towing speed and with the model at several locations relative to the breaking wave crest.

The project was undertaken as a joint effort with the University of Maryland (UMD), where tests were conducted using a smaller scale model. By performing experiments at two different scales it was possible to evaluate the effects of scale on the model test results.

Some new capabilities were developed by the staff of the Hydromechanics Laboratory for these experiments. New software was developed to create the same type of repeatable breaking wave used in UMD experiments, and new electronics were developed to synchronize the start of the wavemaker with that of the towing carriage. These new capabilities will allow the lab to obtain funding for similar projects in the future.

Performance Evaluation of Full Scale Drifting Wave Buoys

Researcher: John J. Zseleczky, Naval Architect (HydroLab)
Sponsor: Naval Research Laboratory

The Navy has sponsored the development of small, expendable wave buoys that can be deployed from an aircraft and then drift freely in the ocean. Each buoy has an internal computer and satellite telemetry system that allows it to process motions data onboard and send summaries of results to a shore station. Instruments inside the buoy sense accelerations, inclinations and global heading and convert the measurements to wave elevation and wave direction spectra.

Because of their low inertia, these buoys experience high frequency angular motions that complicate the output of the motion sensors. Sophisticated methods are used in the onboard software to analyze the measurements and reduce the effects of the high frequency motions. The role of the Hydromechanics Laboratory in this project was to create and carefully measure a seaway under laboratory conditions in the 380 foot towing tank.

The full scale buoys were placed at one end of the tank and allowed to drift with the waves while their measurement equipment was activated. A thorough set of wave elevation measurements were provided by the laboratory to the sponsor for evaluating the wave properties obtained using the wave buoys.

Independent Research

Model Tests to Measure Extreme Wave Loading on a Fully-Restrained Rectangular Barge

Researchers: John J. Zseleczky, Naval Architect (HydroLab)
Stephen W. Enzinger, Naval Architect Technician (HydroLab)

A set of model experiments were conducted in the Hydromechanics Laboratory's 120 foot tank to measure the forces on a fully-restrained barge model as it was subjected to extreme waves. Similar tests were conducted a year earlier as part of a broader test program but some problems were found with the data obtained when the model was fully restrained. This test program was undertaken as an internal project to investigate the problems with the earlier tests and to obtain a new set of fully reliable measurements under an abbreviated set of test conditions.

The barge model tested was approximately 5 feet long, 1.5 feet wide and 0.5 feet high. It was suspended from the towing carriage so that it was half submerged. Forces were measured in the X, Y, and Z directions at two support points along the length of the hull. The model was tested in the same extreme seaway that was developed under the direction of the sponsor for the previous tests, and tests were conducted with the model aligned in the head seas and beam seas orientation.

For these tests, the experimental apparatus was rearranged and reinforced, and estimates were made of the reduced deflections of the model. An investigation was also made into the complex flow around the model that could lead users of the data to misleading conclusions.

Publications

COMPTON, Roger, H., co-author, "The Safety of High Speed Marine Vehicles," HSMV Committee Report to the 21st International Towing Tank Conference, Vol 1, pp. 515-544, Trondheim, Norway, Sept, 1996.

Several areas of the world are now served by fast ferries with the result that hundreds of passengers are conveyed at speed daily over waters which are often congested. Military organizations throughout the world are using, (or at least considering for use) high

speed marine vehicles to serve a number of roles from high speed interception duties to fast patrols, from fast weapon platforms to rapid deployment of troops. Rescue services have joined this upward trend in speed by designing and building faster rescue craft, whose speed is of value by allowing rapid response to a casualty which may be several miles distant.

These lighter, more vulnerable craft, moving at high speeds across the waters of the world have to be safe. They are subjected to structural loads and accelerations which differ considerably in type and magnitude from those in displacement ships. The consequences of an accident to fast vessels have spurred various authorities to produce rules and criteria which must be met for safe operation. Most important of these is the IMO Code of Safety for High Speed Craft. This provides, among other things, guidelines for safe operational limits and is meant to cover all types of high speed craft.

The increase in craft numbers around the world must not be accompanied by a corresponding increase in accidents. A complete understanding of both the dynamics and hydrodynamics of high speed craft is the key to ensuring the safe and predictable behavior of such craft. Clearly there are roles for both theoretical and experimental investigations.

ZSELECZKY, John J., Naval Architect, Co-author, "Investigation of a Hybrid Wave-Piercing Hull Form," FAST '97 Conference, pp. 623-628 Sydney Australia, July 1997.

In recent years, work has been done on the development of a hybrid wave piercing planing hull in an attempt to travel at higher speeds in larger waves. To evaluate the performance of the new hull form, a series of experiments were performed in a towing tank using 1/7th scale models of a new wave piercing hull and a conventional hard chine planing hull. This paper discusses the background of the new hull, the approach used to test the two models and presents a comparison of the model test results.

ZSELECZKY, J., Naval Architect, Co-author, "Force and Moment Measurements on a Low Length-to-Beam Submarine Model," ASME Fluids Engineering Division Summer Meeting, Vancouver British Columbia, June 199, FEDSM 97-3131.

Most of the data published for submarines and other underwater vehicles are based on bodies with high length-to-beam ratios. This paper summarizes hydrodynamic force and moment measurements made on a model submarine with a relatively low length-to-beam ratio of five, which is typical for swimmer delivery vehicles. The model was fitted with horizontal fins and tested over a range of pitch angles. Tests were conducted with several variations in fin span, chord and location.

Presentations

COMPTON, Roger H., Professor, "The Safety of High Speed Marine Vehicles," 21st International Towing Tank conference, Trondheim, Norway, Sept, 1996.

COMPTON, Roger H., Professor, "USS CONSTITUTION Model Tests at the U.S. Naval Academy Hydromechanics Laboratory," NAVSEA/NAVHIST Briefing at U.S. Naval Academy, Jan, 1997.

KRIEBEL, David L., Assoc. Professor, "Extreme Wave Crest Statistics," Maritime Research Institute of the Netherlands, Waginengen, The Netherlands, March 1997.

KRIEBEL, David L., Assoc. Professor, "Extreme Wave Crest Statistics," Royal Dutch Shell Offshore Research Center, The Hague, The Netherlands, March 1997.

ZSELECZKY, John J., Naval Architect, Co-author, "Investigation of a Hybrid Wave-Piercing Hull Form," FAST '97 Conference, Sydney Australia, 21-23 July 1997.

Technical Reports

COMPTON, Roger H., Professor, co-author, "Ship Stability Criteria Revision Project: Intact and Damaged Model Testing of a HAMILTON Class cutter (WHEC) at Zero Speed in Wind and Waves," U. S. Naval Academy Division of Engineering and Weapons Report No. EW-09-96, June 1996.

The realistic assessment of ship stability in typical and severe sea conditions requires dynamic as well as static analysis methods. Thus, the classical naval architectural technologies of intact/damaged stability and seakeeping are rapidly becoming inseparable. An international effort to review, improve, and update ship stability criteria has employed physical scale modeling, analytical modeling, and full scale sea trials to understand and be able to develop criteria which insure adequate safety for ship loading over a ship's life.

The U.S. Naval Academy Hydromechanics Laboratory (NAHL) has been involved in this criteria development process primarily in the performance of physical scale model experimentation in wind, waves, and combined wind and wave environments. The initial results of this NAHL effort, from the Summers of 1993 and 1994, are documented in a series of four technical reports (Shaughnessy, Nehrling, Compton - Oct '93, July '94, Aug '94, Jan '96). A summary presentation on the experimental techniques developed for stability testing of ship models was presented to the Fifth International Conference on Stability of Ships and Ocean Vehicles (STAB '94) by the same three authors in November 1994.

The work described in this report extends this experimental methodology to include a damaged ship scenario. Both direct physical modeling of the U.S. Navy damaged stability criteria (NSTM, Chapter 079) and the behavior of both the intact and damaged model in extreme wave conditions were investigated. Correlation of intact predictions from two different sized models is also investigated. In addition to the written report, a full set of annotated video tapes of the test program was produced.

ZSELECZKY, John J., Naval Architect, "Resistance and Seakeeping Model Tests of a Hard Chine Planing Hull," U.S. Naval Academy Division of Engineering and Weapons Report No. EW-17-96, June 1996.

Model tests were conducted at 1/7th scale to measure the calm water resistance, wave generation properties and seakeeping performance of an existing hard chine planing hull currently in use by the Navy. This report documents the tests, equipment and procedures used in the test program. A full set of results are presented for the calm water resistance tests and summaries of the seakeeping statistics are presented.

ZSELECZKY, John J., Naval Architect, "Resistance and Seakeeping Model Tests of a Wave Piercing Hull," U.S. Naval Academy Division of Engineering and Weapons Report No. EW-18-96, June 1996.

Model tests were conducted to evaluate the calm water resistance, wave generation properties and seakeeping performance of an unconventional hybrid Wave Piercing hull form. This report documents the tests, equipment and procedures used in the test program. A full set of results are presented for the calm water resistance tests and summaries of the seakeeping statistics are presented.

ZSELECZKY, John J., and ENZINGER, Stephen W., "Repeat Model Tests to Measure Extreme Wave Loading on a Moored Rectangular Barge," U.S. Naval Academy Hydromechanics Laboratory Report No. HL-1-96, July 1996.

A set of model experiments were conducted in the Hydromechanics Laboratory's 120 foot tank to measure the forces on a fully-restrained barge model as it was subjected to extreme waves. The barge model tested was approximately 5 feet long, 1.5 feet wide and 0.5 feet high; it was suspended from the towing carriage so that it was half submerged. Forces were measured in the X, Y and Z directions at two support points along the length of the hull. The model was tested in an extreme seaway with the model aligned in the head seas and beam seas orientation. Deflections of the model were estimated and observations of the complex flow around the model were reported.

DEPARTMENT OF MECHANICAL ENGINEERING

Professor Russell A. Smith
Chair

Research by faculty and midshipmen in the Mechanical Engineering Department reflects the broad interests of a diverse and highly qualified group of engineers. Projects active in this period included internal combustion engines, fracture mechanics, fluid mechanics of bearings and pumps, thermal design, materials processing and engineering, corrosion, continuum mechanics, vibrations and flow field studies.

In summary, the department was involved in 40 projects, of which 21 were sponsored research, 12 were midshipmen projects earning academic credit and 7 were independent projects. Research sponsors included the Office of Naval Research, Naval Surface Warfare Center, U.S. Nuclear Regulatory Commission, Naval Research Laboratory, Colorado State University and the National Renewable Energy Laboratory, and the U.S. Naval Academy Research Council. Industrial sponsors included Peugot Sport, the Ford Research Laboratory and Faraday Technologies.

Research efforts in the department are promoted by faculty and midshipman interest in studying new technology and solving problems of interest to the U.S. Navy. This activity not only creates excitement among the research teams, but promotes the study and introduction of new technology in the classroom. Faculty and midshipmen involvement in publication of research and invited presentations reflects credit and recognition for the individuals and the U.S. Naval Academy.

Sponsored Research

Modal Analysis of Thick Sandwich Plate

Researchers: Assistant Professor Oscar Barton, Jr. and Assistant Professor Colin P. Ratcliffe
Sponsor: David Taylor Naval Ship Research Center

This project considers the investigation of the fundamental thick sandwich plate that contains woven fabric layers. The problem has been formulated using a first order shear deformation theory and the Rayleigh-Ritz method to compute the fundamental frequencies. Comparative frequencies are obtained through experimental means.

Vortex Survey

Researchers: Assistant Professor Karen A. Flack, Professor Robert A. Granger
Sponsor: Naval Surface Warfare Center, Dahlgren Division

Wings of aircraft and wing- like objects towed through water shed a relatively strong vortex from the tip of the wing. With regards to aviation, this vortex can be potentially dangerous to nearby airplanes. The ability

to dissipate the vortex quickly or minimize its extent would be of great interest to the aerodynamic community. This research studies the effectiveness of wing modifications, including wing planform, wing trailing edge, and wing tips, in modifying the vortex flow fields generated by the wing. This experimental research will be conducted in the Eiffel wind tunnel located in the Aeronautics laboratory. Results will include flow visualization of the vortex core and velocity measurements of the flow field within and surrounding the vortex. Currently, the experimental equipment is being designed and tested, including the laser Doppler anemometer (LDA) system used to obtain velocity measurements.

The Effect of Environment on the Mechanical Behavior of Advanced Metals

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

High performance engineered materials are required for future naval structural and power systems. Current high temperature applications identify carbon fiber/glass matrix composites (CMC's) as candidate materials. While ambient condition mechanical properly information is available, environmental effects on the performance of these composites require additional investigation. An example is the present study on the effect of a soak in a high temperature oxidizing atmosphere on impact toughness. Recently, another materials system, ultra light metal structures, has been identified as a candidate to meet naval requirements. A study of mechanical properties and toughness similar to the one underway on the CMC's would be informative.

Elastic-Plastic Fracture Mechanics of LWR Alloys

Researcher: Professor J. A. Joyce
Sponsor: United States Nuclear Regulatory Commission

The major effort during this year was applied to testing and the analysis of 60 surface cracked bars loaded in tension and combined tension and bending. Two materials were studies, two load combinations, 2 temperatures, and 7 or 8 repeat tests at each of conditions were used. All tests were conducted in the 500,000 lb test machine at Naval Surface Warfare Center, Annapolis Laboratory. These materials are now being characterized using much smaller Charpy specimens, and with standard 1T C(T) specimens and comparisons of the conditions at fracture are being related between the large tests and the small specimens. These efforts will continue into the next fiscal year.

Constraint Effects in Fracture Toughness

Researcher: Assistant Professor Richard E. Link
Sponsor: Naval Surface Warfare Center, Carderock Fatigue and Fracture Branch

Theoretical, numerical and experimental investigations are being conducted to understand, explain and model the effects of constraint on fracture toughness in the ductile-to-brittle transition region of ferritic materials. The fracture toughness of pressure vessel steels is being measured over a wide range of crack tip constraints using standard laboratory specimens as well as surface cracked structural elements. The experimental data developed in this program is being used to assess the ability of newly-emerging fracture methodologies (two-parameter fracture mechanics, computational cell models and toughness scaling models) to accurately model the fracture behavior of ferritic steels in the transition region. This is part of a

joint program with NSWC, Brown University and University of Illinois.

Dynamic Fracture Initiation Toughness of A533B Steel

Researcher: Assistant Professor Richard E. Link
Sponsor: Naval Surface Warfare Center, Carderock Fatigue and Fracture Branch

The dynamic fracture initiation toughness of ASTM A533, Gr. B steel plate was measured over a range of loading rates from 1 x 10^3 to 2 x 10^5 MPa/m/s and over a temperature range of $0 \leq T\text{-}RT_{NDT} \leq 75°F$. In addition, quasi-static and dynamic mechanical properties were determined. A master curve was developed and the associated reference temperature was used as a basis of comparing the results of this investigation with other fracture data on this grade of steel. The results of the current investigation define the dynamic fracture behavior high in the ductile-to-brittle transition region where the existing database was sparse. It was also demonstrated that the shift in the fracture toughness transition curve due to dynamic loading could be characterized using the recently developed master curve and reference temperature approach.

Computational Fluid Dynamics Analysis of the Flow Distribution Through a Dense-Pack Ceramic Ultrafiltration Membrane in an Oily Waste Polishing System

Researcher: Associate Professor Steven Miner
Sponsor: NSWC Carderock Division (Mr. Larry Murphy)

Research and Development of ultrafiltration membrane systems for oily waste treatment are being conducted to polish the effluent from parallel plate oil/water separators currently installed on Navy ships. These ultrafiltration systems will give ships the ability to reduce the quantity of oil in bilgewater discharges to less than 5 mg/L. The best performance of these systems is achieved when the flow distribution across the membrane is uniform. Computational Fluid Dynamics (CFD) is used to determine the flow distribution across the membranes for the oily water pollution control project.

Computational Fluid Dynamics Analysis of the Flow Patterns in Composite Ball Valves

Researcher: Associate Professor Steven Miner
Sponsor: NSWC Carderock Division (Mr. Dennis Conroy)

The purpose of the study is to evaluate the flow field downstream of a 3" and 6" composite ball valve. Two geometries for each valve are considered, the as designed geometry and an ideal geometry using a 14 degree angle for the diverging section. Of particular interest is the appearance of any flow separation downstream of the valve. Results will include a comparison of the flow fields for the designed geometry and the ideal geometry.

Spray Formed Substrates

Researcher: Associate Professor Angela Moran and Mr. John Hein
Sponsor: NSWC/NARC

Spray Forming is a new method for rapid deposition of metallic components for military applications.

Currently spray formed components are limited to simple asymmetric shapes but the introduction of intelligent processing and computer controlled five axes robotics has extended the possible component configurations. A substrate material such as cement is being investigated to use as an alternative to current substrate materials that must be physically removed from the spray formed part. Complex shapes such as tapered tubes, elbows and hemispheres are not amenable to extensive machining to remove substrates. This project is investigating alternatives to substrate materials and designs for easy removal.

Development of a Remote Sensor for the Detection of Crevice Corrosion

Researchers: Professor Patrick J. Moran, Dr. Maria Inman (Faratech), Dr. Jennings Taylor (Faratech), Mr. Dan Davis (NSWC-Carderock)
Sponsor: NSWC/Carderock Division (Program is in cooperation with an ONR/NSWC-CD Funded Program at Faraday Technology, Inc. in Dayton, OH)

Faraday Technology, Inc. is a small business located in Ohio. This company has a Small Business Innovative Research Grant from ONR to develop remote sensors for the detection of crevice corrosion in seawater piping systems. NSWC-CD is also involved and Prof. Moran is funded by NSWC-CD to function as a technical consultant to the program due to his expertise in crevice corrosion mechanisms and in detection methodology for corrosion processes. Prof. Moran is assisting Faraday Technology, Inc. in the design and development of remote sensors for crevice corrosion based on electrochemical methods. An o-ring based sensor has been developed and test results to date have been very promising. It is currently in high pressure testing in U.S. Navy piping mock-ups.

Failure Analysis of K-Monel Bolts

Researchers: Professor Patrick J. Moran, LT Sandra E. Kwiatek, USNR
Sponsor: NSWC/Carderock Division

A significant number of K-Monel bolts failed during service in a U.S. Navy system. The bolts experienced high mechanical stresses as well as cathodic protection from corrosion during service. The objective of this program is to determine, if possible, to what extent the cathodic protection system influenced the failures. Cathodic protection can cause hydrogen to enter the protected components which can lead to hydrogen embrittlement. Scanning electron microscopy, x-ray microanalysis and metallography are being utilized to examine the fracture surfaces of the failed bolts.

Tracer-Gas Technique Development for Evaluation of Intake-to-Exhaust Short Circuiting During Valve Overlap

Researchers: Assistant Professor Paul V. Puzinauskas, Dan Olsen (Colorado State University)
Sponsor: Peugeot Sport

Four-stroke-cycle engine scavenging is improved under most operating conditions when the intake valve opens before the exhaust valve closes. This time while both valves are open is called the valve-overlap period. The optimum amount of overlap varies as a function of engine speed and intake- and exhaust-system pressures and configurations. One result of valve overlap is that under certain conditions, the intake charge can flow straight through the combustion chamber into the exhaust port. This condition is called 'short-circuiting.' The purpose of this project is to identify a gas which can be injected into the intake stream that is

stable at exhaust temperatures but is consumed during the combustion process and thereby allow quantifying short-circuiting.

To achieve this goal, a literature survey was conducted to determine if similar work was done and to identify any additional potentially appropriate tracer gasses. Several researchers had used monomethylamine tracer gas to calculate trapped air-fuel ratio in two-stroke-cycle engines, but the operating conditions, i.e. the exhaust temperatures and combustion durations, were significantly different than those of interest to the sponsor. The literature search was extended to find any relevant chemical kinetic and equilibrium data which would allow estimating the appropriateness of monomethylamine and other potential tracers under the operating conditions of interest. An analysis was carried out using Arrhenius rate calculations to predict the potential for each tracer. These tracers were then tested in an actual engine.

The last of the data was recently acquired and is now in the process of being reduced. A report will be produced for the sponsor, but as the results of this work are proprietary, no publications can be released until two years after acceptance of this document by the sponsor.

Optimization of Natural-Gas Fueled Spark-Ignited Engine Combustion Systems

Researchers: Assistant Professor Paul V. Puzinauskas and Collaborators from Colorado State University
Sponsor: National Renewable Energy Laboratory

Recent emphasis on air quality has motivated investigating alternatives to gasoline and Diesel fuel for use in automobiles and heavy-duty vehicles. Natural gas is one of the most promising alternative fuels due to its clean burning characteristics and plentiful domestic supply. To date, most of the efforts in developing natural gas for automotive applications have centered on fuel storage and delivery. The engines themselves are not typically substantially different than their gasoline-fueled counterparts. This research will be focused on optimizing the engine intake and combustion systems for use with natural-gas fuel. Issues related to mixing, ignition and flame propagation will be investigated experimentally and analytically.

Fabrication of hardware specific to this research has already begun as has selection of required equipment and certification of test fuel-delivery systems.

Dynamical Systems, Bifurcations, and Fracture Mechanics

Researchers: Associate Professor R. A. Raouf and Professor R. Malek-Madani
Sponsor: Office of Naval Research

This research project is concerned with developing mathematical models that predict the onset of material instabilities and initiation of fracture. Current phase of research studies the thermo-visco-plastic behavior of isotropic materials undergoing high shear rates.

Dynamic Investigation of a GRP Deck Panel

Researcher: Assistant Professor Colin P. Ratcliffe
Sponsor: NSWC, Carderock

This project experimentally investigated the vibrational performance of a new design of glass reinforced plastic composite deck panel. Work was conducted at half scale, with the panel being 20 (ft) by 6 (ft). Two areas were of particular interest. Firstly, it was necessary to determine the fundamental natural

frequency, in order to ensure it is above in-service dominant excitation frequencies. Secondly, the deck panel incorporates inbuilt equipment mounts. These are to replace the more complex and expensive rubber/metal mounts currently used at sea. It was necessary to determine if there was any dynamic coupling between the deck vibrations, and those of the inbuilt mount straps.

The method of investigation was experimental modal analysis, with fixed reference acceleration and moving excitation. Impulsive excitation was used throughout. The final report was submitted September 1996.

Modal Analysis of Composite Deck Panels

Researcher: Assistant Professor Colin P. Ratcliffe
Sponsor: Ingalls Shipbuilding, Pascagoula, Mississippi

This was an experimental investigation into the modal properties of two different glass reinforced plastic composite deck panels, each 20 (ft) by 6 (ft). Work was conducted in Mississippi, and involved road travel from Annapolis in order to carry the equipment. The method of investigation was modal analysis, with fixed reference acceleration and moving excitation. Impulsive excitation was used throughout. The final report was submitted September 1996.

Dynamic Characterization of Urethane Damping

Researcher: Assistant Professor Colin P. Ratcliffe
Sponsor**:** NSWC, Carderock

During the last few years, NSWC has funded projects concerning the vibrational behavior of underwater cylinders constructed from various composite materials and cross sectional geometries. An interesting finding was that reinforced urethane acts both as a structural material, and as a vibrational damping material. This project continued the process of quantifying the performance of the reinforced urethane material system. Experimental modal analysis was used on a variety of structural configurations in order to characterize the material system.

Feasibility Study on a Two-stage Vibration Absorber

Researcher: Assistant Professor Colin P. Ratcliffe
Sponsor**:** NSWC, Carderock

This small project is a preliminary investigation into the feasibility of building a multi-stage vibration absorber. Existing absorbers are in “families”, with typically 5-10 different sizes per family. The aim of the work is to identify whether a single multi-stage absorber can be used to replace several absorbers in each family. There are significant cost and operational benefits if this is possible.

The work is primarily theoretical, building computer based simulations based on experimental data. It is ongoing, and may continue next year, depending on funding to NSWC.

Investigation of Turbulent Transport, Heat Flux and Temperature Distributions at the Wave/Water Interface.

Researcher: Assistant Professor Ralph Volino
Sponsor: NRL-USNA Cooperative Program, ONR

The work was completed at the NRL Free-Surface Hydrodynamics Laboratory to study the fundamental aspects of air/sea interaction physics. The correlation between sub-surface hydrodynamics and the temperature field at a free surface was explored experimentally. A vortex generator was designed and constructed for use in a small water tank, to generate a pair of line vortices with their axes parallel to the free surface. Initially, the water surface is cooled by evaporation, forming a thin thermal boundary layer. As the vortices approach the surface the thermal boundary layer is disturbed, altering the surface temperature. The strain field associated with the vortices is measured using digital particle image velocimetry (DPIV). The free surface temperature is simultaneously measured with an infrared (IR) camera. Through this experiment a better understanding of the relationship between the hydrodynamics below a free surface and their IR signatures is developed. This understanding will be applied in future work to explain the IR signatures generated by more complex flow fields. Direct numerical simulations of the experiments are being performed by a researcher at NRL to provide more insight into the phenomena observed in the laboratory. All work is directed toward remote sensing of the ocean surface. Preliminary results were presented at the American Physical Society, Division of Fluid Dynamics annual meeting in Syracuse NY in November 1996. Journal publications are currently being prepared. Discussions are underway for continued work in 1997, including a midshipman internship at NRL in summer 1997.

Intelligent Computer Aided Instruction (ICAI)

Researcher: Professor Chih Wu
Sponsor: Office of Naval Research

The Mechanical Engineering department at the United States Naval Academy is currently evaluating a new teaching method which implements the use of a computer software. Utilizing the thermodynamic based software CyclePad, Intelligent Computer Aided Instruction (ICAI) is incorporated in a basic Engineering Thermodynamics course (EM319) for engineering major students and an advance Energy Conversion Course (EM443) for mechanical engineering students. The use of the CyclePad software enhances lectures and aids students in visualization and design.

The contents of undergraduate thermodynamics courses were established long before computers existed. Problem assignments appearing in popular textbooks have been developed with an understanding that students will work them by hand. Interesting practical problems which are difficult to solve or which involve parametric studies are usually not assigned because the long calculation would require an unreasonable time investment by the students. CyclePad allows users to concentrate on the fundamental engineering design principles without being distracted by the tedious computation and wrong input design data. As a consequence, students can do more comprehensive design and cover more material without necessarily devoting more study time to the course.

CyclePad introduces students to the concept of design as an open-ended process involving synthesis, analysis, and choices among design alternatives. It provides a valuable design aid by giving visualization of the schematic combination of a variety of thermodynamic cycles. This visualization allows the students easily to explore the effects that changing design parameters have on the behavior of a cycle. The approach of the CyclePad makes the learning of thermodynamic cycle design more exciting and results in more effective training of future designers.

CyclePad has been in use for only one semester now at U.S. Naval academy for design homework and project. The experience has been a positive one. The future version of the software will incorporate modifications suggested by users.

Independent Research

Boundary Layer Flow on a Rotating End Mill

Researchers: Assistant Professor Karen A. Flack, LT Beth L. Pruitt, USN,
ENS Mark J. Callari, USNR

It is important to accurately determine the position of an end mill with respect to the material for automated machining of parts. Tests have shown that sensors located on the material show a strong signal before the end mill touches the material. It is hypothesized that the noise in the signal is due to the boundary layer formed around the rotating tool. The focus of this project is to investigate the boundary layer structure through flow visualization and velocity measurements on a scaled model to determine the structures that are responsible for the noise. The boundary layer was visualized using a dye injection technique. It was determined that the visualized structures were too large to be responsible for the noise. The most likely source is the viscous sublayer deep within the boundary layer. Continued research used a one-component Laser Doppler Anemometer system to measure the velocity profiles in the boundary layer on the end mill.

Web-Centric Learning and Evaluation

Researcher: Associate Professor R. A. Raouf

A set of web-centric self-paced learning and evaluation system has been developed and implemented as Grades On Demand system. The system has been used in EM477 and EM371. Usage data has been collected and is being analyzed.

Effects of Imperfections on the Elastic and Dynamic Stability of Composites

Researcher: Associate Professor R. A. Raouf

This research studies composite structures with manufacturing imperfections. Two imperfections have been studied: irregular thickness and fiber waviness. The governing equations are derived and approximate, closed-form expressions for buckling loads and vibration frequencies are derived using the perturbation theory and the Fredholm alternative theorem. Results are verified using a numerical shooting scheme. Results have been presented in conferences, one paper has been accepted for publication and another one has been submitted.

Wavelet Analysis of Transitional and Turbulent Flow Data

Researcher: Assistant Professor Ralph Volino

The transition from laminar to turbulent flow in a boundary layer subject to strong acceleration, streamwise curvature and high free-stream turbulence is being studied. The purpose of the work is to provide a better understanding of the transition process, which will be useful in the development of improved transition models. The flows in question are representative of the flows in gas turbine engines, where transition is known to be an important phenomenon affecting the engine efficiency and the heat transfer to critical engine components. Experimental velocity data, which was acquired in a wind tunnel facility at the University of Minnesota, is used for analysis. This data is analyzed using “wavelet

analysis," which is used to examine the frequency spectrum of a signal. The objective of the investigation is to determine the important frequencies in the fluctuating velocity and turbulent shear stress in the boundary layer. Particular attention is paid to differences between the laminar and turbulent zones of the flow. Characteristic frequencies of the transition, are also determined. The wavelet analysis, unlike a conventional spectral analysis, allows separate interrogation of the laminar and turbulent zones of the transitional flow. The analysis is performed using MATLAB software on Sun workstations. Some preliminary work was performed last year by Midshipman. 1/C L.A. Camardo as an EM496 independent study. His results were interesting, showing an increased importance of higher frequencies as the flow progressed through transition. This agrees with the results of conventional (Fourier) spectral analysis, providing confidence in the analysis techniques and programs. I have since refined the analysis procedure and am continuing the investigation of more experimental data, focusing on the differences between the laminar and turbulent regions of the flow.

Modeling of Free-Stream Turbulence Effects on Boundary Layers

Researcher: Assistant Professor Ralph Volino

Free-stream turbulence can have a large effect on the behavior of boundary layers. Elevated free-stream turbulence can cause higher skin friction and heat transfer from surfaces. This is true for laminar, transitional and turbulent boundary layers. Elevated free-stream turbulence is found in many practical applications, including the flow over gas turbine blades and vanes. Accurate prediction of gas turbine heat transfer is a limiting factor in improving and advancing future engine designs. Existing turbulence models account for free-stream turbulence effects in a number of ways. Some perform well under some conditions, but none are robust over all conditions. Recent experimental evidence suggests that current models are missing important aspects of the flow physics. The data show a distinct separation of scales between fluctuations induced by the free-stream and fluctuations due to turbulence generated within the boundary layer. A new model has been developed in the present study which treats these two scales separately. The model is relatively simple and can be implemented along with existing computational codes. The model has been developed and tested in comparison to several experimental data sets. Comparisons are good. A paper has been written on results to date, which will be presented at the ASME International Gas Turbine Conference in Orlando, FL in June 1997. Reviews of the paper were very favorable and encouraged continued work. Further development and testing in more complex flows will proceed. External funding will be sought for the work.

Construction of a Wind Tunnel Facility

Researchers: Assistant Professors Ralph Volino and K.A. Flack

A new, low-speed wind tunnel facility has been designed and is under construction in the TSD shop for use in future experiments. The tunnel is modular, allowing arrangement in various configurations for a wide range of investigations. Flexibility and the ability to incorporate specialized test sections will be much greater than possible with existing facilities. Included will be the flexibility for study of both low and high free-stream turbulence flows. The tunnel entrance, settling chambers and contraction are complete. Various test sections will be attached downstream of the wind tunnel contraction. Two such test sections have been designed and are currently under construction. The first will consist of a channel with one flat wall and a flexible wall, which will allow for adjustment of the pressure gradient through the test section. Boundary layer transition will be studied on the flat wall under strong acceleration and deceleration conditions. The work will be directed toward gas turbine research. The second test section will consist of a strongly curved channel. Comparison of the results from the flat wall and curved wall test sections will allow a determination of the importance of curvature on the flow over airfoils under simulated gas

turbine conditions. Measurements will be made using existing hot-wire and laser doppler velocimetry equipment. A permanent location for the facility and electrical connections for the blowers are currently being considered. Plans are to have the entire facility complete and operational for qualification tests in late spring or early summer of 1997.

Research Course Projects

Modeling Effects of Woven Fabrics on the Fundamental Frequency of Thick Composite Plates

Researcher: Midshipman. 1/C Darren Womaks
Faculty Advisor: Assistant Professor Oscar Barton, Jr.

This investigation seeks the understanding of the modeling effects of woven fabric composites on the frequency of composite plates. Both thick and thin structures will be considered. The models to be considered for the woven fabric layers include the antisymmetric cross-ply model, the bridging model and the undulation model. The frequency analysis will be accomplished by casting the governing differential equation into an energy form and employing the Rayleigh-Ritz method to compute the desired frequencies.

Results of this work are to be presented at the Fourth International Conference on Composites Engineering, July 6-11, 1997.

Development of a Fatigue Precracking Machine

Researcher: Midshipman 1/C Michael G. Toribio
Faculty Advisor: Assistant Professor Richard E. Link
Sponsor: Carderock Div. Naval Surface Warfare Center, Fatigue and Fracture Branch

The purpose of this project was to design and construct a fatigue precracking machine. The machine creates a uniform circumferential crack in standard notched round bar specimens via cyclical tension and compression stresses. Round bar specimens offer a variety of advantages over traditional fracture test specimens, including better applicability to high displacement rate and environmental tests. A machine was designed, fabricated and tested in this project. It was demonstrated that the machine met the design objectives and several recommendations for improving the design were suggested. This paper was presented by Midshipman Toribio at the ASEE Mid-Atlantic Section Student Paper Competition held at West Point and won first place.

Development of a Second Order system Laboratory for EM375

Researcher: Midshipmen 1/C Sarah A. Loughead
Faculty Adviser: Associate Professor Steven M. Miner

The purpose of this study was to develop a laboratory that demonstrates the principles of a second order measurement system. The laboratory illustrates the relationship between the magnification factor and the frequency ratio that is dependent on the system mass and stiffness. The student will both model the behavior of the system on the computer and measure the systems behavior, and then compare the two outcomes. This laboratory is being developed for use in EM375.

Materials Selection for TPV Emitter

Researcher: Midshipman. 1/C P. C. Saxton
Faculty Advisor: Associate Professor Angela Moran
Sponsor: Trident Scholar Program, Department of Energy

Thermophotovoltaic energy conversion has the potential for high efficiency while exhibiting characteristics that may prove advantageous to the military and to commercial industry. The TPV process converts thermal energy into photon radiation which can be used to generate DC electric current in a photovoltaic cell. The Knolls Atomic Power Lab has developed a high temperature thermophotovoltaic cell that will potentially operate at much higher efficiencies than previous designs. Unfortunately materials have not been discovered that have the necessary properties to act as a photon emitter and withstand temperatures up to 2400F. This project involves the screening, testing and selecting of suitable materials for a TPV emitter operating at 2400F, based on critical material parameters.

High Temperature Copper Alloys for the Automotive Industry

Researchers: Midshipman. 1/C John V. Wicklund IV and 1/C Chris P. Neish
Faculty Advisor: Associate Professor Angela Moran
Sponsor: Ford Research Laboratory

Spot welding electrodes deteriorate very rapidly when used for welding of aluminum automotive components. This is due to the formation of a low melting point eutectic phase at the interface of the copper electrode and the aluminum, dissolving away the surface of the electrode. This project involves developing novel electrode compositions which suppress the formation of low melting point phases, thereby increasing electrode life. Advanced manufacturing methods such as laser cladding, ion implantation and spray deposition will be utilized.

Pitting of Aluminum as a Function of Crystal Orientation

Researchers: Midshipman 1/C Brandon W. Davis (Trident Scholar), LT Sandra E. Kwiatek, USNR, Professor Patrick J. Moran and Dr. Paul M. Natishan (NRL)
Faculty Advisor: Professor Patrick J. Moran
Sponsor: NRL-USNA Cooperative Program and USNA Trident Scholar Program

Aluminum and many aluminum alloys experience pitting corrosion in marine environments. This pitting often results in pits which are crystallographic in nature and the pits are composed of only 100 crystal faces. The objective of this program is to understand the mechanisms by which this pitting occurs and to utilize this understanding to influence the development of more corrosion resistant aluminum alloys. A Trident Scholar Program, also funded by the NRL-USNA Cooperative Program, during 1996-97 investigated the influence of the particular crystal face on the imitation of corrosion and found that faces other than the 100 face were more likely to initiate corrosion. Some evidence that the 100 faces also cause slower propagation of corrosion was also discovered. Work is continuing with NRL-USNA Cooperative Program support through FY97 and hopefully beyond.

Use of CyclePad as a Teaching and Learning Tool for Applied Thermodynamics

Researchers: Midshipman 1/C J. L. Gibson and M. P. Hollenbach (Fall 96) and
Midshipman 1/C M. P. Hollenbach (Spring 97)
Advisor: Assistant Professor S.C. Palmer
Sponsor: Office of Naval Research

The purpose of this project was to enhance the Applied Thermodynamics curriculum through the use of the program CyclePad (CP). CP was designed to simulate thermodynamic cycles and processes. In-class demos were developed to illustrate concepts. In addition, student design problems were developed and enhanced. The fall semester culminated with a seminar given by Midshipmen Gibson and Hollenbach for the ME and NAOME faculty. The efforts of the entire project will be incorporated into a paper to be submitted to Computer Applications in Engineering Education.

Tuned Exhaust System

Researcher: Midshipman. 1/C T. S. Voglesonger
Faculty Advisor: Assistant Professor P.V. Puzinauskas
Sponsor: SAE/ME Department

The Society of Automotive Engineers sponsors several annual inter-collegiate design competitions, including Formula SAE. In this competition, the student teams design and build an open-wheeled race car that is evaluated relative to competing universities in seven categories. The vehicle's engine must be a four-stroke-cycle design with less than 610cc of displacement and must breath through a 20mm student-designed restrictor. Engine modifications are otherwise nearly unlimited. This project was initiated to design, build and evaluate an exhaust system tuned to optimize engine output and flexibility.

This effort consisted of background literature review and construction of a prototype system-evaluation platform. Analysis techniques realistic for the scope of this project were limited to simple acoustic models which predicted pipe lengths required to optimize synchronization of the exhaust blow-down pulse dynamics with exhaust-valve timing. This theory was utilized to provide a minimum baseline pipe length which could be incrementally lengthened to optimize exhaust system design through development testing.

An adjustable exhaust tuning evaluation system was built using primary lengths determined by the above-described analysis. Due to non-completion of other required engine subsystems, there was no opportunity to test this subsystem. Midshipmen are currently being recruited to expand and complete this investigation next year.

Analysis, Design and Testing of a Venturi Flow Restrictor to Maximize Air Flow

Researcher: Midshipman 1/C A. R. Barlow
Faculty Advisor: Assistant Professor P.V. Puzinauskas
Sponsor: Society of Automotive Engineers/ Mechanical Engineering Department

The Society of Automotive Engineers sponsors several annual inter-collegiate design competitions, including Formula SAE. In this competition, the student teams design and build an open-wheeled race car that is evaluated relative to competing universities in seven categories. The vehicle's engine must be a four-stroke-cycle design with less than 610cc of displacement and must breath through a 20mm student-designed restrictor. This project was initiated to design, build and evaluate a restrictor which minimizes flow losses and thereby allows maximum engine power potential.

Toward the goal of the project, literature was

sought to provide guidelines for an optimum design. A modular flow section with separate converging nozzle and diverging diffuser was created to verify design suggestions from the literature and investigate the effects of off-optimum design compromises with packaging constraints. Because the literature indicated the optimum converging nozzle design was not space limiting, but was geometrically more complex than the diffuser, only one such section was created. To insure its geometric integrity, the section was designed on IDEAS and the manufacturing tool-path information was downloaded to the Harding lathe which automatedly manufactured the part. Five different diffusers were fabricated from fiberglass using internal molds with included diffuser angles of 4, 8, 14, 18 and 28 degrees. A steady-flow bench was used to test each nozzle-diffuser combination in addition to the nozzle by itself and a simple flat-plate restrictor. Contrary to indications from the literature, the four degree diffuser had the highest flow at the tested pressure drops. Gains did decrease sharply after reaching the expected optimum angle. Qualitative observations indicate that inlet-flow turbulence could serve to prolong flow attachment and improve results.

Having determined restrictor flow limitations, a conservation of mass and volumetric efficiency analysis was performed to predict horsepower potential. This analysis estimated maximum power to be in the 75-85 Hp range at ~12,000 rpm.

Web-Centric Engineering

Researcher: Midshipman 1/C J. P. Jankowski
Advisor: Associate Professor R. A. Raouf

A set of web-centric engineering analysis tools are being developed to run as client-side Java applets. The tools are developed for composite engineering applications. Project in process as an EM496 class.

Damage Detection from Experimental Modal Data

Researcher: Midshipman 1/C B.C. Hoerst
Faculty Advisor: Assistant Professor Colin P. Ratcliffe

This project continued an investigation into the use of a modal technique for locating structural damage in beams. Experimental displacement mode shapes were converted to strain shapes. These were then further processed to form a difference function that located the damage. The focus of this work was to consider a steel beam with a localized reduced cross-section. The work was presented at the 15th International Modal Analysis Conference, Orlando.

Modal and Thermal Stress Analysis Procedure

Researcher: Midshipman 1/C B.J. Forney
Faculty Advisor: Assistant Professor Colin P. Ratcliffe

The purpose of the research project was to develop a method for the analysis of structures by combining the processes of modal analysis and thermographic stress analysis. Modal analysis is a useful method for identifying the natural frequencies of a system throughout a range of frequencies. Thermographic stress analysis is a useful method for determining the stress concentrations and loads in a structure due to the amplitude of vibration at a specific frequency. It was hoped that by combining the two methods, a practical method for determining the loads experienced by a structure when it is being excited at the maximum amplitude could be developed.

At the conclusion of the semester, the method has not been completely developed. However, all indications are that, with a little troubleshooting, the modal and thermographic stress analysis procedure will prove to be very effective.

Locating Delaminations in a GRP Beam

Researcher: Midshipman 1/C B.C. Hoerst
Faculty Advisor: Assistant Professor Colin P. Ratcliffe

This project continued to build on previous work which used experimental modal data to locate damage in a steel beam. The main focus of this project was to construct a finite element model of a composite beam with a delamination. Several analyses were conducted with the delamination at different positions and depths in the beam. A variation to the damage detection procedure used for the work in the previous semester's research project successfully located the delamination.

Publications

BARTON, Jr., O., Assistant Professor, and C.P. Ratcliffe, Assistant Professor, "Modal Analysis of a Thick Sandwich Plate: A Comparison between theory and experiment", Proceedings of the Fifteenth International Modal Analysis Conference, Orlando, Fl., February 3 - 6, 1997, pp.71-75.

Composite structure beam, plates and shells are commonplace in many sectors of the automotive and aircraft industries. Use of such structure is now being considered for off-shore and naval applications because of the potential for improved strength-to-weight ratio and resistance to harsh environments. This paper considers the theoretical and experimental modal analysis of a thick sandwich plate, approximately 20 feet by 6 feet. This plate is a scale model of new design for a ships deck. Results are presented from an experimental modal analysis with the plate suspended on rubber bungee cords.

BARTON, Jr., O., Assistant Professor, "Fundamental Frequency of Symmetric Composite Plates on a Winkler Foundation", Proceedings for the Third International Conference on Composites Engineering, ICCE/3, July 21-26, 1996, New Orleans, LA pp. 103-104.

The fundamental frequency of symmetric composite plates resting on a Winkler Foundation is developed using eigensensitvity analysis. The approximate expression is a quadratic Mauclarin series in terms of the coupling stiffnesses D_{16} and D_{26}. For a homogeneous foundation response, it is shown that the natural frequency changes without a change in mod shape.

BARTON, Jr., O., Assistant Professor, and R. Reiss, N. Tomlinson, "Approximate Solution for Quartric Eigenvalue Problems", Proceedings for the Pan American Congress on Applied Mechanics, San Juan, Puerto Rico, Jan 1-7, 1997 pp. 99-104.

Approximate closed-form solutions for the eigenvalues of discrete quartic eigenvalue equations are obtained using the method of eigensensitivity analysis. Each of the matrices governing the eigenvalue problem is split into two components; one contains only diagonal elements and the other contains only off-diagonal elements. An approximation to the eigenvalues is obtained by expanding the eigenvalues in a Taylor series in the off-diagonal matrix elements. The general solution is then applied to a pinned-;pinned elastic beam with viscous damping in the pin joints.

FLACK, K.A., Assistant Professor, "Near-Wall Structure of Three-Dimensional Turbulent Boundary Layers," Experiments in Fluids, Vol. 23, pp. 335-340, 1997.

The surface topology of a separated three-dimensional boundary layer was investigated using oil flow visualization. The separated region was created by subjecting a flat plate boundary layer to both an axial pressure gradient and spanwise pressure gradient. Surface topologies indicate a complex combination of critical points including saddle points, nodes, and foci. The sensitivity of the surface topology to asymmetric disturbances was also investigated, resulting in dramatic changes in surface flow. The complex surface flows were not apparent in the static pressure coefficients which showed little variation across the span.

JOYCE**,** James A., Professor, Manual on Elastic-Plastic Fracture Laboratory Test Procedure, ASTM, W. Conshahabas, PA, 1966.

This manual is intended to provide a background for developing elastic-plastic fracture toughness data in accordance with ASTM Test Method for J-Integral Characterization of Fracture Toughness (E 1737) and ASTM Test Method for Crack-Tip Opening Displacement (CTOG) Fracture Toughness Measurement (E 1290). These standards provide the requirements for obtaining J-integral and CTOD quantities from laboratory tests; however, they provide little information on why certain requirements are imposed and how to carry out various aspects of the tests.

Two different types of tests are described, the basic test procedure leading to a single measurement quantity, i.e., the J-integral at the onset of cleavage fracture, and the advanced or resistance curve procedure that requires an unloading compliance or electric potential apparatus to estimate the crack extension at several locations on the load displacement record.

The apparatus is then described in detail for both procedures, including a discussion of the test machine and the displacement transducer requirements. The test procedures are described, including the test setup, running the test, recording the data, crack length marking, and post test crack length measurements.

Finally, and certainly the most important part, there is a discussion of the data analysis. Examples are presented showing the evaluation of all fracture toughness quantities presently included in ASTM standards E 1737 and E 1290.

JOYCE, James, A, Professor, and LINK, R. E., Assistant Professor "Effects of Constraint on Upper Shelf fracture Toughness," Fracture Mechanics: 26th Volume, ASTM STP 1256, American Society for Testing and Materials, Philadelphia, pp. 142-177, 1995.

The upper shelf fracture toughness and tearing resistance of two structural steels, HY-100 and ASTM A533, Gr.B, were determined over a wide range of applied constraint. The constraint conditions were varied by changes in specimen geometry and loading mode. Bend specimens with shallow and deep cracks, compact specimens, and single and double edge notched tension specimens were used in this study. A rotation correction was developed for the single edge notch tension specimen which greatly improved the behavior of the J-R curves determined using this specimen. The experimental results were used to investigate the applicability of the Q and T stress parameters to the correlation of upper shelf initiation toughness, JIC and tearing resistance, Tmat: The J-Q and J-T stress loci, and corresponding plots of material tearing resistance plotted against Q and T, were developed and compared with the expectations of the O'Dowd and Shih and the Betegon and Hancock analyses. The principle conclusions of this work are that JIc does not appear to be dependent on T stress or Q while the material tearing resistance, Tmat is dependent on T stress and Q, with the tearing modulus increasing as constraint decreases.

JOYCE, J.A., Professor and LINK, R.E., Assistant Professor, " A Ductile-to-Brittle Characterization Using Surface Crack Specimens Loaded in Combined Tension and Bending" ,*@ Fatigue and Fracture Mechanics: 28th Vol. ASTM STP 1321*, J.H. Underwood, B.D. MacDonald and M.R. Mitchell, Eds., American Society for Testing and Materials, 1997.

Surface cracked tension specimens of ASTM A515, Grade B steel plate were tested to failure in the ductile-to-brittle transition region. Two different specimen configurations were used: one configuration was loaded in tension except for the natural bending resulting from the presence of the surface crack, the second configuration had an offset test section and was pin-loaded to provide a strong bending component in addition to the tension load. For each configuration, at least seven repeat tests were conducted at each of two temperatures. All specimens failed by cleavage and the critical J-integral, J_c, was obtained using three-dimensional finite element analysis of the specimen. The FEM analysis was validated by comparison with experimental strain gage and displacement measurements taken during the tests. The results were compared with previous fracture toughness measurements on the same plate using 2T SE(B) specimens and surface cracked bend SC(B) specimens. The present results exhibited the expected elevation in fracture toughness and downward shift in the transition temperature compared to the highly constrained, deeply cracked SE(B) specimens. The master curve approach was used to characterize the transition curves for each specimen geometry and the shift in the transition temperature was characterized by the associated reference temperature.

KWIATEK, Sandra, LT, USNR and Vimal Desai, Paul

Natishan, Patrick J. MORAN, Professor, "Characterization of Cathodically Deposited Carbonaceous Films on a Silicon Substrate", Journal of Materials Science, 32(12), pp. 3123, 1997.

Carbon-based deposits were electrochemically formed on silicon substrates in ethanol at room temperature. This work was based on the work reported by Yoshikatsu Namba, who described the electrochemical deposition of diamond from organic solutions. The deposits were analyzed using a Scanning Electron Microscope (SEM), Energy Dispersive Spectroscopy (EDS), X-Ray Photoelectron Spectroscopy (XPS), Raman Spectroscopy and Electrochemical Impedance Spectroscopy (EIS). SEM micrographs showed some crystalline deposits on the silicon. EDS was unable to identify carbon in the film, but did reveal impurities such as Na, K, Ca and Zn. It was later established that the impurities were most likely appearing from impurities in the graphite used for a counter electrode. XPS showed the presence of carbon species, subsequently Raman Spectroscopy was used to further classify the carbon deposits. Raman Spectroscopy showed the presence of amorphous carbon in some films, but no diamond peak was observed for any of the films. EIS revealed that the impedance of the deposited films was nearly identical to that of the uncoated silicon, and did not resemble the impedance of diamond. Thus, in this work, carbon-based films were formed electrochemically, but these films were not diamond.

MINER, S. M., Associate Professor, "CFD Analysis of the Flow Distribution in the Header of a Filtration System," Proceedings of the ASME Fluids Engineering Division Summer Meeting 1996, FED-Vol. 239, 4. pp. 509-513, July, 1996.

This paper describes the results of a Computational Fluid Dynamics (CFD) analysis of the distribution header for a water filtration system. The header feeds eight parallel filter banks, and the purpose of the study was to determine the flow distribution amongst the filters. Two cases were considered, in the first case all eight filter banks were open, in the second case one of the filter banks was blocked. The second case was run to evaluate the effects of the blockage on the redistribution of the flow to the other filters. The analysis was performed using commercially available CFD software. A two dimensional model of the geometry was considered, and the code solved the 2-D Reynolds Averaged Navier-Stokes equations using a standard κ-ϵ turbulence model. Results for both cases showed distributions that were uniform to within 5%. This uniformity was due to the fact that the pressure drop through the filters was roughly 10-15 times the drop through the header. In addition to the computational results, flow measurements were made on the filtration system for case two using an ultrasonic flow meter. These measurements showed that the distribution to the seven unblocked filters was uniform to within 9%. The largest difference between the measured and computed flow distribution was found to be 9%.

MINER, S. M., Associate Professor, "CFD Analysis of an Axial Flow Pump Impeller Using a Coarse Grid," Proceedings of the 1997 ASME Fluids Engineering Division Summer Meetings, FED VOL. 11, June 1997.

This paper presents the results of a study using a coarse grid to analyze the flow in the impeller of an axial flow pump. A commercial CFD code (FLOTRAN) is used to solve the 3-D Reynolds Averaged Navier Stokes equations in a rotating cylindrical coordinate system. The standard κ-ϵ turbulence model is used. The mesh for this study uses 20,000 nodes and the model is run on a SPARCstation 20. This is in contrast to typical analyses using in excess of 100,000 nodes that are run on a super computer platform. The smaller mesh size has advantages in the design environment. Stage design parameters are, rotational speed 870 RPM, flow coefficient ϕ=0.12, head coefficient ψ=0.06, and specific speed 2.86 (8070 US). Evaluation of the model is based on a comparison of circumferentially averaged results to measured data for the same impeller downstream of the trailing edge, and analysis of the flow field within the impeller passage. Comparisons to measured data include axial and tangential velocities, static pressure, and total pressure. Within the impeller passage the static pressure and axial velocity contours are presented at the leading edge, mid chord, and trailing edge. Results of this study show that the computational results closely match the shapes and magnitudes of the measured profiles, indicating that CFD can be used to accurately predict performance.

MORAN, Angela, Associate Professor, "Test and Evaluation of Spray Formed Alloy 625" with R.Rebis, Advances in Powder Metallurgy and Particulate Materials, MPIF, Princeton, NJ, June 1996.

The Carderock Division of the Naval Surface Warfare Center conducted an evaluation of spray formed Alloy 625 piping under the sponsorship of the Office of the

Secretary of Defense Foreign Comparative Test Program. The objective of the evaluation was to characterize the as-deposited spray formed Alloy 625 preforms and determine if these preforms could be processed into piping meeting current specification requirements and exhibiting equivalent or improved properties in comparison to conventionally produced piping. Spray formed preforms were deposited and reduced via pilger rolling or roll extrusion to produce thin walled piping in diameters of 10.2, 20.3 and 35.6 cm (4, 8 and 14 inch Nominal Pipe Size). Evaluations based on chemical analysis, strength, ductility, hardness, impact toughness, fatigue properties, weldability, corrosion resistance, and burst and shock resistance demonstrated that spray formed piping appears to be a viable substitute for conventionally produced Alloy 625 piping and that a minimal amount of cold working is required on the as-deposited tubular preforms in order for them to meet the specification requirements for Naval applications.

MORAN, Angela, Associate Professor, and R.E. Rebis, "Large Diameter Superalloy 625 Piping", Journal of Testing and Evaluation, Vol. 24, pp.302-315, Sept. 1996.

A comparative testing evaluation program was conducted to assess the mechanical properties, metallurgical characteristics and fabricability of spray-formed Alloy 625 tubes and subsequently processed piping. Spray-formed preforms were deposited and reduced via pilger rolling or roll extrusion to produce thin-walled piping in diameters of 10.2, 20.3 and 35.6 cm (4, 8, and 14 in. nominal pipe sizes). Evaluations based on chemical analysis, strength, ductility, hardness, impact toughness, fatigue properties, weldability, and corrosion resistance demonstrated that spray-formed piping appears to be a viable substitute for conventionally produced Alloy 625 piping and that a minimal mount of cold working is required on the as-deposited tubular preforms in order for them to meet the specification requirements for naval applications.

MORAN, Angela, Associate Professor, and R.E. Rebis, "Spray Formed Superalloy 625 Piping", Proceedings of the Fourth International Special Emphasis Symposium on Superalloys 718, 625, 706 and Derivatives, TMS, Pittsburgh, PA, accepted for publication, June 1997.

Spray formed Alloy 625 piping subjected to standard amounts of cold reduction performed comparably to conventionally processed Alloy 625 piping and met the chemical analysis specifications and metallurgical requirements for porosity, oxide content and grain size required for Navy applications. Mechanical testing indicated that the tensile strength and ductility of roll extruded and pilger rolled pipes easily exceeded the minimum requirements while results of the hardness testing and Charpy impact testing showed no significant difference between as-sprayed preforms, spray formed and processed thin-walled piping, and conventionally produced piping. Results of fatigue testing of spray formed Alloy 625 pipes indicated that post processing is necessary to achieve the fatigue performance in terms of endurance limit of conventionally processed Alloy 625 pipes. Of the two post processing methods employed in this study, both methods diminished porosity and produced a fine grain size but roll-extrusion yielded a more uniform microstructure and better fatigue and strength properties. A weldability evaluation indicated that the hot-cracking resistance and mechanical properties of welded, spray formed Alloy 625 products were at least equivalent to that of conventional Alloy 625. Additionally, spray formed Alloy 625 piping performed comparably in service testing to wrought piping. Thus, Alloy 625 piping produced from spray formed tubulars appears to be a viable substitute for conventionally produced Alloy 625 piping.

MORAN, Angela, Associate Professor, and P.C. Saxton, M. Harper and K. Lindler, "Materials Selection for TPV Emitter," Proceedings of the IECEC Conference, accepted for publication, July 1997.

Thermophotovoltaics (TPV) is a potentially attractive direct energy conversion technology. It reduces the need for complex machinery with moving parts and maintenance. TPV generators can be run from a variety of heat sources including waste heat for smaller scale operations.

The United States Naval Academy's goal was to build a small experimental thermophotovoltaic generator powered by combustion gases from a General Electric T-58 helicopter gas turbine. The design of the generator imposes material limitations that directly affect emitter and structural materials selection. This paper details emitter material goals and requirements, and the methods used to select suitable candidate emitter materials for further testing.

MORAN, Angela, Associate Professor, "Emerging Control Structures," Proceedings of the National Academy of Engineering Frontiers of Engineering Symposium, accepted for publication, Sept. 1997.

The method by which engineering materials are processed into usable components, structures, devices or systems is a critical factor in determining the success of industries as diverse as aerospace, automotive, and construction. [1] Competence, quality, and reproducibility in manufacturing are essential for the processing of new materials into viable products and for the continued improvement of components made from conventional materials. [2] Technologically advanced industries manufacture components and systems requiring tight constraints in terms of material properties and part configuration yet it is not cost effective to perform quality control afer the part is completed. Additionally, flexible manufacturing practices to produce a number of similar parts utilizing the same equipment would be advantageous so that large inventories need not be maintained or long lead times not be required to fabricate modified components. On line process monitoring with in-situ sensors and reactive control systems is required to improve part quality and product yield and allow for flexible processing methods. A program to implement real time sensing and control of spray formed perform conditions was completed by the U.S. Navy. The objective of the program was to develop sensor and control technology to monitor the critical process conditions and to modify parameters during the spray metal forming process to produce components with repeatable microstructural quality.

MORAN, Angela, Associate Professor, and S. KWIATEK, LT, USNR, "Undergraduate Laboratory - Materials Properties and Selection" Journal of Materials Education, Fall 1997.

Based on input from midshipmen and faculty, the following laboratory has been developed for the introductory Materials Science courses offered by the Mechanical Engineering Department. Historically, the emphasis in materials has been placed on metals, but with the development of advanced materials including polymers, composites and ceramics for engineering applications and with the recent emphasis on materials selection in design, it is appropriate to expand the curriculum to involve materials other than metals and alloys. The intention is that as each material type is introduced, students will conduct testing to evaluate material properties and research typical costs, physical properties and applications so as to develop an appreciation for the trade-offs that must be considered in materials design and selection as well as the relationships between structure, properties and processing.

MORAN, P.J., Professor, with M. Sunkara, A.K. Rawat, R. A. Hays and E. J. Taylor, "Methods for Detecting the Sites of Localized Corrosion Applicable to Pipelines", Proc. Vol. 95-16, Critical Factors Localized Corrosion II, p. 413, Electrochem. Soc., 1996.

Two techniques for detecting localized corrosion sites on the interior and/or exterior surfaces of structural elements are described. The techniques rely on the fact that the corroding interface has a much lower "electrochemical impedance" compared to the passive interface. The procedure involves (a) applying a small current signal (AC or DC) to the structural elements and (b) detecting the low impedance sites by measuring the leaking current distribution using the magnetic field associated with the applied current along the structural element or by measuring the currents through multiple counter electrodes placed along the structural element.

MORAN, P. J., Professor, with D. A. Shifler, and J. Kruger, "Effects of Sulfides on the Passivity of Carbon Steel in Organic Solutions", Electrochimica Acta, Vol. 42, No. 4, pp. 567-577, 1997.

Corrosion is known to initiate at sulfide inclusions in aqueous solutions. The effects of sulfides on the passivity and the breakdown of passivity of 99.999% iron and 1018 carbon steel was investigated in two aprotic nonaqueous solvents; (1) propylene carbonate (PC) with LiClO4 or LiAsF6 as supporting electrolytes and (2) dimethoxyethane (DME) with LiAsF6 electrolyte. Carbon steel was also examined in PC-DME/LiAsF6 mixtures. Sulfides do not appear to interfere with the Passivation when it is provided by solvent adsorption in either nonaqueous solvent. Sulfides may lower the solvent oxidation potential and decrease the anodic potential at which breakdown initially occurs in either pure solvent. Sulfides also influence the kinetics of repassivation above the solvent oxidation potential of either solvent when Passivation is provided by salt film formation or electropolymerization. The bleeding of sulfur or sulfide from inclusion sites where electropolymerization has occurred in PC/DME mixtures undermines attempts at Passivation and promotes instability leading to anodic current increases with time and further corrosion of carbon steel.

MORAN, P.J., Professor, with M. Inman, E. Taylor, A. Rawat, M. Sunkara, R. Kain, and R. Hays, "Detection of Crevice Corrosion in Natural Seawater

Using Polarization Resistance Measurements", Paper No. 296, Corrosion 97, NACE Annual Conference, New Orleans, LA, March 1997.

The initiation time and propagation associated with crevice corrosion on alloy 625 (UNS-N06625) and S31603 (UNS-S31603) tubing in flowing natural seawater has been successfully detected by polarization resistance measurements. A substantial decrease in the polarization resistance accompanied the initiation of crevice corrosion which was confirmed by visual observation of the attack through transparent crevice formers and by a decrease in the corrosion potential. After sixty one days exposure, the test was terminated and the degree of crevice corrosion attack was quantified as area of attack, depth of penetration, and mass loss. An excellent correlation between mass loss during the exposure period and the final polarization resistance was obtained for both alloys. An inverse correlation between area of attack and depth of penetration with the final polarization resistance was also examined. The utilization of polarization resistance measurements for determining the onset of crevice corrosion and the mass loss due to crevice corrosion was clearly established. It is also interesting to note that the affected area of crevice corrosion for the UNS-N06625 increased continually following initiation while the depth of attack remained relatively constant and shallow.

MORAN, P. J., Professor, with M. Inman, A. Rawat, E. Taylor, and P. Moran, "Detection of Crevice Corrosion Under an O-Ring by Polarization Resistance Measurements Using Electrodes Imbedded in the O-Ring", Paper No. 312, Corrosion 97, NACE Annual Conference, New Orleans, LA, March 1997.

An electrochemical sensor which incorporates a counter electrode and a reference electrode into an o-ring has been developed for in situ monitoring of crevice corrosion initiation and propagation. It is applicable to crevice corrosion situations where the crevice is created by a gasket or an o-ring and the attack occurs in that crevice. It is shown that polarization resistance values calculated from in situ electrochemical impedance measurements correlate with the onset of crevice corrosion and with its propagation for crevice corrosion of alloy 625 (UNS N06625) in 3.5% NaCl and in 10% FeCl3 solutions.

PALMER, Sheila C., Assistant Professor, "Effect of Evaporator Design Pressure on Dual-Pressure Absorption Heat Pump Performance," International Ab-Sorption Heat Pump Conference, Montreal, Canada, pp. 231-236 Sept. 1996.

A numerical analysis of the effect of evaporator pressure on performance is carried out for several direct-fired dual-pressure ammonia/water absorption heat pumps utilizing a precooler in the refrigeration loop. The evaporator pressure is shown to have lower and upper limits. The evaporator pressure which provides the maximum COP is the "optimum evaporator pressure." This study shows that the evaporator pressure for dual-pressure absorption cycles should be optimized to find the maximum COP. This can also be viewed as optimization of the degree of superheat into the absorber or as optimization of the degree of subcooling into the evaporator. At the maximum COP, the temperature differences at each end of the precooler are equal to each other and the minimum cycle pinch point for all cycles considered.

PALMER, Sheila C., Assistant Professor, "Experimental Investigation and Model Verification for a GAX Absorber," International Ab-Sorption Heat Pump Conference, Montreal, Canada, vol. 1, pp. 367-374 Sept. 1996.

In the ammonia-water generator-absorber heat exchange (GAX) absorption heat pump, the heat and mass transfer processes which occur between the generator and the absorber are the most crucial in assuring that the heat pump will achieve COPs competitive with those of current technologies. In this study, a model is developed for the heat and mass transfer processes that occur in a counter-current vertical fluted tube absorber (VFTA). Correlations for heat and mass transfer in annuli are used to model the processes in the VFTA. Experimental data is used to validate the model for three different insert geometries. Comparison of model results with experimental data provides insight into model corrections necessary to bring the model into agreement with the physical phenomena observed in the laboratory.

RAOUF, R. A., Associate Professor and Palazotto, A. N., "Nonlinear Analysis of Pressurized Spinning Fiber-Reinforced Tori," AIAA Journal, Vol. 34, No. 12, pp 2596-2603, 1996.

The symbolic manipulator Mathematica is used to implement a procedure combining the theory of elasticity, differential geometry, and variational techniques to derive and solve a set of equations that approximates the steady-state response of pressurized spinning toroidal shells. The resulting set of nonlinear equations is solved for various values of the applied

pressure, fiber content, and spinning speeds. Qualitative results are obtained and linear results are compared and contrasted to nonlinear results.

RAOUF, R. A., Associate Professor and MALEK-MADANI, R., "Stability Analysis of Thermo--Visco-Plastic Materials Undergoing High-Rate Shear Deformations," Quarterly of Applied Mathematics, accepted for publication.

This paper studies the stability of the homogeneous, simple shear solution of a thermo-visco-plastic material when subjected to a constant rate of shear. The paper derives an explicit expression for the stability criteria of the simple shear solution. Numerical solutions using the method of lines are presented.

RAOUF, R. A., Associate Professor, "A Study of the Effects of Fiber Waviness on the Buckling Characteristics of Laminated Plates," Journal of Reinforced Plastics and Composites, in press. Also in the proceedings of the SPACE96 Conference.

The equations of equilibrium of a composite plate with in-plane fiber waviness are derived and the effects of waviness on the buckling loads are studied. The plate is assumed to be in cylindrical bending and the resulting eigenvalue problem is solved using a combination of the shooting technique and the secant method. A numerical example of a plate with sinusoidal fiber waviness shows that the buckling load decreases as the amplitude of the waviness increases. However, results indicate that it is possible to enhance the stability characteristics of the plate by introducing artificial fiber waviness to increase its buckling load.

RAOUF, R. A., Associate Professor and Palazotto, A. N., "Parametric Stability of Spinning, Composite Tori under Periodic Internal Pressure," International Journal of Solids and Structures, submitted.

This paper studies the parametric stability of spinning, fiber-reinforced tori when subjected to periodic pressure. The tori are assumed to be this and obey the Love-Kirchhoff's assumptions. A combination of differential geometry, theory of elasticity, and the Rayleigh-Ritz technique is used to derive the equilibrium equations. These equations are linear ordinary differential equations with periodic coefficients. The stability characteristics of these equations are studied numerically using the Floquet theory and the perturbation method of multiple time scales. Stability results are presented for various amplitudes and frequencies of the internal pressures and spinning speeds.

RAOUF, R. A., Associate Professor, "Buckling of Composite Plates with Fiber Imperfections," International Journal for Computers and Structures, submitted.

This paper presents a simple analytical expression for the buckling load of a fiber-reinforced composite plate with fiber imperfections. The structural analysis is based on the classical laminated plate theory and assumes cylindrical bending. The solution strategy is to derive the solution of the plate with fiber imperfections as a perturbation to the solution of the problem of a plate with straight fiber. The derived expression is verified numerically using a numerical shooting technique.

RAOUF, R. A., Associate Professor, "Learning, Technology, and Grades," ASEE Journal of Engineering Education, in preparation.

The rapid development and increasing popularity of the Internet and the world wide web gives educators the opportunity to test new and exciting learning and teaching techniques. This paper documents the use of the web within the mechanical engineering design curriculum to enhance the students' educational experience and use grades to reward learning.

RATCLIFFE, Colin P., Assistant Professor, "Damage Detection Using a Modified Laplacian Operator on Mode Shape Data." The Journal of Sound and Vibration V204(3) pp. 505-517, July 1997.

Localized damage to a structure affects its dynamic properties, and much work has been undertaken investigating the variation of natural frequencies with damage. However, use of mode shape data has seen much less effort. This paper develops and presents a technique for identifying the location of structural damage in a beam. The procedure operates solely on the mode shape from the damaged structure, and does not require a priori knowledge of the undamaged structure. The procedure is developed using a one-dimensional finite element model of a beam, and demonstrated by experiment. When damage is severe (a localized thickness reduction of more than 10%), applying a finite difference approximation of Laplace's differential operator to the mode shape successfully identifies the location of the damage. However, when

damage is less severe, further processing of the Laplacian output is required before the location can be determined. This post-processing enables the location of thickness reductions of less than 0.5% to be identified. The procedure is best suited to the mode shape obtained from the fundamental natural frequency. The mode shapes from higher natural frequencies can be used to verify the location of damage, but they are not as sensitive as the lower modes..

RATCLIFFE, Colin P., Assistant Professor and Crane, Roger M, Santiago, A. L. "Optimizing Reinforced Polyurethane as a Combined Structural and Damping Component." American Society of Mechanical Engineers, Noise Control and Acoustics Division, NCA-V**23**, Advanced Materials for Vibro-Acoustic Applications Volume 2, pp. 1-8, 1996.

In many engineering applications, mechanical vibration can cause structural failure or other problems. While traditional composite systems are typically more heavily damped than metal structures, there may still be insufficient energy dissipation for vibration control. When more control is required, additional mechanical damping treatments may be applied, commonly in the form of viscoelastic free or constrained layers.

Reinforced polyurethane has been shown to be both a structural system, and one that dissipates significant amounts of vibration energy. This material system has been shown to significantly enhance the damping loss factor of cylindrical and flat plate structures. For these structures, mechanical strength and flexibility were the primary design requirements. The level of damping for each structure was quantified, but the material systems were not optimized for energy dissipation.

The high level of damping in these reinforced polyurethane systems was attributed to a combination of the flexibility, i.e. high strains, of the material, coupled with energy dissipation within the matrix. As the system deforms, the matrix is subject to time-varying shear, and energy is dissipated in the matrix. This mechanism can be likened to micro-mechanical constrained layer damping.

This paper presents an experimental technique for the determination of the damping of thin fiber reinforced damping layers. A conventional composite beam with varying thicknesses of reinforced polyurethane was modally tested. The results of the modal analysis were then processed to yield the damping of the free layer. The experimentally determined levels of damping were significantly higher than conventional free layer treatments, especially at low frequencies.

VOLINO, R.J., Assistant Professor. "A New Model For Free-Stream Turbulence Effects On Boundary Layers," ASME paper 97-GT-122.

A model has been developed to incorporate more of the physics of free-stream turbulence effects into boundary layer calculations. The transport in the boundary layer is modeled using three terms: 1) the molecular viscosity, n; 2) the turbulent eddy viscosity, e_T, as used in existing turbulence models; and 3) a new free-stream induced eddy viscosity, e_f. The three terms are added to give an effective total viscosity. The free-stream induced viscosity is modeled algebraically with guidance from experimental data. It scales on the rms fluctuating velocity in the free-stream, the distance from the wall, and the boundary layer thickness. The model assumes a direct tie between boundary layer and free-stream fluctuations, and a distinctly different mechanism than the diffusion of turbulence from the free-stream to the boundary layer assumed in existing higher order turbulence models. The new model can be used in combination with any existing turbulence model. It is tested here in conjunction with a simple mixing length model and a parabolic boundary layer solver. Comparisons to experimental data are presented for flows with free-stream turbulence intensities ranging from 1 to 8% and for both zero and non-zero streamwise pressure gradient cases. Comparisons are good. Enhanced heat transfer in higher turbulence cases is correctly predicted. The effect of the free-stream turbulence on mean velocity and temperature profiles is also well predicted. In turbulent flow, the log region in the inner part of the boundary layer is preserved, while the wake is suppressed. The new model provides a simple and effective improvement for boundary layer prediction.

MURAWSKI, C.G., with R. Songergaard, R.B. Rivir, Simon, T.W., Vafai, K., and VOLINO, R.J., Assistant Professor. "Experimental Study of the Unsteady Aerodynamics in a Linear Cascade with Low Reynolds Number Low Pressure Turbine Blades," ASME paper 97-GT-095.

Low pressure turbines in aircraft experience large changes in flow Reynolds number as the gas turbine engine operates from takeoff to high altitude cruise. Low pressure turbine blades are also subject to regions of strong acceleration and diffusion. These changes in Reynolds number, strong acceleration, as well as

elevated levels of turbulence and periodic wake passage disturbances can result in unsteady separation and transition zones on the surface of the low pressure turbine blade. An experimental study was conducted in a two-dimensional linear cascade, focusing on the suction surface of a low pressure turbine blade. The intent was to assess the effects of changes in Reynolds number, and freestream turbulence intensity. Flow Reynolds numbers, based on exit velocity and suction surface length, have been varied from 50,000 to 300,000. The freestream turbulence intensity was varied from 1.1 to 8.1 percent. Separation was observed at all test Reynolds numbers. Increasing the flow Reynolds number, without changing freestream turbulence, resulted in a slightly rearward movement of the onset of separation and shrinkage of the separation zone. Increasing the freestream turbulence intensity, without changing Reynolds number resulted in a rearward movement of the onset of separation, and shrinkage of the separation region on the suction surface. Increasing both flow Reynolds numbers and freestream turbulence intensity compounded these effects such that at a Reynolds number of 300,000 and a freestream turbulence intensity of 8.1%, the separation zone was almost nonexistent. The influence on the blade's wake of freestream turbulence and Reynolds number are also documented. The width of the wake and velocity defect rise with a decrease in either turbulence level or chord Reynolds number. Numercial simulations were performed in support of experimental results. The numerical results compare well qualitatively with the low turbulence experimental cases.

FLACK, K.A., Assistant Professor with VOLINO, R.J. Assistant Professor. A Series - Parallel Heat Exchanger Experiment," ASME HTD Vol. 344, pp. 27-34.

An experimental apparatus has been designed to test the use of cross flow heat exchangers in series and parallel configurations. The experiment can be used in a number of ways to demonstrate heat exchanger performance in a laboratory. The apparatus consists of three identical fin-tube type cross flow heat exchangers mounted on a board which is instrumented with thermocouples, flow meters and a pressure transducer. The apparatus can be set to test the performance of a solo heat exchanger, two or three heat exchangers in series or parallel, or combinations incorporating both series and parallel configurations. The apparatus is relatively simple, inexpensive and versatile. It may be used in a variety of configurations for several types of student laboratories ranging from demonstrations to design projects. This allows the instructor to design and change experiments for a specific course. The use of an apparatus such as this gives students hands-on experience with experimental procedures and helps them to gain a physical understanding of heat transfer phenomena.

WU, Chih, Professor, "Analysis of waste-heat thermoelectric power generators," Applied Thermal Engineering, v16, #1, (1996), pp. 63-70.

A real thermoelectric power generator utilizing waste heat is proposed. The generator is treated as an external and internal irreversible heat engine. The specific power output of the generator is analyzed and compared with that of the Carnot, endoreversible and external reversible thermoelectric heat engines.

WU, Chih, Professor, "General performance characteristics of a finite-speed Carnot refrigerator," Applied Thermal Engineering, vo16, #4 (1996), pp. 299-304.

The general performance characteristic of a finite-speed Carnot refrigerator is investigated. The relationship between the COP and the cooling load of the refrigerator is obtained for several different heat transfer cases. The result provides a realistic design criterion for actual refrigerators.

WU, Chih, Professor, "The R-ϵ characteristics of a three-heat-source refrigeration cycle," Applied Thermal Engineering, v16, #11, (1996), pp. 901-906.

The influence of irreversibilities of finite-rate heat transfer and heat leak on the performance of a refrigerator driven by low grade heat transfer rather than high grade work is investigated by means of an endoreversible three-heat-source cycle model. The cooling rate and coefficient of performance are adopted to be objective functions for optimization. The optimal performance of the refrigeration cycle is analyzed. Some new results are obtained. For example, the maximum cooling rate and corresponding coefficient of performance are determined. The maximum coefficient of performance and corresponding cooling rate are shown. The curves indicating the performance characteristics of the refrigeration cycle are presented. The results obtained here will play an instructive role in the exploitation of real refrigerators.

WU, Chih, Professor, "Heat transfer effect on the

specific heating load of heat pumps," Applied Thermal Engineering, v16, #12, (1996), pp. 989-997.

The maximum possible specific heating load that can be obtained from two-heat-reservoir heat pumps with a set of high temperature heat sinks and low temperature heat sources is analyzed. The heat pumps considered in this paper include (1) externally and internally reversible, (2) externally irreversible and internally reversible, (3) externally reversible and internally irreversible and (4) externally and internally. irreversible heat pumps. The irreversibilities are assumed to be caused by heat transfer only. The specific heating load, defined as the heating load per unit total heat exchanger surface area, is adopted as the objective function for the heat pump performance analysis in this paper.

WU, Chih, Professor, "Heat transfer effect on the specific cooling load of refrigerators," Applied Thermal Engineering, v17, #1, (1997), pp. 103-110.

The maximum possible specific cooling load that can be obtained from two-heat-reservoir refrigerators with a set of high temperature heat sinks and low temperature heat sources is analyzed. The refrigerators considered in this paper include (1) externally and internally reversible, (2) externally irreversible and internally reversible, (3) externally reversible and internally irreversible and (4) externally and internally irreversible refrigerators. The irreversibilities are assumed to be caused by heat transfer only. The specific cooling load, defined as the cooling load per unit total heat exchanger surface area, is adopted as the objective function for the refrigerator performance analysis in this paper.

WU, Chih, Professor, "Optimization of solar absorption refrigerator," Applied Thermal Engineering, v17, #2, (1997), pp. 203-208.

A solar refrigerator is made of a solar collector and a refrigeration system. Real solar refrigerators are usually operating between two limits, maximum COP (coefficient of performance) and maximum cooling load. The relationships among the solar collector temperature, COP and cooling load are derived in this paper. The optimum collector temperatures under the conditions of either maximum COP or maximum cooling load are found. The results provide a theoretical base for designing real solar refrigeration systems.

WU, Chih, Professor, "Influence of heat transfer law on the performance of Carnot heat engine," Applied Thermal Engineering, v17, #3, (1997), pp. 277-282.

This paper derives the relations between optimal efficiency and power output of Carnot engines with heat transfer laws of $q \propto (\Delta T^{-1})$ and $q \propto (\Delta T)^n$. The bounds of efficiency at maximum power output are also given. The results, which are different from those based on Newton's law $q \propto \Delta T$, involve some which have previously been presented.

WU, Chih, Professor, "A generalized model of a real refrigerator and its performance," Applied Thermal Engineering, v17, #4, (1997), pp. 401-412.

The sole irreversibility considered in classical endoreversible Carnot refrigerator model is the heat resistance loss between the refrigerator and its surrounding heat reservoirs. This paper presents a new steady-state flow irreversible Carnot refrigerator model by taking additional account of several internal irreversibilities of the refrigerator such as heat leak, friction, turbulance, etc. This is done by using a constant parameter and a constant coefficient together with the heat resistance loss. Analysis and optimization of the model are carried out to investigate the effect of the various irreversibilities on the performance of the model. Numerical examples are made to illustrate the effectiveness of the model.

WU, Chih, Professor, "Steady flow combined refrigeration cycle performance with heat leak," Applied Thermal Engineering, paper accepted for publication.

The Influence of bypass heat leak on the optimal performance of a combined refrigeration cycle is examined in this paper. This is done by adding a heat leak term into an endoreversible combined cycle. The relationships between optimal cooling load and coefficient of performance (COP), as well as the maximum COP and the corresponding cooling load for a steady-state irreversible combined refrigeration cycle are derived. The performance characteristic of the irreversible combined cycle is found to be strongly affected by the rate of heat leak. This model allows a more reasonable prediction of the performance for an actual combined refrigeration cycle than that obtained through a conventional ideal cycle analysis.

WU, Chih, Professor, "Effect of heat transfer law on finite time exergeoeconomic performance of real heat

engines," ENERGY:The International Journal, v21, #12, (1996), pp. 1127-1134.

Finite-time energoeconomic analysis is a combination of finite-time thermodynamics and energoeconomics (or thermoeconomics). It emphasizes the optimistic compromise between economics (profit) and the utilization factor of energy (efficiency vs. coefficient of performance). The relation between optimal profit and efficiency of an endoreversible Carnot engine is derived based on a relatively general heat transfer law, $q \propto \Delta(T^n)$. The efficiency bounds at the maximum profit, termed finite-time energoeconomic perform bounds, are obtained for three common heat transfer laws: Newton's Law (n=1), Linear pheomenological Law in irreversible thermodynamics (n=-1), and the radiative heat law (n=4).

WU, Chih, Professor, "Maximum power from combined cycle isothermal endoreversible chemical engines," Energy:The International Journal, paper accepted for publication.

A chemical engine processes mass flow to convert the differences in chemical potentials into work. An isothermal endoreversible chemical engine, in which the sole irreversibility is finite-rate mass transfer, is modeled in this paper. The expression of maximum power from the model using the analogous method of finite-time thermodynamics for a combined-cycle heat engine, is derived. An important result shows that the efficiency at maximum power output is half of the maximum efficiency for chemical and heat engines.

WU, Chih, Professor, "Optimization of a two-stage combined refrigeration system," Energy Conversion and Management, v37, #3, (1996), pp. 353-358.

The optimal performance of a two-stage refrigeration system affected by the irreversibility of finite-rate heat transfer is analyzed by using an endoreversible combined cycle model with continuous flow. It is proven that the optimal COP is a monotonically decreasing function of the specific cooling rate for a two-stage endoreversible combined refrigeration system. The optimal temperatures of the working fluid in the isothermal processes of a cycle are determined. The optimal distribution of the heat transfer area are also discussed. The results obtained can provide a tool for practising engineers for designing two-stage refrigeration systems.

WU, Chih, Professor, "General performance characteristics of an n-stage endoreversible combined power cycle system at maximum specific power output," Energy Conversion and Management,v37, #9, (1996) pp. 1401-1406.

A general endoreversible cycle model with continuous flow is used to study the performance characteristics of an n-stage combined power system affected by the irreversibility of finite-rate heat transfer. The specific power output is chosen as an objective function for optimization. The maximum specific power output of the system is derived. The optimal performance of other parameters of the system, such as the temperatures of the working fluids in respective cycles and the heat-transfer areas of the heat exchangers, is also discussed. The general results obtained can describe the optimal characteristics of an arbitrary-stage endoreversible combined power system operating between two heat reservoirs.

WU, Chih, Professor, "Performance of an endoreversible Carnot refrigerator," Energy Conversion and Management, v37, #10, (1996), pp. 1509-1512.

The performance characteristic of an endoreversible Carnot refrigerator is investigated. The relationship between the coefficient of performance and the cooling load of the refrigerator is obtained. The results provides a realistic design criterion for actual refrigerators.

WU, Chih, Professor, "Heat exchanger effect on a gas refrigeration cycle," Energy Conversion and Management, v37, #10, (1996), pp. 1513-1516.

The heat exchanger effect on the power input of a gas refrigerator with a given cooling load is analyzed. The finite-time thermodynamic model adopted is a Brayton cycle coupled to a heat source and a heat sink with two heat exchangers. Both the heat source and heat sink have infinite heat capacity rates. Mathematical expressions for minimum power input and other characteristics of the refrigerator at minimum power are obtained for the cycle. The results of this theoretical work provide base line criteria for use in the performance evaluation and design of such refrigeration cycle as well as for use in performance comparsions with existing refrigerators.

WU, Chih, Professor, "Performance analysis of solar three-heat-reservoir cooling systems," Energy Conversion and Management, v37, #11, (1996),

pp. 1671-1676.

The optimum performance of a solar three-heat-reservoir cooling system which consists of a solar collector and a three-heat-reservoir cooler is studied. The analysis is based on the linear (conventional and/or conductive) and radiative heat transfer models of solar collectors and the general optimum characteristics of endoreversible three-heat-reservoir coolers with Newton's and linear phenomenological heat transfer laws between the working fluid and the reservoirs of the coolers. The overall COP (coefficient of performance) of the system is adopted as the objective function of the performance analysis. The optimum operating temperatures of the collectors at the systems maximum possible COP or at the systems maximum possible cooling load are carried out. The results provide the basis for designing a real solar three-heat-reservoir cooling system.

WU, Chih, Professor, "Finite time analysis of a geothermal heat engine driven air conditioning system," Energy Conversion and management, v38, #3, (1997), pp. 263-268.

A geothermally powered, low temperature Rankine cycle used to operate a conventional mechanical compression air conditioning system is analyzed using a finite-time thermodynamic approach to determine the optimum performance of such a system. The system is considered to be endoreversible. That is, the only irreversibilities are those associated with the heat transfers between the system and the surrounding thermal reservoirs. This approach provides a more conservative prediction of the performance than does the Carnot theoretical heat engine and air conditioning unit.

WU, Chih, Professor, "Optimal coefficient of performance and heating load relationship of a three-heat-reservoir endoreversible heat pump," Energy Conversion and Management, v38, #8, (1997), pp. 727-734.

The relationship between the optimal COP (coefficient of performance) and the heating load of a three-heat-reservoir endoreversible heat pump (including both temperature amplifier and heat amplifier cycles) with non-linear heat transfer (phenomenological law in irreversible thermodynamics) is derived. The results presented in this paper are different from those obtained with a linear heat transfer law. The relationships provide a theoretical basis for developing and utilizing a variety of three-heat-reservoir heat pumps.

WU, Chih, Professor, "Theoretical analysis of the performance of a regenerative closed Brayton cycle with irreversibilities," Energy Conversion and Management, v38, #9, (1997), pp. 871-877.

Performance analysis of a real power cycle has been performed by using finite-time thermodynamics in this paper. The analytical formulas about the relations between power output and pressure ratio, and efficiency and pressure ratio of an irreversible closed regenerated Brayton cycle coupled to variable-temperature heat reservoirs are derived. In the analysis of this paper, the irreversibilities involve the heat resistance losses in the hot- and cold-side heat exchangers and the regenerator, and the irreversible (nonisentropic) expansion and compression losses in turbine and compressor. The optimal performance characteristics of the cycle may be obtained by optimizing the distribution of heat conductances or heat-transfer surface areas among two heat exchangers and regenerator, and the matching between working fluid and heat reservoirs. For the specified heat reservoir conditions, the power output is strongly dependent on the effectiveness of the regenerator, and there exists an optimal matching among the effectiveness of the hot- and cold-side heat exchangers and the regenerator. The conclusions are different from those obtained by conventional analysis of real engineering cycle.

WU, Chih, Professor, "Optimal performance of an endoreversible Carnot heat pump," Energy Conversion and Management, v38, #14, (1997), pp. 1439-1444.

The relation between the optimal coefficient of performance and the cooling load of a three-heat-reservoir endoreversible refrigerator with nonlinear heat transfer condition is derived. The results presented in this paper are different from those with Newton's linear heat transfer law. The relationships provide a theoretical basis for developing and utilizing of a variety of three-heat-reservoir refrigerators.

WU, Chih, Professor, "Optimal collector temperature for solar driven heat pump systems," Energy Conversion and Management, v17, #2, (1996), pp. 73-78.

The optimal characteristic of a solar-driven heat pump system consisting of a solar collector and a three-heat-reservoir heat pump is performed. The overall COP

(coefficient of performance) of the system is adopted to be the objective function of the study. The optimum operating temperature of the solar collector at the system's maximum possible COP or at the system's maximum possible heating load are found. The results provide a theoretical basis for designing a real solar-driven heat pump system.

WU, Chih, Professor, "Performance characteristic of isothermal endoreversible chemical engines," Energy Conversion and Management, v38, #18, (1997), pp. 1841-1846.

Chemical engines processes mass flow to convert the differences in chemical potentials into work. An isothermal endoreversible chemical engine, in which the sole irreversibility is finite-rate mass transfer, is modeled in this paper. The power versus efficiency relationships of the chemical engine using the analogous method of finite-time thermodynamics for a heat engine, are derived. The performance comparsion between a heat engine and a chemical heat engine is carried out.

WU, Chih, Professor, "The influence of internal heat leak on the power vs efficiency characteristics of heat engines," Energy Conversion and Management, v38, #14, (1997), pp. 1501-1508.

The influence of internal heat leak on the optimal performance of heat engines is examined in this paper. Relation between optimal power output and efficiency for a steady state irreversible heat engine with irreversibilities due to external heat resistance and internal heat leak is derived. The power versus efficiency characteristics obtained in this paper is qualitatively different from that of an endoreversible heat engine. The characteristics is also in good agreement with that of a real heat engine.

WU, Chih, Professor, "A multi-stage endoreversible refrigerator for low temperature applications," The International Journal of Ambient Energy, v17, #1 (1996), pp. 49-54.

A multi-stage endoreversible refrigerator for low temperature applications is modeled and described. A performance analysis of the system is carried out. The optimal combination between two adjacent cycles in the multi-stage system is discussed. The optimal ratios of the temperatures of the working fluids in the heat transfer processes and the optimal distribution of the heat transfer areas of the heat exchangers in the multi-stage system are also determined.

WU, Chih, Professor, "Optimum collector temperature for solar heat engines ," International Journal of Ambient Energy , v17, #2, (1997), pp. 73-78.

Four solar collector models are presented for a solar heat engine designed to function either at its maximum possible efficiency or at its maximum possible output power in this paper. The operating temperatures of the solar collectors under these conditions are found. The results provides the basis for designing a real solar heat engine.

WU, Chih, Professor, "Optimization of steady flow refrigeration cycles," International Journal of Ambient Energy, v17, #4, (1996), pp. 199-206.

The finite-time thermodynamic performance of steady flow refrigeration cycles are studied for both finite and infinite thermal capacitance rates of heat reservoirs. The fundamental optimal relations of the cycles are obtained. A comparison of the performance characteristics of the cycles for the same boundary conditions is shown. The effects of finite thermal capacitance rates of the working fluid and heat reservoirs, and the internal irreversibilities of the cycles on their performance are analyzed. Optimal matching between the temperatures of the working fluid and heat reservoirs is discussed.

WU, Chih, Professor,"Heat pump performance with internal heat leak," International Journal of Ambient Energy, v18, #3, (1997), pp. 129-134.

Influence of internal heat leaks on the optimal performance of a heat pump is examined in this paper. This is done by adding a heat leak term into an endoreversible heat pump. The relation between optimal heating load and coefficients of performance for a steady-state irreversible heat pump is derived. The performance characteristics of the irreversible heat pump is found to be deeply affected by the rate of heat leak. This model allows more reasonable prediction in the performance of an actual heat pump.

WU, Chih, Professor, "Maximum profit performance of an absorption refrigerator," International Journal of Energy, Environment and Economics, v4, #1, (1996), pp. 1-7.

The operation of an absorption refrigerator is viewed as a production process with exergy as its output. The

relations between the optimal profit and COP (coefficient of performance) and the COP bound at the maximum profit of the refrigerator are derived based on a general heat transfer law. The results provide a theoretical basis for developing and utilizing a variety of absorption refrigerators. The focus of this paper is to search the comprise optimization between economics (profit) and the utilization factor (COP) for finite-time endoreversible thermodynamic cycles.

WU, Chih, Professor, "Specific power optimization for Carnot combined power plants," International Journal of Energy, Environment and Economics, v4, #1, (1996), pp. 9-16.

Performance optimization of a combined cycle formed by two endoreversible Carnot cycles in series without intermediate reservoirs is investigated using finite-time thermodynamics in this paper. The fundamental relation between work and efficiency of the combined cycle is derived for the combined cycle. Relations are found between optimal specific power (average power per unit of total heat-transfer surface area) and the efficiency for reciprocating and steady flow heat engine combined cycles. The maximum specific power and the corresponding efficiency relationship are also carried out. The results can be extended to an endoreversible, combined power plant formed by more than two endoreversible Carnot cycles.

WU, Chih, Professor, "Finite time thermodynamic performance of an isentropic closed regenerated Brayton refrigeration cycle," International Journal of Energy, Environment and Economics, v4, #4, (1997), pp. 261-274.

Finite-time thermodynamic performance of isentropic closed regenerated Brayton refrigeration cycles coupled to constant- and variable- temperature heat reservoirs has been analyzed in this paper. The relations between cooling load and pressure ratio, and between COP (coefficient of performance) and pressure ratio are derived for the two cases of heat reservoirs. In the analysis, the sole irreversibilities are the heat resistance losses in the heat exchangers between working fluid and the high- and low-temperature heat reservoirs and in the regenerator. A numerical example is also given.

WU, Chih, Professor, "The influence of heat transfer law on the endoreversible Carnot refrigerator," Journal of the Institute of Energy, v69, #480, (1996), pp. 96-100.

The general performance characteristic of a finite-speed Carnot refrigerator is investigated. The relationship between the coefficient of performance and the cooling load of the refrigerator is obtained for several different heat transfer cases. The result provides a realistic design criterion for actual refrigerators.

WU, Chih, Professor, "Performance analysis of an irreversible Brayton cycle via method of finite-time thermodynamics," Journal of the Institute of Energy, v70, #482, (1997), pp. 2-8.

A finite-time thermodynamic analysis on a real closed Brayton cycle is performed in this paper. Analytical characteristic formulas (relationships among power output, compressor pressure ratio and thermal efficiency) of the cycle coupled with its surrounding heat reservoirs are derived. The optimal characteristics of the cycle may be obtained by optimizing the distribution of heat conductances and heat transfer surface areas of the two heat exchangers between the cycle and its surrounding heat reservoirs.

WU, Chih, Professor, "Performance analysis of an irreversible Brayton heat engine," Journal of the Institute of Energy, paper accepted for publication.

The performance of an irreversible Brayton heat engine is analyzed. Analytical formulas related power output, pressure ratio, and efficiency of the heat engine coupled to either constant- or variable-temperature heat reservoirs are derived. The irreversibilities considered include heat resistance losses in the hot- and cold-side heat exchangers, and nonisentropic expansion and compression losses in the turbine and compressor. The optimal performance characteristics of the heat engine is obtained by optimizing the distribution of heat conductances or heat-transfer surface areas between the heat exchangers, and the matching between the working fluid and heat reservoirs.

WU, Chih, Professor, "Power economics of renewable energy endoreversible heat engines," International Journal of Power and Energy Systems, v16, #1, (1996), pp. 24-28.

One key economic requirement for the commercialization of renewable energy is the power cost competitiveness of renewable energy heat engines with current conventional central power plants. Since the fuel cost of the renewable energy heat engines is

free, the power cost is dominated by capital plant costs. The costs of heat exchangers between a heat engine and its surroundings usually dictate the total capital plant cost. A specific power analysis of renewable heat engines utilizing output power per unit total heat exchanger surface area is adopted in this paper as the objective function in determining power economics.

WU, Chih, Professor, "Performance characteristic of an endoreversible Stirling refrigerator,"accepted for publication, International Journal of Power and Energy Systems,

An endoreversible Stirling refrigerator is modeled in this paper. The performance characteristic relationships among working fluid temperatures, COP (coefficient of performance) and cooling load of the endoreversible refrigerator is derived in this paper. These equations provide a base for practicing engineers to design a new refrigerator.

WU, Chih, Professor, "Optimal performance coefficient and cooling load relationship of a three-heat-reservoir endoreversible refrigerator," International Journal of Power and Energy Systems, v17, #3, (1997), pp. 206-208.

The relation between the optimal coefficient of performance and the cooling load of a three-heat-reservoir endoreversible refrigerator with nonlinear heat transfer condition is derived. The results presented in this paper are different from those with Newton's linear heat transfer law. The relationships provide a theoretical basis for developing and utilizing of a variety of three-heat-reservoir refrigerators.

WU, Chih, Professor, "Effect of heat resistance on the performance of closed gas turbine regenerative cycles," accepted for publication, International Journal of Power and Energy Systems.

The effect of heat resistance on the performance of a closed gas turbine regenerative cycle is examined. The analysis focuses on the heat resistances associated with the hot and cold side heat exchangers as well as with the regenerator of the cycle. The relations among power output, thermal efficiency and compressor pressure ratio are derived by considering the irreversibilities of heat resistance losses in the three heat exchangers and non-isentropic power losses in compressor and turbine. The results indicate that the power output of the cycle is strongly dependent on the effectivenesses of the three heat exchangers. It is concluded that there exist some optimal temperature matching among the working fluid of the cycle and the working fluid of the surrounding heat reservoirs for maximum power production.

WU, Chih, Professor, "Analysis of MODM for marine steam turbine stages," International Journal of Power and Energy Systems, paper accepted for publication.

The advantages of using a multi-objective decision making (MODM) method in the design optimization of a marine steam turbine stage and/or stage group is discussed in this paper. Two computer models capable of optimizing significant design variables of the turbine are described. Also discussed is the criteria for selection of the decision making variables and the objective functions, the assumptions made for the constraints within which the solution is searched and the optimization procedure. Cascade losses are predicted by three different methods. The computer programs developed for this analysis were run successfully on microcomputer. Analytical results of MODM for a turbine stage and a stage group is provided and an analysis of the influence of the number of stages on the efficiency of a steam turbine is given. The calculations show the method to be effective.

WU, Chih, Professor, "Preliminary design optimization of marine dual tandem gear," International Journal of Power and Energy Systems, v17, #3, (1997), pp. 218-222.

On the basis of pinion size formulas previously deduced by the authors, this paper advances an optimization method for the preliminary design of marine dual tandem gear (with two power inputs and two power paths). In this method, the reduction ratios and helix angles for first and second reduction of each power input are taken as the optimization variables, and the total weight of gear is taken as the objective function. The results of optimization show the accuracy and convergence of the algorithm.

WU, Chih, Professor, "Multi-objective optimum design method for a radial axial flow turbine with optimum criteria of blade twist at outlet of blades," International Journal of Power and Energy Systems, paper accepted for publication.

This paper gives a multiobjective optimum design method for a radial-axial flow turbine stage which is subject to various engineering construction constraint.

Five parameters (α_1, β_2, μ, u_1 and m) at the mean radius and the criteria of blade twist at the outlet of blades.These constraints and criteria are taken as design variables, and both the internal efficiency of the design condition and the total weight are taken as the objective functions. The model presented is a nonlinear multiobjective programming problem with two objective functions, twenty nine constrained functions and six variables. The optimization statement for a variety of types of twisted blades is also provided. The results show the method to be valid and effective.

WU, Chih, Professor, "Optimum design of centrifugal compressor stages," International Journal of Power and Energy Systems, paper accepted for publication.

The design of an axial flow compressor stage at subsonic Mach numbers has been formulated as a nonlinear multiobjective mathematical programming problem with the objective of minimizing the aerodynamic losses and the weight of the stage, while maximizing the compressor stall margin . Aerodynamic as well as mechanical constraints are considered in the optimization. The Prediction model of estimating the performance characteristics, such as efficiency, weight and stall margin of the compressor stage is presented. The present design optimization procedure can be applied also to a multistage compressor.

Presentations

FLACK, K.A., Assistant Professor, "Experimental Investigation of Three-Dimensional Flow Separation," ASME Fluid Engineering Division Summer Meeting, San Diego, CA, July 7-11, 1996.

JOYCE, James A., Professor, "Ductile-to-Brittle Transition Characterization of Using Surface Crack Specimens Loaded in Combined Tension and Bending," 28th National Fatigue and Fracture Mechanics Symposium, 26 June 1996, Saratoga Springs, New York.

JOYCE, James A., Professor, "Development of a New Method to Assure the Integrity of Reactor Pressure Vessels in the Ductile-to-Brittle Fracture Transition Regime, 15 Nov. 1996, Univ. of Texas, Austin, Texas.

JOYCE, James A., Professor, "Ti-6-4 KIc Crack Length Ratio Study," ASTM Week, 19 November 1996, New Orleans, Louisiana.

JOYCE, James A., Professor, "On the Utilization of High Rate Charpy Test Results and the Master Curve to Obtain Accurate Lower Bound Toughness Prediction in the Ductile-to-Brittle Transition," 14 January 1997, New Orleans, Louisiana.

JOYCE, James A., Professor, "Technical Justification of Negative Ballot - To Reference Temperature Proposed Standard," United States Nuclear Regulatory Commission, Bethesda, Maryland,
12 October 1996.

JOYCE, James A., Professor, "Predicting the Ductile-to-Brittle Transition in Nuclear Pressure Vessel Steels from Chahrpy Surveillance SpecimensTMS Annual Meeting, 11 February 1997.

JOYCE, James A., Professor, "Development of a New Method to Assure the Integrity of Reactor Pressure Vessels in the Ductile-to-Brittle Fracture Transition Regime, Solids, Structures and Materials Seminar, The University of Texas, 15 November 1996.

MINER, S. M., Associate Professor, "CFD Analysis of the Flow Distribution in the Header of a Filtration System," ASME Fluids Engineering Division Summer Meeting, San Diego, CA, July 1996.

MINER, S. M., Associate Professor, "Fundamentals of Fluid Mechanics," Computational Fluid Dynamics Using Finite Elements Short Course, University of Maryland, November 1996.

MINER, S. M., Associate Professor, "CFD Analysis of an Axial Flow Pump Impeller Using a Coarse Grid," to be presented at the Third Pumping Machinery Symposium, Vancouver, British Columbia, June, 1997.

MORAN, A.L., Associate Professor, with R.Rebis, "Test and Evaluation of Spray Formed Alloy 625", 1996 World Congress on Powder Metallurgy and Particulate Materials, Washington, DC, June 1996.

MORAN, A.L., Associate Professor, "Engineering Education, Opportunities and Employment," Loyola

College Engineering Seminar, Baltimore, MD, April 1997.

MORAN, A.L., Associate Professor, with P.C. Saxton, M. Harper and K. Lindler, "Materials Design and Selection for TPV Emitter," ASNE presentation, Annapolis,MD, April 1997

MORAN, A.L., Associate Professor, with P.C. Saxton, M. Harper and K. Lindler, "Materials Selection for TPV Emitter," IECEC Conference, Honolulu, Hawaii, July 1997.

MORAN, A.L., Associate Professor, "Advances in Intelligent Manufacturing," invited presentation, National Academy of Engineering Frontiers of Engineering Symposium, Irvine, CA, September 1997

MORAN, P.J., Professor, with M. Inman, E.J. Taylor, A. Rawat, M. Sunkara, R.M. Kain, and R.Hays, "Detection of Crevice Corrosion in Natural Seawater Using Polarization Resistance Measurements", Corrosion 97, National Assoc. of Corrosion Engineers, New Orleans, LA, March 1997

MORAN, P.J., Professor, with M. Inman, A. Rawat, and E.J. Taylor, "Detection of Crevice Corrosion Under an O-ring by Polarization Resistance Measurements Using Electrodes Embedded in the O-ring", Corrosion 97, National Assoc. of Corrosion Engineers, New Orleans, LA, March 1997

MORAN, P. J., Professor, "The Thermodynamics which Govern Corrosion", University of Virginia, Charlottesville, VA, June 1997

MORAN, P.J., Professor, "Electrochemical Reaction Rates and Corrosion Processes", University of Virginia, Charlottesville, VA, June 1997

MORAN, P.J., Professor, " Methods for Predicting and Controlling Corrosion Rates", University of Virginia, Charlottesville, VA, June 1997

MORAN, P.J., Professor, " AC Electrochemical Methods for the Characterization of Corroding Interfaces", University of Virginia, Charlottesville, VA, June 1997

PALMER, Sheila C., Assistant Professor,"Effectiveness of the Woodruff School Doctoral Teaching Intern Program," American Society of Engineering Education Annual Meeting, Washington, D.C., June 1996.

PALMER, Sheila C., Assistant Professor, "Effect of Evaporator Design Pressure on Dual-Pressure Absorption Heat Pump Performance," International Ab-Sorption Heat Pump Conference, Montreal, Canada, Sept. 1996.

PALMER, Sheila C., Assistant Professor, "Experimental Investigation and Model Verification for a GAX Absorber," International Ab-Sorption Heat Pump Conference, Montreal, Canada, Sept. 1996.

PUZINAUSKAS, Paulius V., Assistant Professor, Engine Combustion Analysis Demonstration, Advanced Engine Technology Conference, SuperFlow Corporation, Colorado Springs CO, 21-22 January 1997.

PUZINAUSKAS, Paulius V., Assistant Professor, "Engine Research and Education at the US Naval Academy," Baltimore Section SAE Meeting, USNA, 27 March 1997.

RAOUF, Raouf A., Associate Professor, "Collaborative Learning: Prerequisites and Consequences," Center for Teaching and Learning, U.S. Naval Academy, Annapolis, MD, 1 November 1996.

RATCLIFFE, Colin P., Assistant Professor and BARTON Oscar, "Modal Analysis of a Thick Sandwich Plate: a Comparison Between Theory And Experiment." C.P. Ratcliffe and O. Barton. The Society for Experimental Mechanics, International Modal Analysis Conference IMAC-XV, Orlando, 1997.

RATCLIFFE, Colin P., Assistant Professor and Hoerst, Brian C., "Damage Detection in Beams Using Laplacian Operators on Experimental Modal Data." The Society for Experimental Mechanics, International Modal Analysis Conference IMAC-XV, Orlando, 1997.

RATCLIFFE, Colin P., Assistant Professor, CRANE, Roger M. and SANTIAGO, Armando L., "Experimental Modal Analysis Comparison of the Vibration Damping Properties of Composite Cylinders Measured In-Air and Underwater." The Third Joint Meeting, Acoustical Society of America and Acoustical Society of Japan, Honolulu, 1996.

RATCLIFFE, Colin P., Assistant Professor, CRANE, Roger M. and SANTIAGO, Armando L., "Optimizing Reinforced Polyurethane as a Combined Structural and Damping Component." Winter Annual Meeting of the American Society of Mechanical Engineers, Atlanta, 1996.

VOLINO, R.J. Assistant Professor, with G.B. Smith, R.I. Leighton and W. McKeown. "Effect of a Vortex Pair on the Temperature Field at a Free Surface," 49th Annual Meeting of the Division of Fluid Dynamics of the American Physical Society, Syracuse, New York, November 24-26, 1996.

VOLINO, R.J., Assistant Professor, with G.B. Smith, R.A. Handler and R.I. Leighton. "Simulation of a Vortex Pair at a Free Surface with Heat Transfer," 49th Annual Meeting of the Division of Fluid Dynamics of the American Physical Society, Syracuse, New York, November 24-26, 1996.

VOLINO, R.J., Assistant Professor. "A New Model For Free-Stream Turbulence Effects On Boundary Layers," 42nd ASME International Gas Turbine & Aeroengine Congress, Exposition and Users Symposium, Orlando, Florida, June 2-5, 1997.

VOLINO, R.J., Assistant Professor, with C.G. Murawski, R. Songergaard, R.B. Rivir, T.W. Simon, and K. Vafai "Experimental Study of the Unsteady Aerodynamics in a Linear Cascade with Low Reynolds Number Low Pressure Turbine Blades," 42nd ASME International Gas Turbine & Aeroengine Congress, Exposition and Users Symposium, Orlando, Florida, June 2-5, 1997.

VOLINO. R.J., Assistant Professor, and FLACK, K.A., Assistant Professor, "A Series - Parallel Heat Exchanger Experiment," ASME National Heat Transfer Conference, Baltimore, Maryland, August 10-12, 1997.

WU, Chih, Professor, "Using ICAI (Intelligent Computer Aided Instruction) software to enhance teaching of thermodynamic cycles at the U.S. Naval Academy," First Annual USMA Conference on Teaching and Learning, West Point, NY, 27-28 September 1996.

Technical Reports

MINER, S. M., Associate Professor, "Computational Fluid Dynamics Analysis of the Flow Distribution Through a Dense-Pack Ceramic Ultrafiltration Membrane in an Oily waste Polishing System," NSWCCD-TR-63-97/24, August, 1997.

Research and Development of ultrafiltration membrane systems for oily waste treatment are being conducted to polish the effluent from parallel plate oil/water separators currently installed on Navy ships. These ultrafiltration systems will give ships the ability to reduce the quantity of oil in bilgewater discharges to less than 5 mg/L. The best performance of these systems is achieved when the flow distribution across the membrane is uniform. Computational Fluid Dynamics (CFD) is used to determine the flow distribution across the membranes for the oily water pollution control project.

MORAN, Angela, Associate Professor, EW-11-96, "Corrosion Investigations into Spray Deposited, Powder Processed and Conventionally Manufactured 304L Stainless Steels" with T. Barz, June 1996.

The effect of steel processing methods on corrosion resistance was examined. Three samples of 304L stainless steel - spray deposited, powder processed and conventionally manufactured - were tested in order to determine which had the highest resistance to pitting. It appeared that the powder processed sample had an 0.09 to 0.1V higher pitting potential than the spray deposited and conventional materials. The later two behaved very similarly to one another in levels of resistance by possessing average pitting potentials of -0.135 and -0.130V vs. SCE.

MORAN, Angela, Associate Professor, and T. Hoyte, EW-12-96, "Comparative Analysis of Conventional, Powder Spray and Spray/HIPped Processed 304L Stainless Steels", June 1996.

A comparison of conventional, powder, spray and spray/HIPped manufactured 304L stainless steel was conducted. Density testing, tensile testing, optical microscopy and elemental analysis were performed on the samples as a basis for comparison. Results from the testing indicated that the conventionally processed steel and the powder processed steel showed very similar characteristics. Although similar to each other, the mechanical properties of the spray and spray/HIPped samples were considerably less than both the conventional and the powder processed steels.

RATCLIFFE, Colin P., Assistant Professor, "The 3:4:5 Coincidence of an Optimized Moment of Inertia Classroom Demonstration." U.S. Naval Academy of Engineering and Weapons Technical Report EW-06-96, April 1996.

A physical classroom demonstration of a basic principle can be a powerful way of presenting information. Although many commercial models are available, this paper presents a simple model, one that can be manufactured in almost any engineering workshop. The demonstration shows that, for rolling motion, both mass and mass moment of inertia have to be considered. The model consists of two cylinders, with the same geometry, size and mass. However, they have different mass moments of inertia. When rolled down a slope, one cylinder accelerates faster than the other.

The demonstration idea is not new. However, this paper presents an optimization of the design. This ensures the model has greatest classroom impact. When conventional materials (brass and aluminum) are chosen, it is shown that the critical diameters for the cylinders are coincidentally in the ratio 3:4:5.

RATCLIFFE, Colin P., Assistant Professor, "Trial Report: Modal Testing of Composite Deck Panels, Ingalls Shipbuilding" Ingalls Shipbuilding Filed Trial Report, 7/30-31/97, August 1996.

This report covers the experimental modal analysis of a hat stiffened panel and a sandwich panel. The aim of the work was to provide experimental natural frequency data that can be used by Casde Corporation to verify their finite element models of the panels. The work was undertaken at Ingalls Shipbuilding, Pascagoula, Mississippi, on July 30 and 31, 1996. Overall supervision and quality control was by Dr. Colin P. Ratcliffe, United States Naval Academy. The local shop supervisor was Mr. Meloin J. Washington, Jr, who provided some outstanding assistance. There is no doubt that he personally ensured the experiment was ahead of the timetable. The "hitter" for the hat stiffened panel was Mr. F.P. "Kojak" Hilbrant, and for the sandwich panel, Mr. T.L. Seales.

DEPARTMENT OF NAVAL ARCHITECTURE, OCEAN AND MARINE ENGINEERING

Professor Roger Compton
Chair

The Naval Architecture, Ocean and Marine Engineering Department conducted scholarly marine research and professional development actively in all three departmental disciplines during Academic Year 1996-1997. Faculty members and midshipmen undertook both funded and unfunded research activities which utilized the outstanding experimental, library, and computational facilities available to this department. Two Trident Scholars and ten independent research projects were supported by the department during this academic year.

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 or international seminars. One outcome of the department's deep involvement in research by the civilian and military faculty members is an energized and current academic environment in the classroom for professional and major courses.

A broad spectrum of research themes reflected the varied specialties of the department's three technical areas of concentration. Marine Engineering research included studies in dosimetry, combustion, safe refrigerants, thermophotovoltaic (TPV) energy systems, radiation detection, emissions from power systems and solid waste combustion, neural network sensor systems, reliability-centered maintenance, soil contamination, and radiation effects on RAM devices. Ocean Engineering topics included wave groups, extreme wave statistics, building loads due to winds and flooding events, effectiveness of vertical wave barriers, bonded composite joints, the thermal performance of diving suits, the absorption of CO_2 in disabled submarines, and the design and fabrication of a remotely operated, underwater vehicle (and its control system). Naval architecture topics included model testing of a 25th scale model of the CONSTITUTION in preparation for the 200th anniversary sail of the ship, CAD software for space systems, composite panel failures, welding of barge deck panels, seakeeping of planing craft, and motions of fully submerged hydrofoils.

Research funding was made available from many sources including department operating funds, the Naval Academy Research Council, the Trident Scholar Program, as well as contracts and grants from the Office of Naval Research; the Dahlgren, Carderock and Annapolis offices of the Naval Surface Warfare Center; the National Science Foundation; the Department of Energy; the U.S. Coast Guard; the Naval Sea Systems Command; the National Research Council; the Applied Physics Laboratory; the Naval Space Command Laboratory; the Alaska Science and Technology Foundation; the Defense Special Weapons Agency; the Naval Research Laboratory; the American Society of Civil Engineers; and the Society of Naval Architects and Marine Engineering.

Sponsored Research

Investigation of Copper-Doped Lithium Fluoride Thermoluminiscent Detector

Researcher: Lieutenant James R. Cassata, USN (former NAOME faculty member and doctoral candidate in the Nuclear Engineering department at the University of Maryland)
Adviser: Professor Martin E. Nelson (primary advisor and on LT Cassata's doctoral committee)
Sponsor: NAVSEA/NSWC-White Oak

This research forms the basis of Lieutenant Cassata's doctoral research. The copper-doped Lithium Fluoride (LiF) detector has a significantly greater neutron and photon response than the manganese-doped LiF detector, which the United States Navy currently uses. The researcher irradiated both the copper and manganese-doped LiF with beta, x-ray, gamma and neutron radiation to determine the response of each to different fields. The test sequence reflected the recent changes in ANSI standards for all dosimeters; it included irradiations in mixed fields as well as angular source energy variations. Lieutenant Cassata developed a decision tree algorithm to determine the dose received by the dosimeter during an irradiation; he based the decision tree on the measured response of the four LiF chips that compose the dosimeter.

A second approach for measuring the exposed dose uses a neural network methodology. This method had in general similar accuracy as the decision tree algorithm in measuring the correct dose; however, when significant beta exposure was present, the neural network gave a far superior estimate to the actual dose received by the dosimeter than did the decision tree algorithm.

The researcher also developed a technique that allows other LiF users to update their dose algorithms to comply with the recent ANSI changes without the need to perform any experimentation.

Lieutenant Cassata has submitted and successfully defended his dissertation; the research is complete. Besides the results published in the dissertation, further results appear in two other papers. Radiation Protection Dosimetry has accepted a paper describing the impact of the recent ANSI changes on LiF algorithms; the second was part of a presentation to the Health Physics Society in August 1996.

An Investigation into the Effect of Synthetic Atmospheres on the Combustion Process of an IC Engine

Researcher: Associate Professor Martin R. Cerza
Sponsor: Naval Surface Warfare Center

The purpose of this investigation is to look for ways to reduce the nitrous oxide (NO_x) and carbon monoxide (CO) formation in internal engine exhaust gas byproducts. Utilizing a synthetic atmosphere, a mixture of carbon dioxide and other gases such as argon, nitrogen, etc, at the engine intake should accomplish our goal. The effort is to try and reduce oxidation of the undesirable compounds by utilizing less air. We have procured a state of the art exhaust gas analyzation system to measure the concentrations in the exhaust gas products for varying types of synthetic atmospheres. Results obtained for a gasoline CFR engine are very favorable. An increase in CO_2 in the intake of the gasoline engine does reduce NO formation. Investigation into the application of the process to diesel engines is ongoing. This research is a cooperative effort with the Department of Mechanical Engineering.

Boiling and Condensation Thermal Performance for Non-CFC Refrigerants with and without Enhanced Heat Transfer Surfaces

Researcher: Associate Professor Martin R. Cerza
Sponsor: Naval Surface Warfare Center

An international agreement in 1992 called the Montreal Protocol has set the stage for the phasing out of Ozone-harmful refrigerants, CFC's (Chlorofluorocarbons) and has established guidelines for phasing in HFC's (HydroFlouroCarbons) which are Ozone safe. In its efforts to comply with the Montreal Protocol, the US Navy will be redesigning its shipboard refrigeration facilities. The new HFC refrigerants will require the examination of phenomena associated with the thermal performance of refrigeration facilities, namely, boiling and condensation heat transfer. Development of enhanced heat transfer surfaces will make the new equipment lighter and more compact. These new surfaces show great promise for enhancing heat transfer on boiling and condensation surfaces. This investigation studies the phenomena involved with new HFC refrigerants on existing and enhanced boiling and condensation heat transfer surfaces. The heat transfer loop is almost operational and should be ready for preliminary shakedown runs during the summer of 1997.

Thermodynamic Mixing of Real Gasses and Gas/Liquid Mixtures and the Effect on Enthalpy and Entropy

Researcher: Associate Professor Martin R. Cerza
Sponsor: Office of Naval Research

The purpose of this ongoing theoretical investigation is to evaluate the use of an ideal gas to modify the compressibility and decrease the enthalpy departure of a real gas (working fluid) for the purpose of increasing the power output and/or the thermal efficiency of modern power cycles. This research should answer several posed questions pertaining to the mixing of real gases and gas/liquid systems and should determine whether or not further experimental or theoretical investigations are warranted. The theoretical investigation will entail classical and possibly statistical thermodynamics. Plans call for the presentation of the results this year (FY98) at the ONR Propulsion Meeting.

USS CONSTITUTION Model Testing Program

Researcher: Professor Roger H. Compton
Sponsor: NAVSEA Hydrodynamics Division (NAVSEA-USNA MOU)

Plans to celebrate the 200th birthday of the USS CONSTITUTION include a planned sailing of the frigate in July 1997. There exists concern for the safety of the ship during the actual sail and during the tow to and from the sailing venue. The United States Naval Academy (USNA) Technical Support Department fabricated a 1:25 scale model of the USS CONSTITUTION; the USNA Hydromechanics Laboratory tested this model to support the planned limited sailing of the frigate. Regular, long-crested beam seas testing characterized the resonant roll behavior of the ship with and without the planned sail plan. Experimental conditions limited testing of the ships response to wind and irregular long-crested waves to zero forward speed; however, except for soft tethers at bow and stern, the CONSTITUTION model was free to respond in all six degrees of motion freedom. These tests used three headings and three "weather conditions" with various sail plan configurations. A non-intrusive 3D-video system measured model motions for all wind/wave testing. The tow test, to simulate the tow to the venue, consisted of towing the model in calm water tests at three slow speeds at each of three towing hawser lengths.

Wave Groups in Random Seas

Researcher: Professor Thomas H. Dawson
Sponsor: Office of Naval Research

This experiment uses the Naval Academy's 380 foot towing tank to study wave groups in random deep-water waves. The investigator has compared results with theoretical work that accounts for nonlinear effects on crest amplitudes. Most recent work deals with investigation of wave-group statistics derived from Markov theory for wave runs. The work is continuing under ONR sponsorship.

Development of Load Factors for Combined Wind and Flood Events

Researcher:Associate Professor David L. Kriebel
Sponsor: American Society of Civil Engineers

The purpose of this project is to derive load factors for coastal wind and flood loading on buildings for inclusion in the American Society of Civil Engineers (ASCE) Standard for design of buildings and other structures, a peer-reviewed set of building standards that can be incorporated into local, state, and national building codes. The design of both residential and commercial buildings is increasingly based on a load and resistance factor design (LRFD) format in which each type of load on the building, e.g. dead load, live load, wind load, etc., is multiplied by a unique factor to account for the statistical variability and uncertainty in the load. This is in contrast to the more traditional working stress design approach in which a single factor, termed a factor of safety, is applied to the sum of all loads acting on the building. At present, the ASCE building standards do not account for flood loads, nor do they account for the simultaneous occurrence of extreme wind and flood loads. This project involves three major phases: (1) the development of a national database on simultaneous wind and flood events for hurricanes in coastal regions, (2) the development of a database on simultaneous wind and flood loadings on buildings in coastal regions, and (3) the development of load factors to account for the statistical variability in extreme wind and flood loads. The first phase is complete; the second and third phases are part of the ongoing investigation and are now in progress.

Statistics of Extreme Wave Crests

Researcher: Associate Professor David L. Kriebel and Professor Thomas Dawson
Sponsor: National Science Foundation and Office of Naval Research

This project uses field data from instrumented ocean platforms to further evaluate a probabilistic model for the occurrence of high nonlinear wave crests in a random sea; it also extends the model to derive extreme value statistics. The probabilistic model accounts for the probability of exceedence for high wave crests based on a combination of the Rayleigh probability law for wave heights and the Stokes second-order wave theory for nonlinear wave crests. As a result, it is possible to describe the probability that a wave crest will exceed some elevation above the still water surface for extreme sea states. The present work uses field data obtained from the Shell Development Company for hurricanes Camille and Andrew in the Gulf of Mexico to evaluate the probability model. Additional work is in progress to further evaluate the probability model using data measured on two North Sea oil production platforms provided to us by Shell Offshore Research and by Amoco Production Company. A second phase of this work is to extend the probability model to theoretically derive extreme value statistics. Of interest are higher-order statistical quantities such as the most probable maximum wave crest that would be expected if some number, N, waves are observed. The offshore industry could use such information to assess the probability of deck overtopping or to establish the design elevation of the deck of a fixed offshore platform.

Wave Interaction with Vertical Wave Barriers

Researcher: Associate Professor David L. Kriebel
Sponsor: National Science Foundation and Alaska Science and Technology Foundation

The researcher performed laboratory tests in the Naval Academy Hydromechanics Laboratory to investigate wave interaction with vertical wave barriers. A wave barrier is a type of breakwater which consists of a solid impermeable vertical wall extending from above the water surface down to about mid-depth. A gap between the bottom of the barrier and the seafloor allows some transmission of wave energy into the harbor or marina behind the wall. This work is part of a three phase research program which includes: (1) small-scale laboratory tests conducted at the United States Naval Academy (USNA), (2) large scale laboratory tests conducted at Oregon State University, and (3) field measurements of a full-scale wave barrier located in Seattle, Washington. The overall project goals are to improve the design of vertical wave barriers by better understanding the wave transmission past the barrier and wave forces on the barrier.

In the USNA tests, the investigator installed a model wave barrier in the small wave/towing tank of the Hydromechanics Laboratory at four different barrier depths (drafts): 2, 2.5, 3, and 3.5 feet. This tank is 120 feet long, 8 feet wide, and 5 feet deep. For each of the barrier depths, the tests subjected the barrier to regular waves using 21 combinations of wave height and period. Test instrumentation provided measurements of the incident, transmitted, and reflected wave heights; the water surface elevation on either side of the barrier; and wave forces near the top and bottom of the wall. The force measurements provided the data needed to compute the total wave force and the wave-induced overturning moments.

Preliminary results of these tests were published at the 25th International Conference on Coastal Engineering. That paper compares measured values of regular wave transmission to three analytic theories, two based on wave power transmission and one based on an eigenfunction expansion. Work is in progress to analyze wave force measurements. In addition, larger scale tests at Oregon State University repeat the USNA tests to investigate model scale effects since viscous losses are important.

The Space Mission Computer Aided Design Program

Researcher: Associate Professor Thomas J. Langan
Sponsor: Naval Space Command Laboratory

Over the years, Associate Professor Thomas J. Langan has formulated a philosophy on the design of computer aided engineering design systems. The purpose of the present ongoing research is to test this philosophy by applying it to a windows based software system that will aid designers of space missions. This philosophy views each synthesis step in the design process as an operation applied to the design and the analysis of the design at the output of each of these steps as a feedback. A properly designed system will have feedback and feedforward; the designer can use the provided analysis to evaluate the analysis at each point in the synthesis. Secondly, it should be possible to develop software tools that allow the designer to build his design system similar to the way one builds a computational scheme into a spreadsheet. In the former case the cell might be a window running an interactive program or displaying graphics, parts drawings, schematics, or computational results. In any case the windows display information that the designer desires at each point in the design process. Finally, the X Window System with the Motif toolkit or an equivalent one can be used to develop the software for the design system.

During the past year, progress was anticipated in the development of working data bases and completion of some major segments of the design program including all second level programs. Data was downloaded from the European Space Agency, Jet Propulsion Laboratory, and National Aeronautics and Space Administration and archived this material for future reference. The use of an intranet as an interface between the design program and the reference files downloaded from the World Wide Web (WWW), was explored, but this approach was abandoned, since it was not applicable to the situation. Instead, the approach is to condense each of the reference files into a standardized HTML-file. An HTML-file is one

written in the language of a web page. UNIX will be used to search these files for data desired by the designer and then presented for him in a tabular online format or printout. The chosen format for the data files reduces the storage space and provides accessibility from the WWW, when desired. Reference books on the various levels of X recommend that resource files be used to assign resources. This advice caused more problems than it was worth and slowed progress in the development of the program. This approach was abandoned and resources were simply programmed into the individual programs. Once this decision was made, progress was made on the design program. The goal for this year is to complete a working design program, which the midshipmen can use in their design projects come Fall.

The Design and Construction of a High Temperature Photon Emitter for a Thermophotovoltaic Generator

Researchers: Professor Keith W. Lindler and Associate Professor Mark J. Harper
Sponsor: Department of Energy

The United States Naval Academy (USNA) design team is in the process of designing and fabricating a combustor/emitter which is compatible with a Department of Energy furnished thermophotovoltaic (TPV) power module. The unit is to be totally self sufficient, and the TPV cells must power any required ancillary equipment.

The current effort is to use the combustion gases from a T-58 gas turbine as the energy source for the TPV emitter. Recent effort has been in the area of overcoming the numerous problems associated with the installation of the gas turbine for indoor use in Rickover Hall. Tests, conducted with the T-58 gas turbine, determined the best location to remove combustion gases to power the TPV module. The USNA team is responsible for material selection, emitter design, determining temperature effects on combustor/emitter materials, system optimization, and safety controls to shut down the gas turbine in the event of loss of coolant to the TPV cells. This is an ongoing project with an expected completion date of August 1998.

Development of a Lightweight Portable Neutron Detector for Arms Control and Non-Proliferation Applications

Researchers: Lieutenant Marshall G. Millett Doctoral candidate in Nuclear Engineering at University of Maryland and Ensign James Adams, USN
Adviser: Professor Martin E. Nelson (primary advisor and member of the doctoral committee)
Sponsor: Defense Special Weapons Agency

This project involves designing an improved neutron detector with a higher efficiency and lower weight than the detector(s) currently used for arms control purposes. Part of this project formed the basis of Lieutenant Millet's doctoral research at the University of Maryland. He used a Monte Carlo computer code, MCNP, to develop a computer model of the physics of a gas filled proportional counter exposed to a fast neutron source. Experiments performed with a suitable gas filled detector validated the mathematical model. Lieutenant Millett applied his mathematical model to the design of a prototype detector; he then constructed the prototype and performed experiments with it to establish its operating characteristics. Naval Surface Warfare Center, Carderock Division-Annapolis helped in the material selection and construction of the composite box used to transport the detector. The composite materials substantially decreased the system weight. Lieutenant Millett's Ph.D. dissertation describes all experimental and analytical results and presents the final design specifications of the prototype detector. Professor Nelson gave briefings of the project status to the Defense Special Weapons Agency in September, 1996 and April, 1997.

Feasibility Study on the Development of Advanced Composite Hull Panels for Large Surface Ships

Researcher: Assistant Professor Sarah E. Mouring
Sponsor: National Science Foundation

For over thirty years, conventional glass fiber-reinforced polyester resin composites (fiberglass) have dominated the recreational boating industry. However, such conventional composites cannot meet the demands of marine systems in the defense, oil, and shipping industries. The recent introduction of advanced composites, meets many of these demands for large marine structures. Advanced composites have high strength-to-weight ratios, high stiffness-to-weight ratios, and are resistant to corrosion. Technology exists to fabricate advanced composites into unusual shapes which reduces the number of fasteners and results in fewer parts and which at the same time can satisfy operational requirements. Such advantages demonstrate that it is possible to use advanced composites in large marine structures, including surface ships, offshore platforms, and submarines. In 1993, the Committee of Marine Structures concluded that research in advanced composites was strongly recommended and crucial to the future competitiveness of the United States ship-building industry. This study investigates the feasibility of using advanced composites in one such area, large surface ship hulls for both military and commercial use.

In the preliminary research the investigator completed an extensive literature search into aerospace, aeronautics, automotive, and naval uses of advanced composites. Currently, she continues to use Finite Element Analysis (FEA) to analyze several composite hull panels and to verify FEA predictions with results from several experimental tests of composite hull panels performed at the Naval Academy. Other activities include attendance at conferences on advanced composites, naval architecture, and ocean engineering, investigations into several pertinent topics, and development of a proposal submitted to NSF for consideration. NSF funded the proposal; it will provide funding for the period from June 1997 to June 1999.

Flaw Criticality in Glass Reinforced Plastic (GRP) Sandwich Panels

Researcher: Assistant Professor Sarah E. Mouring
Sponsor: Naval Surface Warfare Center, Carderock Division

The purpose of this research is to quantify the defects of glass reinforced plastic (GRP) panels in relationship to their use in the construction of Navy ships. The Navy expects the use of composites in Navy ship construction to expand in the future. For this study the investigator will utilize the Grillage Test Fixture in the Ship Structural Laboratory at the United States Naval Academy to apply in-plane compressive forces to a total of 21 panels. Five of the 21 composite panels will be baseline panels; the other ones will have structural defects such as disbonding of core and skin or impact damage. The panels are 3 feet by 4 feet sandwich construction panels with balsa or foam cores. Testing of several baseline panels is complete; this testing took place under an independent research project. Under the same independent research project, Midshipman Joseph Ertel programmed a spreadsheet to process the data from the experiments. The schedule calls for completing the tests of the remaining composite panels this Summer. The strength and stiffness data will be compared for the baseline panels with the corresponding results for the defected panels. The goal is to evaluate the strength/stiffness retention after the defects have occurred. The investigator will use a Finite Element Analysis (FEA) to model the baseline and defected panels in order to predict their structural behavior. Hopefully, a comparison between the experimental data and the FEA data will be used to validate the FEA model. A final report will summarize the correlation of flaw type and severity with the strength/stiffness retention.

Improved Navy Marine Bonded Composite Joint Concepts

Researcher: Assistant Professor Sarah Mouring
Sponsor: Naval Surface Warfare Center, Carderock Division

Results from recent programs indicate the following for typical Navy laminate materials: they have low interlaminar strengths relative to their aerospace counterparts; interlaminar failures are predominately interfacial bond failures; improved material toughness does not necessarily correspond to improved interlaminar tensile strength; and static joint performance does not always correlate with dynamic performance. These observations, coupled with Navy constraints that limit the ability to "design away" out-of-plane joints and out-of-plane loadings, demonstrate the need for improved composite bonded joint concepts for the Navy. The studies completed to date also provide guidance as to how to improve both material and structural performance such as enhancing interfacial bond strength in an effort to improve interlaminar tensile strength.

The present work uses a subcomponent test to evaluate a number of concepts designed to improve both Mode I and interlaminar tensile strength performance. This test is unique in that it captures elements of Mode I and interlaminar tension simultaneously and is suitable for both high and low strain rate testing. It also provides insight regarding fillet material performance and fillet-laminate interactions which are not provided in component tests and are too costly to evaluate in full-scale component tests.

Structural component validations tests will use the most promising concepts. Preliminary component candidates include hat-stiffened panels, T-joints, or platform joints. Mode I, interlaminar tension, and fillet material behavior control the failure of all components to varying degrees. Previous analysis indicates that finite element analysis can reasonably predict failure modes and locations for static loading. High strain rate testing of full-scale components is beyond the scope of this program, but every effort will be made to make use of existing data from previous programs or to incorporate the results into high strain rate testing of large scale pieces.

Currently, analytical and experimental work is progressing on the subcomponent test. After this work is completed, component testing will begin.

Structural Behavior of Composite Panels Stiffened With Preform Frames

Researcher: Assistant Professor Sarah E. Mouring
Sponsor: Naval Academy Research Council

Composite materials, particularly glass fiber reinforced plastic (GRP), dominate the small boat industry and offer many advantages over traditional materials for ship building. Navy ship construction traditionally uses steel and other conventional materials; however, the Navy is using more composites on new vessels and replacing components constructed of other materials with composites on older vessels. The main reasons for these changes are weight savings, stealth, and low maintenance. Presently, the disadvantage associated with composite material construction is cost. While open mold hand lay-up fabrication with GRP composite materials is cost effective for small boats, it is not for larger vessels. The cost of material, molds and labor have prevented the use of GRP for producing larger vessels, except for specialty vessels such as the Coastal Mine Hunter (MHC). Much of the labor cost is incurred during the framing of the GRP structures. The framing of GRP small craft typically takes more man-hours than the process of fabricating ("laying up") the hull laminate. Traditional framing methods involve trapezoidal foam blocks which must be formed and bonded into place on the laminate, and then the frame laminate must be fabricated or attached to the foam.

A newly developed preform frame technology, PRISMA Preform Frames, significantly reduces the labor required to frame a laminate. The preforms feature a dry fiber reinforced outer surface that is cast to shape in a closed mold with an urethane foam core. Typically, the installation of the cast preforms requires installing them in an open mold laminate by wetting the bottom of the frame tabs with resin, placing the frame on the wet laminate surface, applying resin to the remainder of the preform laminate and rolling the tab section. The preforms also can be used in resin

infusion processes such as Seeman composite resin infusion molding process (SCRIMP),vacuum assisted resin transfer molding (VARTM), or standard resin transfer molding (RTM). Before the Navy can use these preforms in the production of composite ships, it needs more information on the structural behavior of the preform frames as a function of their different geometries, materials, and fiber orientation. This research will consider the question of proper fiber orientation of the GRP laminates.

The objective of this project is to develop a numerical modeling technique which can be used to investigate frames of different fiber orientations. There is considerable debate over the optimum fiber orientations for GRP frames. Commonly used laminates for frames are biaxial (0,90), double bias (+45,-45), triaxial (+45,-45,0) and quadaxial (0,90,+45,-45) . The present research analyzes these laminates for stiffness and strength, with particular attention to failure modes in order to determine optimum laminates for in-plane loading conditions. Comparison of results from this numerical model with results from structural testing of a series of composite panel in the United States Naval Academy Ship Structures Laboratory will help quantify any modeling errors. The information gained should be helpful in developing an optimal framing system for a naval vessels.

So far this research has completed the development of analytical models of the hat-stiffened panels; however, the models still need to be experimentally verified. The six composite panels to be used in the experiments arrived at the Naval Academy in March 1997. Testing will begin this summer.

Characterization and Remediation of Thorium Contaminated Soils at Sites Within Kirtland Air Force Base.

Researchers: Professor Martin E. Nelson and Associate Professor Mark J. Harper
Sponsor: Naval Research Lab

The Interservice Nuclear Weapons School deliberately contaminated eight sites at Kirtland Air Force Base (KAFB) with thorium Th-232 compounds to provide realistic training scenarios for Department of Defense personnel. These trained persons would then be available to respond to a potential nuclear emergency. In response to the Comprehensive Environmental Response, Compensation, and Liability Act, KAFB has initiated an Installation Remediation Program for complete environmental restoration. Before remediation can commence, it is necessary to fully characterize the contaminated soil. This project involved performing geophysical, chemical, as well as soil sample collection and analysis at the four sites. Gamma spectroscopy provided the radionuclide analysis of the soil samples ; repeating the gamma spectroscopy on sieved samples of the original samples provided a distribution of concentration according to soil particle size. A chemical analysis of the soil will determine if non-radioactive contaminants are present and if a mixed waste problem exists at the sites. A final report will be issued in the July-August, 1997 time period together with recommendations to Kirkland AFB personnel concerning potential future remedial actions.

Analytical Modeling of the Thermal Performance of the MicroPCM-Enhanced Dry Suit

Researcher: Professor Marshall L. Nuckols
Sponsor: Naval Surface Warfare Center, Dahlgren Division

This investigation uses analytical models of the thermal performance of optional types of insulative MicroPCM (phase change materials) to evaluate the effects of MicroPCM mediums, medium thicknesses, and foam-to-MicroPCM ratios on diver thermal protection. Additionally, the researcher analytically compared the relative thermal performances of MicroPCM-enhanced dry suits with commercial dry suits. The ongoing research is using analytical models to compare the relative thermal potentials of foams interspersed with MicroPCM's with those of liquid slurries containing various combinations of MicroPCM's and those of liquid carriers.

Reliability Centered Maintenance

Researcher: Associate Professor Kenneth L. Tuttle
Sponsor: Naval Sea Systems Command, Surface Ship Maintenance Office (NAVSEA 915)

The purpose of this project is to provide a Maintenance Engineering Laboratory at the U.S. Naval Academy for instruction of the Midshipmen in modern maintenance engineering concepts. The present objectives are: to develop instructional capabilities in maintenance engineering, to introduce Reliability Centered Maintenance (RCM), to Naval Officers, and to conduct long range planning for introducing maintenance engineering into the curriculum.

Completed an upgrade of the Maintenance Engineering Laboratory portion of the Diesel Engine-Room Laboratory to Machinery Condition Assessment System (MCAS) from the Diesel Engine Monitoring and Analysis System (DEMA). The next phase is to upgrade the Integrated Condition Assessment System (ICAS). Upgrading to ICAS would bring the Naval Academy Maintenance Engineering Laboratory up to the level of Diesel Engine Monitoring and Analysis found in the fleet. The ICAS components and hardware include a computer workstation, ICAS software, OPTO22 electronic data acquisition devices for slow speed A/D conversion at 1 Hz and an IDAX100 high speed data logger and an A/D converter operating at 50kHz for vibrations and cylinder firing pressures analyses. Recent upgrades allow operation of the MCAS System on the GM 3-71 Diesel Engine/Generator Set using a Personal Computer. The IDAX 100 computer which controls data acquisition, monitors alarm conditions, makes log sheets, maintains trend analyses, and offers some expert system capability has a unique operating system and communication is difficult. The new PC Interface has made a dramatic improvement in the quality of the instruction being given the midshipmen in modern maintenance concepts. The engine head has been modified to allow measurement of cylinder firing pressures. A probe to allow vibrations analysis or the engine and nearby equipment has been added to the basic DEMA System. Planning for Trident Scholar research support has produced potential research areas for future Trident Scholars interested in artificial intelligence or in maintenance engineering. In addition, a slide show presentation has been developed to instruct the midshipmen in modern maintenance concepts such as Reliability Centered Maintenance. During the past eight years, more than seven thousand new naval officers or future naval officers have been introduced to the concepts of modern maintenance practices in the U.S. Naval Academy, Maintenance Engineering Laboratory.

Environmental Text

Researcher: Associate Professor Kenneth L. Tuttle
Sponsor: Society of Naval Architects and Marine Engineers

The researcher is Chairman of the Environmental Panel for the Society of Naval Architects and Marine Engineers (SNAME), and editor of the reference text, The Principles of Environmental Design and Operation of Ships, for SNAME and have the responsibility for its production. Planning for the text has progressed, and the researcher has appointed two members to the Environmental Panel from the United States Naval Academy, Associate Professor Robert Mayer and Assistant Professor Jennifer Waters. The text will be a comprehensive review of the environmental problems recognized to exist aboard ships, the technology available to treat these environmental problems, and the regulations pertaining to marine pollution.

Bending and Compression Failure of Marine FRP Panels

Researcher: Professor Gregory J. White
Sponsor: Johns Hopkins Applied Physics Laboratory (APL)

The United States Naval Academy (USNA) Ship Structures Laboratory conducted a series of structural test on FRP panels provided by Johns Hopkins Applied Physics Laboratory (APL). Each series consisted of nine panels: three solid laminate panels, three sandwich panels, and three hat-stiffened panels. APL

specified for each series the boundary conditions for the loaded edges prior to the test. The Grillage Test Fixture at the USNA Ship Structures Laboratory exerted the loading on the panels according to the following schedule: Test Series 1 tested nine FRP panels to destruction under in-plane compression only; Test Series 2 tested nine FRP panels under uniform lateral pressure to measure the load at which deflections exceed a distance two-hundredth the width of the panel; Test Series 3 tested the same nine panels used in Test Series 2 to destruction under a combination of inplane compression and uniform lateral pressure. APL in consultation with Professor White decided the magnitude of the lateral pressure for each test. The Ship Structural Lab completed the test series during the Fall of 1996, and APL has the data and results.

Effects of Intermittent Stiffener Welding on the Ultimate Strength of Barge Deck Panels

Researcher: Professor Gregory J. White
Sponsor: U.S. Coast Guard Office of Merchant Marine Safety (HSC A-3)

This is an ongoing investigation to determine the failure mode and load at failure of six pre-fabricated steel stiffened panels provided by the USCG. The test series consists of two panels with continuously welded longitudinal stiffeners, two panels with intermittent welds on the longitudinal stiffeners; and two panels with scalloped stiffeners with intermittent welds. Under the direction of Dr. White, the United States Naval Academy Ship Structures Laboratory will use their Grillage Test Fixture to apply inplane loads to the six panels. Sufficient strain and deflection measurements will provide data with which Professor White can identify the mode of failure and load at failure for each of the panels. This investigation is ongoing.

Independent Research

Radiation Induced Single Upset Events of Dynamic and Static RAM Memory Devices

Researcher: Ensign James Adams, USN
Adviser: Professor Martin E. Nelson

The purpose of this experiment was to determine the SER cross sections of dRAM memory chips with respect to different types of radiation found in cosmic rays. Ensign Adams used the United States Naval Academy (USNA) nuclear facilities to create neutrons with a discrete energy of 14.3 MeV to irradiate dRAM memory chips. The neutrons induce soft failures in chips from six different vendors. Additionally, experiments at the Los Alamos Meson Physics Facility in Los Alamos, New Mexico used 400 MeV pions to produce soft failure in chips similar to those used in the USNA experiments. Cross sections were obtained from these experiments, as well as graphs of soft fails versus chip design.

Our research found a wide variation in chip cross sections between the chips from the various vendors. Memory chips on the average are ten times more sensitive to 100-250 MeV pions than similar energy protons. Both positively and negatively charged pions react on the same order of magnitude with the memory chips. Finally, chips that are sensitive to pions in other energy ranges are also sensitive to neutrons on the same relative scale.

Professor Nelson has presented results of this study at the HEART Conference in March, 1997, which is a radiation effects Conference, and at the Joint APS/AAPT, Annual Conference, April, 1997. He has also submitted a paper to a refereed journal.

A Methodology of Neural Network Based Sensor Validation in Nuclear Power Systems

Researcher: Ensign Dale D. Klein, USN (VGEP Student - University of MD)
Adviser: Professor Martin E. Nelson

The use of neural networks (NN) to model a complex, non-linear system is not a new science, but has been very complicated in the past. Recent developments in user friendly software allows quick application of the powerful tool of neural networks to many areas. This project demonstrated and validated a method using commercially available software to model responses of instrumentation within a nuclear power system. Ensign Klein used a commercially available nuclear power plant simulation package to generate the data for the NN. The neural network predicted expected output readings of various sensors based on other plant parameters. This methodology would allow the plant operator to validate a given instrument or sensor reading by comparing a predicted instrument response to an observed instrument reading. The project also develops a statistical analysis of the predicted and observed instrument readings.

Ensign Kline presented the results of this research to the University of Maryland Nuclear Engineering Department Seminar in December, 1996; he submitted the details in his master's dissertation to the University of Maryland.

Combustion Generated Particulate Emissions from Solid Waste Fuels

Researcher: Associate Professor Kenneth L. Tuttle

This area of research is the one in which the author has the most unique expertise and experience. He was appointed to the Naval Studies Board of the National Research Council to study the disposal of solid wastes from ships because of his expertise in combustion of solid waste fuels. The National Research Council is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. The researcher has been investigating the possibility of incineration to destroy shipboard trash rather than dumping it at sea. There is world-wide support for burning shipboard combustible wastes. Most of the combustible solid wastes generated on navy ships is on ships which have incinerators that are being used. The questions are how to use the incinerators effectively and how to improve incinerator design to make it compatible with shipboard use as well as emissions regulations. The author is prepared to publish substantial research data on the emissions from the combustion of solid waste fuels. The author conducted a statistically designed, fractional factorial experiment that included the seven known independent variables suspected of affecting air pollution and measured the seven dependent variables that are considered to be potential pollutants. The experiment includes both unsteady as well as steady state experiments. Professor Tuttle has submitted a paper to the American Society of Mechanical Engineers' Journal of Energy Resources Technology.

Pollution from Ship Stack Emissions

Researcher: Associate Professor Kenneth L. Tuttle

The purpose of this research is to determine whether stack emissions from ships can be effectively reduced by modifications to the combustion process or by add-on end of pipe devices and whether the exhaust emissions should be regulated either nationally or internationally. Professor Tuttle has submitted written input to the EPA in attempt to convince the United States not to regulate ship exhaust emissions and especially not Navy ships, as they already burn low sulfur fuel and most have engines that produce low oxides of nitrogen. The investigator presented results of this research to the Society of Naval Architects and Marine Engineers (SNAME) and has submitted them for publication in Marine Technology; he has also published them in a book titled, "Ship Design and Operation in Harmony with the Environment," a SNAME Publication and the Proceedings of the Maritime Environmental Symposium '95 by the American Society of Naval Engineers. Efforts are underway with ONR to fund the Naval Academy as the Environmental Research Center for the US Navy; this plan includes funding for all faculty interested in environmental research and an Environmental Chair to coordinate and administer the program.

Research Course Projects

Seakeeping Characteristics of Planing Craft

Researcher: Midshipman 1/C Mark A. Laubach, USN
Adviser: Professor Rameswar Bhattacharyya

This research investigates the following various sea keeping characteristics of a planing craft: hull form characteristics and their influence on heaving and pitching motions, dynamic effects of added resistance and speed loss in a seaway, and static and dynamic instabilities. These instabilities include purposing and impact accelerations in a particular sea state.

A study of tests performed on planing hull models shows the effects of deadrise and running trim on the performance of planing hulls. The project includes developing the equations of motion along with an appropriate set of coefficients to describe the motion.

Motions of Hydrofoil Craft with Fully-Submerged Hydrofoils

Midshipman 1/C J. Patrick Thompson III, USN
Adviser: Professor Rameswar Bhattacharyya

The violent motions, that occur in surface-piercing hydrofoil configurations in heavy seas, has caused a considerable effort to develop theoretical predictions of the forces on these hydrofoils in order to determine the optimum foil shape. However, less attention has been paid to theoretical prediction of the pitching and heaving motions of a fully-submerged hydrofoil configuration. Designers of hydrofoil craft presume that an elaborate automatic control system (ACS) has the capability to smooth out the motions of a hydrofoil in heavy seas. An automatic control system may "smooth" the motions of the hydrofoil; regardless, the foil control systems (typically a trailing edge flap or variable incident system) requires a large amount of power. Any effort to improve the efficiency of the foil control systems also boosts the overall efficiency of the craft. Consequently, we should develop a method to predict the motions of a fully-submerged hydrofoil configuration in order to improve the operating efficiency of the craft.

This project includes the study of various coefficients used in the coupled equations of motions for a hydrofoil craft.

Evaluation and Design of Heat Pipes for Very High Temperature Applications

Researcher: Midshipman 2/C Scot G. Hughes, USN
Advisers: Associate Professor Mark J. Harper and Associate Professor Keith W. Lindler

Scientists at the Los Alamos Scientific Laboratory discovered heat pipes in 1964. The "heat pipe" developed as a high-performance heat transmission device. They can transfer heat over long distances with very small temperature differences; they are simple, require no external pumping power, and have no moving mechanical parts. Recovery of thermal energy is one of the primary functions of the heat pipe. They are also used to augment the performance of existing heating, ventilation, and air conditioning systems by transferring the exhaust gas heat back to the system's evaporator. National Aeronautics and Space Administration has used heat pipes in their shuttle program to cool sensitive electronic equipment and to control temperature inside the spacecraft.

This project will study the theory and design of heat pipes for very high temperature applications. If heat pipe technology can be extended to high temperatures, it will open the door to numerous energy conversion devices such as a combustion-powered thermophotovoltaic generator.

Gamma Spectroscopy in a Germanium Detector Using Canberra Software

Researcher: Midshipman 1/C Joseph R. Salus, USA
Adviser: Associate Professor Mark J. Harper

One major problem of nuclear power is environmental radioactive contamination. Since most nuclear power plants use a nearby body of water for cooling, the best way to measure the amount of radioactive particles released to the environment is through sediment sampling. One measures the presence of a radioactive nuclide in any sample by detecting and recording the energy of the photon released as the radioactive nuclide in the sample decays. The Department of Naval Architecture, Ocean, and Marine Engineering installed a new software package by Canberra to be used with the NaI and Germanium detectors in the United States Naval Academy's nuclear laboratory. These new programs should make reading the energy levels easier for Reactor Physics students during labs and for faculty members working on research. The purpose of this research project is to assist the faculty and staff of the laboratory in learning the new software and to prove its effectiveness.

The first stage of the project was to learn the software by completing the tutorials and to analyze simple radioactive sources. The next phase was to decide which detector and geometry would yield the best results. The investigators used the various combinations of detectors and geometries to count a standard sample of Irish Sea sediment approved by National Institute of Science and Technology and used the results to determine the best detector efficiency for the various combinations. The third stage tested the ability to count accurately by comparing the lab results of two Yenisey River samples to the Naval Research Laboratory results for the same samples. The final stage was to count an unknown sample taken from the Severn River and determine the presence of any radionuclides.

Design and Construction of a Thermophotovoltaic Energy Conversion System using Combustion Gases from a T-58 Gas Turbine

Researcher: Midshipman 1/C Timothy A. Erickson, USN
Advisers: Associate Professor Keith W. Lindler and Associate Professor Mark J. Harper
Sponsor: Department of Energy and Trident Scholar

Thermophotovoltaics (TPV) is a relatively new science, which utilizes previous experience and technology from solar photovoltaics, to convert heat energy directly into electricity. This technology offers the advantage of having a higher power density than other types of power generation systems currently in use. It also offers a distinct advantage of generating electricity without using moving parts, which are subjected to wear, cause vibration and noise, and are prone to breakdown. Unlike solar photovoltaics, any high temperature heat source can provide energy for thermophotovoltaic cells.

The current project at the U.S. Naval Academy involves the development of a prototype TPV generator, which uses a General Electric T-58 gas turbine as the heat source. This design provides for tapping the combustion gas from the T-58's combustor through one of the two ignitor ports and extracting it through a silicon carbide tube into the ceramic emitter. The chosen material for the emitter is silicon carbide. The design for the generator is modular and provides for the removal of the emitter; this scheme provides for the use of different materials at a later date. The combustion gas heats the ceramic emitter via convection, and the heated emitter radiates the heat outwards. Thermophotovoltaic cells absorb the radiation and convert it directly into electricity. A selective coating applied directly to the cells and gold foil located in the spaces between the cells reflects the radiant energy not absorbed by the cells back to the emitter. National Instrument's Labview computer program monitors the gas turbine and generator module and performs both data collection and control functions. This project details the design of the TPV generator and gives results of initial tests with the gas turbine driven TPV energy conversion system.

Thermophotovoltaic Emitter Material Selection and Design

Researcher: Midshipman 1/C Patrick C. Saxton, USN
Advisers: Assistant Professor Angela Moran, Associate Professor Mark J. Harper and Associate Professor Keith W. Lindler
Sponsor: Department of Energy and Trident Scholar Project

Direct energy conversion is an attractive option for the Navy, because it eliminates the need for complex machinery and reduces maintenance concerns by eliminating moving parts. Thermophotovoltaic (TPV) generators offer all of the advantages of direct energy conversion and can function off waste heat. Current TPV generators are either inefficient or impractical. The focus of the present research is to further technical understanding of the material issues involved in designing a TPV generator. Much like a solar power system, TPV generators use photocells to collect radiant energy and produce electric power. In this system, a high temperature emitter material emits photons with a wide spectrum of energies; the photocells collect this radiation and convert it to electric power. The peak in the radiation spectrum is directly related to the material temperature. Current TPV cell technology dictates that the emitter material needs to withstand 1300^{o} C in a combustion gas atmosphere and achieve an emissivity of at least 0.90. The initial materials considered for emitters included ceramics, refractories, metallics, and ceramic matrix composites. The materials evaluation process used available published data, thermal shock and oxidation experiments, material machinability, thermal conductivity, and thermal expansion in choosing the material for the emmiter. In addition, we evaluated the emissivity properties of the materials in conjunction with NASA Lewis Research Center. C/SiC with a SiC overcoat and SiC/Si were the most viable emitter candidates.

A Study of Glass Reinforced Plastic Composite Sandwich Panels

Researcher: Midshipman Joseph Ertel, USN
Adviser: Assistant Professor Sarah Mouring
Sponsor: Naval Surface Warfare Center, Carderock Division

This study tested and analyzed the in-plane compressive load capacity of glass reinforced plastic (GRP) sandwich panels. For the experiments the Grillage Test Fixture in the Ship Structural Laboratory at the United States Naval Academy loaded each of three panels compressively in-plane to failure. The composite panels were of woven roving construction, consisting of E-glass fibers and dexatrene, a vinyl ester resin. Each panel had a core of H80 PVC foam. The composite facesheets for each test varied from 0.115 inches to 0.136 inches while the core was one inch thick, and each panel tested was nominally three feet by four feet in size. The first two panels tested were simply supported on the sides with fixed end supports; the last panel had free conditions on the sides with fixed end supports. The failure mode for the first two panels was local buckling (wrinkling); whereas, it was global buckling for the last panel.

Instrumentation for each experiment recorded strain, end shortening, out-of-plane deflection, and load data. Theoretical predictions for failure mode for the given boundary conditions compared with the experimental results; however, the failure loading was significantly less than the theoretically predicted forces. The load predictions, being higher than the experimental loads, were definitely not conservative. These results indicate a need for further study into the mathematical theory for the failure prediction of composite panels with specific attention to sandwich panels.

A final report has been completed. Future work is planned in this area of research in the summer of 1997.

Investigation of ONDAC Detector for Arms Control Applications

Researcher: Midshipman 2/C Andrew J. Roxo, USN
Adviser: Professor Martin E. Nelson
Sponsor: Defense Special Weapons Agency, Los Alamos SARA Program

This research project involves investigating the field response of the International Nuclear Federation (INF) detector and the ONDAC detector to special radiation sources as well as conventional neutron sources at Los Alamos National Laboratory (LANL). The ONDAC detector, developed by the United States Naval Academy (USNA), has the potential to provide high sensitivity neutron measurements required for nuclear treaty verification purposes. The purpose of this project is to compare the experimental response of the detector currently in use (i.e., the INF detector) with the ONDAC detector. The researcher developed a test plan, collected experimental data, performed the necessary statistical analysis and data reduction, and summarized the findings in a final report. The project is a part of the LANL intership program with the USNA. It is hoped that these tests will demonstrate that the ONDAC detector has an efficiency equal to or greater than the INF detector and that the ONDAC instrument has significant field portability advantages over the INF detector.

The researcher expects to finish a final project report by July, 1997.

Carbon Dioxide Absorption Investigation for Disabled Submarines

Researcher: Midshipman 1/C. Beaubien, USN
Adviser: Professor Marshall L. Nuckols
Sponsor: Naval Submarine Medical Research Laboratory, Groton, CT

The objective of this research is to attempt to quantify the relative efficiencies of two alternative carbon dioxide absorption techniques for a disabled submarine. Among the methods being investigated are active and passive absorption using lithium hydroxide, seawater absorption, and the use of hollow-fiber membranes to selectively remove toxic levels of carbon dioxide with minimal power requirements. Within the past year, methods were developed to predict the levels of carbon dioxide in disabled submarines and techniques using human power were investigated to alleviate these harmful carbon dioxide levels.

The Development of Control System for a Remotely Operated Underwater Vehicle

Researcher: Midshipman 1/C Benjamin Chong, USN
Advisers: Professor Marshall L. Nuckols and Associate Professor Carl Wick

The objective of this project was to design and build a control system for the Ocean Engineering ROV "CHUBBY." The end product of this project is a joystick control console, offering the ROV operator top-level control capability of the vehicle's motion. Logic circuits will provide low-level control of individual thrusters and will free the operator from this task by effectively hiding it in the logic circuits. The system utilizes multiplexing of the power feed and the control signals to minimize power losses through the umbilical.

The Use of Phase Change Materials in the Non-Return Valve (NRV) Suit to Enhance Thermal Protection

Researcher: Midshipman 1/C Cara Grupe, USN
Adviser: Professor Marshall L. Nuckols
Sponsor: Naval Surface Warfare Center, Coastal Systems Station, Panama City, FL

This research sought to develop a thermally protective skin to be worn by divers that will enhance their thermal protection for at least twenty minutes in the event of an accidental interruption in the flow of hot

water into the NRV suit. The latent heat of the phase change materials will protect the divers when the phase change material, which is incorporated into a conventional dive skin, is placed in contact with cold temperatures. The first phase of the project involved developing 12" x 12" test panels of micro-encapsulated and macro-encapsulated phase change materials. Tests of these panels in a Rapid-K Thermal Conductivity test apparatus provided a record of the temperature changes during the phase change transition. These tests help determine the type of phase change material and the proper thickness of the phase change material needed in a diver liner. Fabrication of prototype suits, incorporating this phase change material, is proceeding; we expect to test these prototypes at the Naval
Experimental Diving Unit in Panama City, FL this summer.

Innovative Concepts in Diver Thermal Protection

Researcher: Midshipman 1/C James Zoulias, USN
Adviser: Professor Marshall L. Nuckols
Sponsor: Naval Surface Warfare Center, Coastal Systems Station, Panama City, FL

The diving community seeks passive methods of protecting a diver from cold exposures as alternatives to active heating systems. All passive thermal protection techniques share one common advantage over their active heating counterparts; they require no energy storage or energy distribution. This advantage tends to make passive protection less complex and usually less expensive. Unfortunately in severe cold water, passive systems have customarily required divers to use thick, layered insulating garments worn beneath waterproof diving suits to reduce the loss of body heat to the surrounding cold water. These suits are excessively buoyant, bulky, difficult to keep waterproof, and only minimally effective in protecting the divers' feet and hands from the cold. This research explored innovative passive protection techniques, including the use of phase change -materials (PCM's) and insulating liquids. The investigator conducted laboratory tests of conceptual insulating concepts. The objective of this research has been to provide the diving community with improvements in thermal protection for long duration, cold water missions.

Publications

AYYUB, B. M., WHITE, Gregory J., MANSOUR A. E., and WIRSCHING, P. H., "Probability Based Design Requirements for Unstiffened Panels in Ship Structures," 7th ASCE Specialty Conference on Probabilistic Mechanics and Structural Reliability, Worcester, MA., August 7-9, 1996.

This paper describes the development of a reliability-based design format for unstiffened panels and presents the development of load and resistance factor design rules for unstiffened panels for demonstration purposes. The authors base the resulting rules on an assigned target reliability level using the first-order reliability method (FORM).

CASSATA, James R., Lieutenant, USNR, co-author, "Impact of the Revised ANSI Standard on Accredited Thermoluminiscent Dosimeter Processors," Radiation Protection Dosimetry, Vol. 67, No.3 , pp 167-177 (1996).

Changes in 1993 to ANSI N13:11 will have an impact on the performance of thermoluminiscent dosimetry algorithms used to determine dose equivalent measurements. Accredited processors should update their algorithms to account for these changes. This paper quantifies the performance impact from the changes in two new energy x-ray beams, changes in the dose conversion factor C_K, and testing at angles. It prescribes a predictive model that will determine new correction factors used in the calculation of dose equivalent and presents a comparative study between predicted and experimental values. A proficiency test using the predicted values on a set of dosimeters irradiated at PNL demonstrates the validity of this approach. Extensive angular testing was also performed at NIST.

COMPTON, Roger H., Professor, co-author, "The Safety of High Speed Marine Vehicles," HSMV Committee Report to the 21st International Towing Tank Conference, Trondheim, Norway, pp. 515-544, September 1996.

In the years between 1990 and 1995 the world-wide fast ferry fleet grew by nearly 33% with catamarans increasing their share, largely at the expense of hovercraft and hydrofoils. The share of monohulls and surface effect ships (SES) remained sensibly constant.

Fast ferries now serve several areas of the world with the result that hundreds of passengers daily travel at high speed over waters which are often congested. Under these conditions rough seas lead to problems in maintaining an acceptable degree of passenger comfort. Military organizations throughout the world are using or considering for use high speed marine vehicles to serve a number of roles: high speed interception, fast patrols, fast weapon platforms and rapid deployment of troops. Rescue services have joined this upward trend in speed by designing and building faster rescue craft; speed in this case allows rapid response to a casualty, which may be several miles distant. Furthermore, recent improvements in technology have been such that the economics of high speed commercial craft (mainly passenger ferries) have improved considerably, allowing a wide sphere of employment to be opened up. Therefore, the future of high speed marine vehicles seems assured world-wide with intense activity seen in Europe, the USA, Asia, the Mediterranean, South America, Canada, and Australia.

A price comes with this almost explosive growth in the fast vessel market. These lighter, more vulnerable craft, moving at high speeds across the waters of the world have to be safe. The structural loads and accelerations for these fast ships differ considerably in type and magnitude from those for displacement ships; the codes for displacement ships do not necessary apply. Fast ferries can carry 300 passengers or more, and with the advent of the Stena HSS vessel this capacity has risen dramatically to 1500. The consequences of an accident to a fast vessel filled to capacity is too obvious, and this specter spurs various authorities to produce rules and criteria which must be met for safe operation. The most important of these is the IMO Code of Safety for High Speed Craft (IMO document 187E). This code provides guidelines for safe operational limits for all types of high speed craft. The need for such a Code cannot be disputed because the growth of operation has been accompanied by a growth in accidents. The increase in craft numbers around the world must not be accompanied by a corresponding increase in accidents. Much remains to be done.

The Committee sees a complete understanding of both the dynamics and hydrodynamics of high speed craft to be the key to ensuring the safe and predictable behavior of such craft in the years to come. It feels there is insufficient knowledge of the dynamic instability to which HSMV's are prone. Clearly there is a role for experiment and theory.

The emphasis of this report is on craft safety and the successful identification of any important dynamic problems at the model test/design stage, which impact on safety.

DAWSON, Thomas H., Professor, "Group Structure in Random Seas," Journal of Atmospheric and Oceanic Technology, Vol. 14 (1997).

This paper extends Markov theory for statistics of runs of high waves in a random sea to the special case, where runs consist of two or more high waves, that is, for the case of wave groups. The author derives expressions for the average number of waves forming the groups, for the relative number of groups expected, and for the average number of waves between the beginnings of groups. Theoretical results of the present research are in good agreement with data determined from laboratory, computer simulations, and field measurements.

HARPER, Mark J., Associate Professor, co-author, "An application of HIMS Technology to the Study of Radionuclear and Chemical Pollutant Dynamics in the Angara-Yenisey River System," Ecological Modelling, in review March 1997.

In this paper the authors considers the problem of the origin of the pollution level in the Yenisey River estuary, which is located in north central Siberia and empties into the Kara Sea. In the framework of this problem, a joint US/Russian environmental and hydrophysical expedition to the Angara and Yenisey Rivers of Siberia occurred in Summer 1995. The results of the pollution measurements taken during this expedition makes it possible to begin the synthesis of the spatial mathematical model for pollution transport in the Angara-Yenisey River system. The model includes blocks describing the flows of pollutants from biogeochemical, hydrophysical and anthropogenic sources, and it takes into consideration the influence of soil-plant formations. Its design provides for interactive use of the computer in the mode of a

computer experiment.

This paper presents the expedition results and the results of the model calculations.

HARPER, Mark J., Associate Professor, co-author, "Radionuclear Pollutants in the Angara and Yenisey Rivers of Siberia," International Symposium on Radionuclides in the Oceans, Cherbourg, France, 7-11 October 1996.

A joint US/Russian expedition to Siberia's Angara and Yenisey Rivers in July and August 1995 detected manmade contaminants in water and sediment samples from both industrial regions and wilderness areas. The team sampled from small boats using hand cores on or near the river banks and a gravity corer in deeper water; it sampled above and below the hydroelectric dams at Irkutsk and Bratsk, in and around the industrial city of Angarsk, and in the region of the junction of the Angara and Yenisey Rivers. To obtain near real-time results on the samples collected in the field the team established an on-site laboratory at the Irkutsk Scientific Center; the laboratory included the following three types of instruments: 1) a low-background high-resolution gamma-ray spectrometer for radionuclides, 2) an x-ray fluorescence spectrometer for heavy metals, and 3) a gas chromatograph for volatile organic compounds (VOCs). Samples were brought back for more extensive laboratory analysis. Samples of dry sediment taken from the Yenisey River just above the junction with the Angara contained the reactor products 60-Co, 137-Cs, and 152-Eu at levels in the range of 200-500 Bq/kg. These results indicate that the nuclear production facility at Krasnoyarsk-26, on the Yenisey River 270 km above the junction, has introduced radioactive contamination far downstream and is a probable source of previously detected radioactivity in the Yenisey estuary at its outlet into the Kara Sea. Samples downstream from the industrial complexes contained two heavy metals, As and Zn, at levels much higher than the median for fresh water. In addition, samples taken on the Angara downstream from industrial complexes contained the VOCs toluene and m-xylene; moreover, all samples from the Yenisey contained methylene chloride. These are common industrial solvents and toluene is commonly used as an octane booster in Russian fuels.

HARPER, Mark J., Associate Professor, co-author, "Radionuclear Pollutants in the Angara and Yenisey Rivers of Siberia," Radioprotection, Vol 32, C2, April 1997.

Sediment samples taken from the Yenisey River just above the junction with the Angara about 250 km downstream from the production reactors at Krasnoyarsk-26 contained the reactor products ^{60}Co, ^{137}Cs, and ^{152}Eu at levels in the range of 150-420 Bq/kg dry weight. A joint US/Russian expedition to the Yenisey and Angara Rivers made these measurements during July and August 1995. Together these rivers drain a major portion of the industrial heartland of Siberia into the Kara Sea and from there into the Arctic Ocean. Members of the expedition used hand cores on or near the river banks and a gravity corer in deeper water to take sediment samples along the Yenisey and Angara Rivers in the region of their junction, the Angara River above and below the hydroelectric dams at Irkutsk and Bratsk, and on the Angara and its tributaries in and around the industrial city of Angarsk. The sediment samples taken from the Yenisey approximately 250 km downstream from the nuclear production facility at Krasnoyarsk-26 contained significant levels of long-lived reactor products.

HARPER, Mark J., Associate Professor, and Keith W. LINDLER, Associate Professor, "Design and Construction of a Thermophotovoltaic Energy Conversion System Using Combustion Gases from a T-58 Gas Turbine," 32nd Intersociety Energy Conversion Engineering Conference (IECEC), Honolulu, HI, 27 July - 1 August 1997.

The project at the U.S. Naval Academy involves the development of a prototype thermophotovoltaic (TPV) generator that uses a General Electric T-58 gas turbine as the heat source. The goals of this project are to demonstrate the viability of using TPV and external combustion gases to generate electricity and to develop a system which could also be used for materials testing. The modular design of the generator permits the testing of different materials at a later date.

This design provides for the tapping of the combustion gas from the T-58's combustor through one of the two ignitor ports and extracting it through a silicon carbide matrix ceramic composite tube into a similarly constructed ceramic composite radiant emitter. The ceramic radiant emitter, heated by the combustion gas via convection, radiates the heat outwards to be absorbed by thermophotovoltaic cells and converted directly into electricity. A data acquisition system monitors the gas turbine and generator module and performs both the data collection and control functions. This paper details the design of the TPV generator and gives results of initial

tests with the gas turbine driven TPV energy conversion system.

HARPER, Mark J., Associate Professor, and Keith W. LINDLER, Associate Professor, "Material Selection and Design of a High Temperature Thermophotovoltaic Emitter," 32nd Intersociety Energy Conversion Engineering Conference (IECEC), Honolulu, HI, 17 July - 1 August 1997.

Direct energy conversion is an attractive option for the Navy as it eliminates the need for complex machinery and reduces maintenance concerns by eliminating moving parts. Thermophotovoltaics is one viable candidate for direct energy conversion. TPV generators offer all of the advantages of direct energy conversion, and waste heat can run them for smaller scale operations. At the present time, current TPV generators are either inefficient or impractical.

The United States Naval Academy's goal was to build a thermophotovoltaic generator powered by the combustion gases of a T-58 gas turbine. The design of the generator imposed material limitations that directly affected emitter and structural material selection. This paper details the emitter material goals and requirements, and the method used to select the final emitter material.

HAWLEY, J.G., and Marshall L. NUCKOLS, Professor, "Underwater Engineering and Education at the U.S. Naval Academy Focusing on Novel ROV Designs," J. of the Institute of Marine Engineers, June 1996.

The Department of Naval Architecture, Ocean and Marine Engineering at the United States Naval Academy (USNA) has developed within its engineering programmes a curriculum in the general area of "underwater engineering." Currently, the engineering programmes within the department are so aligned that the midshipmen (students) can follow an "underwater engineering track" by selecting a mixture of relative courses and undertaking individual research. The courses comprise specialized electives, which address the varied technology aspects associated with "man and machine underwater," and a one semester ocean engineering systems design course. Midshipmen who achieve certain scholarly requirements may undertake individual research outside these courses. The ocean engineering systems design course revolves around a "design and build" project in which groups of midshipmen are presented with scenarios which reflect real-life underwater engineering tasks and requirements. One recent project, which is ongoing in collaboration with the Naval Surface Warfare Center, is the design and evaluation of a prototype Automated Hull Maintenance Vehicle (AHMV). This paper describes the development of specialist courses in an undergraduate programme to address the man and machinery aspects associated with underwater engineering. The paper further details the philosophy by which these courses have been used to support specialist projects with a particular focus on the design of an AHMV to undertake in-water environmental cleaning operations.

HAWLEY, J.G., Marshall L. NUCKOLS, Professor, G.T. READER and I. J. POTTER, Underwater Intervention Systems, Kendall/Hunt Publishing Company, Dubuque, IA, July 1996.

This is a textbook for undergraduate students of any discipline who are undertaking courses and conducting independent/group projects and research in ocean engineering, underwater technology, and offshore studies. It is the authors' intention to provide with this book a good foundation and reference guide for graduate students, practicing engineers, and other professionals, who are starting to work in underwater technology and have little prior knowledge of its scope. Non-specialists will find that the pragmatic approach of the book will enable a ready understanding of the complex problems associated with underwater vehicle technology without additional highly specialized study.

JOHNSON, Bruce, Professor, "Version 1996 of the International Towing Tank Conference Symbols and Terminology List," distributed as an Acrobat.pdf format over the World Wide Web, September 1996.

The Symbols and Terminology Group (SaT), formed in October 1985 with Professor Johnson as chairman, has produced three hard copy versions of the Standard Symbols and Terminology List. It distributed the first one to all ITTC members during the Kobe Conference (October 1987); the second during the Madrid Conference (September 1990), and the third one before the 20th conference in San Francisco in 1993.

The main activity of the SaT Group during the 1993-1996 period was to restructure the 1993 Version of the SaT List to make it more user friendly and consistent, by avoiding unnecessary duplications, and by depleting cryptic notation. A Hypertext Version of the SaT List is presently available on the World Wide Web.

The Committee recommended to the 21st ITTC Conference in September 1996 in Norway that it adopt

the 1996 Version of the ITTC Symbols and Terminology List as a reference document. The ITTC SaT List needs continuous updating, revision, and extensions; the SaT Group can update and reissue the Hypertext Version on an annual basis. Since 1996 the SaT Group has revised and republished the Hypertext Version twice.

JOHNSON, Bruce, Professor, ENS Edward CHAPMAN, USN, and Mrs. Nancy HARRIS, naval architect, "Concerning the Electronic Distribution of ITTC Documents," Vol II, Proceedings of the 21st ITTC, Norway 1997, pp 75-76.

In this paper the authors discuss the various ways to distribute documents electronically; they cover two primary methods: e-mail and posting on the World Wide Web (WWW). With e-mail the sender must know all the addresses for the recipients, but it has the advantage of maintaining the privacy of the communication. E-mail also limits the format and type choice; however, attaching binary files circumvents this disadvantage. If the receiver has the software to read the attachments, the sender can attach any type of file: word processor, data base, graphic, or one for which the sender and receiver have the software to write and read respectively. By posting the article on the internet, the sender makes it available to anyone or a limited group with password protection. By posting on the WWW, the author can use word processing, data bases, graphics, and full character sets; moreover, imbedding File Transfer Protocol allows for almost unlimited information exchange to a limited or unlimited group of receivers.

KRIEBEL, David L., Associate Professor, and Midshipman C. BOLLMAN, "Wave Transmission Past a Vertical Wave Barrier," Proc. 25th Intl. Conf. On Coastal Engineering, Vol. 2, pp. 2470-2483, Orlando, September 1996.

The authors use three sets of experimental data to evaluate theories for predicting regular wave transmission past vertical wave barriers. The three theories are: (1) the power transmission theory of Wiegel (1960), (2) a modified power transmission theory that includes effects of wave reflection, and (3) the eigenfunction expansion theory of Losada et al. (1992). Under deep and near-deep water conditions - which are typical of most design conditions - the theory of Wiegel is found to over predict wave transmission under most circumstances. The modified power transmission theory provides better agreement with the data. The eigenfunction method provides good agreement for deep wave barrier drafts but overestimates transmission for shallow drafts.

KRIEBEL, David L., Associate Professor, R. DALRYMPLE, A. PRATT, and V. SAKOVITCH, "A Shoreline Risk Index for Northeasters," National Conference on Natural Disaster Reduction, Washington, D.C., December 1996, pp. 225-235.

The authors develop a simple five-point index to assess the erosion risk associated with the impact of northeast storms along the Delaware coast. The Ash Wednesday Northeaster of March, 1992 caused a complete loss of dunes and flooding of the area landward of the dune line. This storm defines the classification for a Category 5 Northeaster in the index. To develop the other categories (from 1 to 4), the authors applied an analytic storm erosion model to beach profiles from four locations: Dewey beach, Bethany Beach, South Bethany Beach, and Fenwick Island. They used a range of storm surge elevations, storm duration, and breaking wave heights to predict erosion values observed in historical Northeasters. This analysis led to a simple equation relating the expected beach and dune erosion to these input parameters. The authors normalized the equation by applying the equation to the Ash Wednesday Northeaster of March, 1992. The developed five point index indicates the relative severity of Northeast storms on the Delaware shore and should serve as an aid to state emergency management and natural disaster planning officials.

LINDLER, Keith W., Associate Professor, and Mark J. HARPER, Associate Professor, "Combustor/Emitter Design Tool for a Thermophotovoltaic Energy Converter," Energy Conversion and Management, accepted for publication, Elsevier Science Ltd, 2 January 1997.

Recently, there has been a renewed interest in thermophotovoltaic (TPV) energy conversion. A TPV device converts radiant energy from a high temperature incandescent emitter directly into electricity by photovoltaic cells. The current research at the United States Naval Academy involves the design, construction and demonstration of a prototype TPV converter that uses a hydrocarbon fuel (such as natural gas) as the energy source. Since the photovoltaic cells are designed to convert radiant energy efficiently at prescribed wavelength, it is important that the temperature of the emitter be nearly constant over its entire surface. The U.S. Naval Academy is developing a small emitter (with a high

emissivity) that can be maintained near 1478 K (2200F). This paper describes the computer spreadsheet model that was written as a tool to be used for the design of the high temperature emitter.

MANSOUR, A.E., P. H. WIRSCHING, B. M. AYYUB, and Gregory J. WHITE, "Code Development for Ships - A Demonstration," 15th International Conference on Offshore Mechanics and Arctic Engineering, OMAE'96, Florence, Italy, June 16-20, 1996.

This paper demonstrates a reliability-based structural design code for two ship types, a cruiser and a tanker. The reason for the development of such a code is to provide specifications which produce ship structure having a weight savings and/or improvement in reliability relative to structure designed by traditional methods.

MANSOUR, A.E., P.H. WIRSCHING, B.M. AYYUB, and Gregory J. WHITE, Professor, "Probability Based Design Requirements for Ship Structures," 7th ASCE Specialty Conference on Probabilistic Mechanics and Structural Reliability, Worcester, MA., August 7-9, 1996.

This paper concerns the development of partial safety factors associated with the important failure modes of ships. It demonstrates a procedure for developing probability based safety factors and presents the resulting values of partial safety factors obtained in the demonstration. The paper also summarizes the target reliability levels used and one of the developed safety check expressions.

McCORMICK, Michael E., Professor, Rameswar BHATTACHARYYA, Professor, and Sarah E. MOURING, Assistant Professor, "Hydroelastic Considerations in Ship Panel Design," Naval Engineering Journal, American Society of Naval Engineers, (accepted for publication, Summer 1997).

Panels and all other structural components of surface ships and submarines vibrate when the vessel is underway. The vibratory motions are primarily excited by the power plant. At operational (design) speeds, panels vibrate in their fundamental modes and those associated with their higher harmonic frequencies. The panel motions have rather well-defined energy spectra which depend on the structural design, position of the panel and the rotational speed of the single or multiple power plants. The panel motions will interact with the vortices in the adjacent turbulent boundary layer. The interaction can result in either an increase in the frictional drag or a decrease. Because of this, the argument is made that the designs of the panels and their support systems should include considerations of the hydroelastic effect.

NELSON, Martin E., Professor, co-author, "Soft Error Rates in Modern Memory Chips induced by High Energy Particles," IEEE, Journal of Solid State circuits, Feb 1998.

This paper presents a new study on the effects of high energy neutrons, protons, and pions on modern memory chips. It shows that an observed factor of 1000 can be found in the SER in three types of modern memory chip designs currently used for commercially available memory chips. The results show that the trench design with internal charge storage has a significantly lower SER than the other two chip designs. The results also show that the particle's energy is most important in predicting the chip SER except for a large resonance which exists for pions in the 100-250 MeV energy range. The paper also includes a discussion of the effects of system electronics on the observed SER.

NUCKOLS, Marshall L., Professor, "Analytical Modeling of a MicroPCM-Enhanced Diver Dry Suit," International Journal of Ocean Engineering, Submitted for publication 1 November 1996.

Over the years, various forms of phase change materials (PCMs) have served as thermal storage mediums for cooling and heating applications. Recently, the U.S. Navy has investigated using phase change materials inside divers' dry suits to enhance thermal protection in extremely cold water applications. In this paper the author develops analytical models for the thermal performance of optional types of insulative MicroPCM[1] mediums, medium thicknesses, and foam-to-MicroPCM ratios; he then uses the results to develop an analytical model of dry suit systems, both conventional and those containing MicroPCM materials. Using the model, he compares the relative thermal performances of MicroPCM-enhanced dry suits with existing commercial dry suits in simulated ocean environments

[1]MicroPCM is a trade name used by Frisby Technologies of Clemmons, NC to cover a family of patented microencapsulated phase change materials.

and assesses the relative thermal performances of candidate MicroPCM foam materials in an effort to maximize thermal storage capabilities. These candidates include those interspersed with different weight percentages of phase change materials. The observations from this modelling effort provide guidelines and recommendations for materials selection and thickness requirements for candidate MicroPCM materials to be used in prototype dry suits for divers.

NUCKOLS, Marshall L., Professor and Rudolph J. HUGHES, "Thermal Analysis of a Firefighters' Breathing Gas Cooler," J. International Society for Respiratory Protection. Accepted for publication.

This paper describes a breathing gas cooler design to keep the life-support gas inside a firefighter's face mask at, or below, 120°F for a period of at least 30 minutes; it also presents an evaluation of the thermal performances of two basic heat exchanger designs, which might be used for this purpose. Both designs incorporate a modification to the existing firefighter's apparatus with MicroPCM™ wrapped around the breathing gas supply lines within a foamed metal matrix . The gas cooler designs are in the configuration of an air-to-liquid (or solid) heat exchanger. The application requires the heat exchangers to fit comfortably on the firefighter and have quick connect and disconnect air supply fittings for ease of switch out. A 5 foot long, single pass heat exchanger, surrounded with a MicroPCM slurry in either a pig nose or bullseye configuration adequately reduces a firefighter's breathing gas from a temperature of 200°F to 120°F with a respiratory minute volume of 62.5 LPM. Both design configurations have a foamed aluminum matrix in contact with the outside of the breathing gas tube to enhance the heat transfer from the breathing gas to the MicroPCM slurry. Eicosane, $C_{20}H_{42}$, with a melting temperature of 98.1°F is the best candidate MicroPCM for maximizing the heat transfer efficiency in the breathing gas cooler. Less than 2 pounds of a slurry consisting of 60% Eicosane, and 40% water provided sufficient heat storage capacity to operate the breathing gas cooler for a 30 minute duration.

NUCKOLS, Marshall L., Professor, A. SARICH and W. TUCKER, Life Support Systems Design: Diving and Hyperbaric Applications, Simon & Schuster Publishing Company, New York, July 1996.

This textbook presents methods for designing hardware for the following systems used in diving: conventional and saturation diving systems, pressure vessels and environmental control systems for deep diving applications, and open-circuit breathing apparatus for shallow-water diving. To accomplish its purpose, the text first explores the underwater physics of the transport of light, heat, and gases in and about the diver. Since the authors wish to place a particular emphasis on the effects of hyperbaric exposures to the diver's ability to function, they cover the uptake of inert gases in the human body at elevated pressures, decompression theory, and its practice. They review carbon dioxide absorption processes and present a systemic procedure for CO_2 scrubber design.

READER, G.T., J.G. HAWLEY, and M. L. NUCKOLS, Professor, "Experience with International Collaboration at the Undergraduate and Graduate Level," Proceedings of the Mechanical Engineering Department Heads Education Conference, American Society of Mechanical Engineers, San Diego, CA, 19-21 March 97.

Individually, the authors have been involved in a variety of international collaborative ventures concerning engineering education and scholarly exchanges since the 1970s. This paper presents some personal observations on these experiences and current international trends; it describes the experiences of the authors in working *together* on various research and engineering education projects over the last ten years. Our discussion covers the concepts and needs of the "Globalization" of education, particularly engineering education, especially with regard to the effectiveness of the use of international resources in developing "link" agreements. Good communications is a key element to success, and the recent advent of electronic and internet facilities can do much to enhance the communications process. However, there needs to be an agreed vision and mission because the vagaries of cross-border co-operation can lead to great frustrations. An appreciation of the different educational cultures is as important as communications.

WATERS, Jennifer K., Assistant Professor, "Environmental Protections," Chapter in Principles of Small Craft Design, Society of Naval Architects and Marine Engineers.

Environmental protection has taken a paramount role in the design of all water-borne craft. While design and construction recommendations and regulatory guidance exist in many references for larger vessels,

very little information is available for small craft design. This chapter is therefore the first comprehensive environmental protection reference for smaller craft. Covered topics include water pollution, air pollution, noise pollution, and domestic and foreign legislative and regulatory bodies, which have concerns with environmental protection.

WHITE, Gregory J., Professor, B.M. AYYUB, A.E. MANSOUR, and P.H. WIRSCHING, "Probability Based Design Requirements for Longitudinally Stiffened Panels in Ship Structures," 7th ASCE Specialty Conference on Probabilistic Mechanics and Structural Reliability, Worcester, MA., August 7-9, 1996.

A stiffened panel is a panel of plating which has stiffeners running in two orthogonal directions. Loads can arise from hydrostatic and hydrodynamic pressure associated with still water, wave, and dynamic conditions and inplane loads from the same conditions. This paper presents an analysis of one possible failure mode, that of the longitudinally stiffened sub panel and provides a limit state formulation of the failure mode. The authors used this limit state for an example deck and bottom structure to derive partial safety factors for both a cruiser and a tanker.

WIRSCHING, P.H., A.E. B. M. MANSOUR, B.M. AYYUB, and Gregory J.. WHITE, Professor, "Probability Based Design Requirements with Respect to Fatigue in Ship Structures," 7th ASCE Specialty Conference on Probabilistic Mechanics and Structural Reliability, Worcester, MA., August 7-9, 1996.

A Ship Structure Committee project developed a prototype code statement of probability-based design requirements with respect to fatigue for ship structural details. This presentation summarizes the method of deriving probability-based safety margins and the definition of target reliabilities, and provides an example of the safety margins.

Technical Reports

CERZA, Martin R., Associate Professor, "The Use of a Synthetic Atmosphere (EGR) for Control of Emissions in a CFR Spark Ignition Engine," USNA Technical Report EW-01-97.

This report deals with the fabrication and testing of a synthetic atmosphere delivery system for Internal Combustion Engines. An atmospheric chamber was fabricated to house mixtures of gases such as Carbon Dioxide, Nitrogen, Oxygen, Argon, and Helium. Different mixtures of gases would be fed into the intake of an Internal Combustion Engine in an effort to reduce emissions, i.e., the content of nitric oxides, nitrous oxides, carbon monoxide, and unburned hydrocarbons. Connecting the facility to a spark ignited CFR engine provided favorable results. Essentially the presence of carbon dioxide in the engine intake reduced NO by lowering the combustion chamber temperature. The next thing to do is to test the synthetic atmosphere facility with Diesel Engines. The synthetic atmosphere apparatus is much like the Exhaust Gas Recirculation (EGR) on an automobile.

COMPTON, Roger H., Professor, co-author, "Ship Stability Criteria Revision Project: Intact and Damaged Model Testing of a HAMILTON Class cutter (WHEC) at Zero Speed in Wind and Waves," Report #EW 09-96, June 1996.

The realistic assessment of ship stability in typical and severe sea conditions requires dynamic as well as static analysis methods; thus, the classical naval architectural technologies of intact/damaged stability and Sea keeping are rapidly becoming inseparable. An international effort to review, improve, and update ship stability criteria has employed physical scale modeling, analytical modeling, and full scale sea trials to understand and be able to develop criteria which insure adequate safety for ship loading over a ship's life.

The United States Naval Academy Hydromechanics Laboratory (NAHL) has been involved in this criteria development process primarily in the performance of physical scale model experimentation in wind, waves, and combined wind and wave environments. The initial results of this NAHL effort, from the Summers of 1993 and 1994, are documented in a series of four technical reports (Shaughnessy, Nehrling, Compton - Oct '93, July '94, Aug '94, and Jan '96). In November 1994 these same three authors presented a summary of the experimental techniques developed for stability testing of ship models to the Fifth International Conference on Stability of Ships and Ocean Vehicles (STAB '94).

This report extends this experimental

methodology to include a damaged ship scenario. It presents a direct physical modeling of the U.S. Navy damaged stability criteria (NSTM, Chapter 079) and investigates the behavior of both the intact and damaged model in extreme wave conditions. The reported work investigates the correlation of intact predictions from two different sized models. In addition to the written report, the authors produced a full set of annotated video tapes of the test program.

MANSOUR, A.E., AYYUB, B. M., WHITE, Professor, and P.H. WIRSCHING, "Probability-Based Ship Design - Implementation of Design Guidelines for Ships," Ship Structure Committee Report No. SSC-392, October, 1996.

In this report the authors demonstrate a reliability-based structural design code for two ship types, a cruiser and a tanker. The reason for the development of such a code is to provide specifications which produce ship structure having a weight savings and/or improvement in reliability relative to structure designed by traditional methods.

The demonstration code requirements cover four failure modes: hull girder buckling, unstiffened plate yielding and buckling, stiffened panel buckling, and fatigue of critical details. It accounts for both serviceability and ultimate limit states.

A complete reliability based code for the structure of a ship would require a multi-year team effort. What is provided herein is a road map for the development of such a code. This demonstration code is not a working document; it lacks extensive professional comments and review.

MAYER, Robert H., and Bruce JOHNSON, Professor, "Integrated Design of an Offshore Structure Enhanced with Window-based Spreadsheets," USNA Technical Report EW-16-96, June 1996.

Preliminary and detailed design of offshore structures requires the computation of forces and moments, the sizing and integration of components, the evaluation of structural and foundation stability, and the assessment of functional and economic viability. Typically, the design process involves numerous iterations to satisfy all criteria.

Windows-based spreadsheets are convenient for computation of structural loadings as well as for integrating and evaluating the performance of system components. Such spreadsheets are also useful for exploring the significance of relevant design parameters.

Linked by windows' paging, a series of design-oriented spreadsheets facilitate parameter selection for a Tower Tanker Mooring (TTM). Four senior-level courses in the Ocean Engineering curriculum at the United States Naval Academy use variations of these spreadsheets developed in the TTM project. By directly integrating wave forces with the mooring's structural components, students gain appreciation for the impact of structural sizing on drag and inertial forces and can determine an optimal design that satisfies the relevant design criteria.

MOURING, Sarah E., Assistant Professor, "Feasibility Study on the Development of Advanced Composite Hull Panels for Large Surface Ships," NSF Final Project Report, Award No. 9522768, August 1996.

This research planning grant supported the investigation into the feasibility of using advanced composites in large surface ship hulls for both military and commercial use. Both preliminary research and planning activities to develop a subsequent proposal were part of this research planning grant.

The preliminary research was broken into two areas: an extensive literature search on advanced composites and involvement in an ongoing research project at the Naval Academy to gain valuable experience in experimental and analytical techniques in the composites field. This preliminary research involved the comparison of results from several experimental tests of composite panels to analytical results from Finite Element Analysis (FEA).

Planning activities included attendance of conferences on advanced composites, investigations into pertinent topics, and the development of a proposal to be submitted to NSF for consideration.

This study revealed that composite-construction hulls were feasible using state-of-the-art technology and new materials for lengths up to 400 feet. One area of major concern, observed in experimental testing and discussed in the current literature, is joint connection failures. Currently, there is a lack of research and general understanding of composite joint connections. Research into joint connections must proceed major development of composite-construction hulls.

NUCKOLS, Marshall L., Professor, "Analytical Modeling of a MicroPCM-Enhanced Diver Dry Suit," US Naval Academy Technical Report EW-20-96, August 1996.

The objective of this effort was the analytical

evaluation of the thermal performance of optional types of insulative MicroPCM mediums, medium thicknesses, and foam-to-MicroPCM ratios and an analytical comparison between the predicted performances of MicroPCM-enhanced dry suits with that of existing commercial dry suits.

The investigator developed an analytical thermal model of MicroPCM-enhanced dry suits to quantify their thermal performances in various ocean temperatures and pressures. The model helped to generate data with which to compare the relative thermal performances of MicroPCM-enhanced dry suits with existing commercial dry suits; it also helped in the selection of the best suit system for the GEN I prototypes for the NSW Enhanced Thermal Protection Project. This model can also be used to extend the experimental test results from NEDU and NCTRF to other mission profiles.

NUCKOLS, Marshall L., Professor, "The Use of Micro-Encapsulated Phase Change Materials In The Non-Return Valve (NRV) Suit To Enhance Thermal Protection," US Naval Academy Technical Report, August 1996.

This paper presents a thermal analysis to determine the feasibility of using 100% micro-encapsulated phase change materials (micro-PCM's) in an NRV suit liner. In this analysis the primary emphasis is to determine if the stored energy contained in the phase change materials would provide a significant improvement in thermal protection for a diver in the event of a failure of his warm water supply. The author compares the thermal performances of two conceptual liners containing phase change materials with melt temperatures of 83°F (Octadecane, $C_{18}H_{38}$) and 98.1°F (Eicosane, $C_{20}H_{42}$) with that of a conventional neoprene foam liner. Results of these analyses indicate that the liners containing PCM's will maintain temperatures adjacent to the diver's skin at, or near, the melt temperatures for the PCM until all of the phase change material undergoes transition from a liquid to a solid. This result contrasts markedly with the observed temperature behavior for a conventional neoprene liner; the temperature drops rapidly after an interruption in the warm water supply for a suit with a neoprene liner. A 0.1-inch thick liner containing Octadecane maintained temperatures adjacent to the diver's skin approximately 30°F higher than did the conventional liner after 7 minutes. The Octadecane liner depleted all of its stored energy after 7 minutes but still maintained temperatures almost 10°F higher than the conventional liner after 10 minutes. The Eicosane liner maintained higher temperatures initially, but it depleted its stored energy after the first 5 minutes following the interruption of the warm water supply to the hot water suit. This is a shorter duration protection time than that for the Octadecane liner; the thermal advantage of the Eicosane liner was lost. These results may suggest that there is some optimum intermediate melt temperature for the phase change liners. A material with this optimal melt temperature would provide adequately high temperatures adjacent to the diver's skin, because it maximizes the period of time required for the phase change materials to transition from liquid to solid. This report proposes a laboratory test program to help identify this optimum melt temperature.

NUCKOLS, Marshall L., Professor, "Feasibility Analysis--Surface Ventilation of a Disabled Submarine," US Naval Academy Technical Report EW-5-96, 1996.

Flooding in the aft cabin of a 688 class submarine during a diving accident, results in the submarine sinking in 600 feet of seawater. There are 120 survivors in the forward cabin which has a floodable volume of 50,787 ft^3. We have assumed that the pressure in the forward cabin was elevated to 5 Ata as a result of seawater infiltration before bringing this leakage under control. One proposal to ventilate the forward cabin with surface air (79% nitrogen, 21% oxygen, 0.035% carbon dioxide) uses gas hoses from the surface that are connected with the disabled submarine's salvage connectors. This report outlines the analysis that was conducted to determine the feasibility of maintaining life within a disabled submarine.

NUCKOLS, Marshall L., Professor, "Thermal Analysis of a Firefighters' Breathing Gas Cooler," US Naval Academy Technical Report EW-19-96, July 1996.

Requirements for a breathing gas cooler require maintaining the life-support gas inside the firefighter's face mask at, or below, 120°F for a period of at least 30 minutes. A cooler/heat exchanger is not presently incorporated in the type of firefighter's gas breathing apparatus currently in use in the fleet. There are two basic concepts that the Navy is presently evaluating. The first is a "horse-collar" design that will integrate a heat exchanger surrounded with MicroPCM™ into a yoke. The second is a modification to the existing firefighter's apparatus with MicroPCM™ wrapped

around the air canister and gas lines. In either option, the connecting gas whip umbilical to the face mask is the standard type with a length of no longer than 24 inches. The cooler, normally in the configuration of an air-to-liquid (or solid) heat exchanger, should be capable of being worn comfortably by the firefighter and have quick connect and disconnect air supply fittings for ease of switch out. The objective of this analysis is to quantify the required heat exchanger surface area to cool breathing gases under the following design parameters:

a) The breathing gas entrance temperature into the heat exchanger will not exceed 200°F.

b) The exit temperature from the heat exchanger should not exceed 120°F during 30 minutes of operation.

c) The exterior surface temperature of the breathing gas apparatus will not exceed 200°F (this may vary depending on the type of insulation used in the backpack redesign.

d) The heat exchanger will see mid-stage pressure of 130 psig.

e) The gas delivery flow rate to the user is 62.5 liters per minute (at 1 Ata and 98.6°F).

f) The MicroPCM™ will be capable of being recharged when submerged in 90°F water for 30 minutes.

WATERS, Jennifer K., Assistant Professor, "Water Quality Modeling of the Chesapeake Bay," US Naval Academy Report EW-26-96, December 1996.

The Chesapeake Bay is the largest, most studied, and historically most productive estuary in the country. Recent water quality degradation in the Bay has gained considerable public attention and prompted much concern. Water quality models of the Bay have been instrumental in the establishment of governmental policies and regulations with respect to any substance or activity impacting the Chesapeake Bay water quality. Often, it is only through such a model that a potential or present environmental threat can be properly assessed, avoided or mitigated. Despite the recognized importance of analytic and numerical modeling in aiding regulatory decisions, the few models in use have significant limitations and need further validation and calibration. It is a time in which significant research efforts are needed to ease and refine water quality analysis.

This report discusses a recent United States Naval Academy (USNA) investigation of Chesapeake Bay water quality models. The primary objective of this research was to establish a foundation for continuing USNA research and experimental studies in water quality modeling of the Chesapeake Bay and other water bodies. To meet this objective, the author sets forth the following three goals:

(1) identify the primary existing water quality mathematical models presently in use for water quality assessment, monitoring and prediction,

(2) adapt one or more of these models to a local portion of the Bay,

(3) establish the capability to perform experimental model-scale and full-scale test programs in order to acquire data for calibrating and/or validating the modified mathematical code(s).

The report discusses the study's finding and some of the details involved in accomplishing these goals.

WHITE, Gregory J., Professor, Ensign Robert H.VROMAN, USN, David D. KIHL, D.Sc., and Sarah E. MOURING, Assistant Professor, "An Experimental Investigation of the Ultimate Strength of Stiffened Panels," US Naval Academy Report EW-022-96, July 1996.

A recent series of tests used the Grillage Test Fixture at the U.S. Naval Academy to test a series of six multi-bay steel grillages to collapse. These tests were part of a student research project investigating reliability-based design methods for stiffened panels. The six nominally identical panels were ordinary steel panels with longitudinal and transverse T-shaped stiffeners, 1/3-scale models of typical warship deck structures. The Grillage Test Fixture applied in-plane loads only to three of the panels, and it applied a combination of in-plane loads and initial lateral pressure to the other three panels. Sixty strain gages and twelve displacement gages provided the test data. This report compares theoretical predictions of failure mode and stress levels with the observed values; it also compares the test results with historical tests conducted at other facilities. The authors also compare results from a Finite Element Method analysis of the one grillage, using ABAQUS, with results from the structural testing of the stiffened panels. The investigators also used the historical and test results to evaluate the accuracy of theoretical predictions over a wide range of test conditions.

KIHL, David, D.Sc., Gregory J. WHITE, Professor, Ensign Robert H. VROMAN, USN, and Sarah E. MOURING, Assistant Professor, "An Analysis into the Uncertainty of Stiffened Panel Ultimate Strength," NSWC Report, 1996.

Tee-stiffened plate panels are the most common structural element in ships. The design of these panels provides for resistance to large compressive and tensile loads along with large bending moments. In the past, designers used simplified design procedures which incorporated factors of safety to account for uncertainties in the loading conditions. However, the newer method of reliability-based design requires a better method which can predict the strength of the plate panels within a given probability of failure.
A recent series of tests used the Grillage Test Fixture at the U.S. Naval Academy to test a series of six tee-stiffened panels to collapse. These tests were part of a student research project investigating reliability-based design methods for stiffened panels. The six nominally identical panels were ordinary steel panels with longitudinal and transverse T-shaped stiffeners. The Grillage Test Fixture applied in-plane loads only to three of the panels, and it applied a combination of in-plane loads and initial lateral pressure to the other three panels. This report compares the test results with results from historical tests conducted at other facilities and with theoretical predictions of failure mode and stress level. Results from a Finite Element Method analysis of the one grillage, using ABAQUS, are compared to results from the structural testing of the stiffened panels. Plans call for using all the information gained to help develop a reliability-based design procedure.

Presentations

BHATTACHARYYA, Rameswar, Professor, "Computer-Aided Ship Design," Carlton University, Perth, Australia, June 1996.

BHATTACHARYYA, Rameswar, Professor, "Design of High-Speed Marine Vehicles," University of New South Wales, Sydney, Australia, June, 1996.

CASSATA, James R., Lieutenant, USNR, "Improved Personnel Dosimetry Using Copper-Doped LiF TLDs and Neural Network Algorithms," Health Physics Society, Seattle, Washington, 21 - 25 July 1996.

COMPTON, Roger H., Professor, "The Safety of High Speed Marine Vehicles," 21st International Towing Tank Conference, Trondheim, Norway, September, 1996.

COMPTON, Roger H., Professor, "USS CONSTITUTION Model Tests at the U.S. Naval Academy Hydromechanics Laboratory," NAVSEA/NAVHIST Briefing at U.S. Naval Academy, January 1997.

ERTEL, Joseph, Midshipman 1/C, and Assistant Professor Sarah E. MOURING, "A Study of Glass Reinforced Plastic Composite Sandwich Panels," U.S. Naval Academy, 5 May 1997.

HARPER, Mark J., Associate Professor, "A Concept Design for the Power Module of a T58 Gas Turbine Thermophotovoltaic Generator," Knolls Atomic Power Laboratory (KAPL), Schenectady, New York, 26 July 1996.

HARPER, Mark J., Associate Professor, and Associate Professor Keith W. LINDLER "Design and Construction of a Thermophotovoltaic Energy Conversion System Using Combustion Gases from a T-58 Gas Turbine," 32nd *Intersociety Energy Conversion Engineering Conference* (IECEC), Honolulu, Hawaii, 27 July-1 August, 1997.

HARPER, Mark J., Associate Professor, "Radiation in Siberian Rivers," Joint Session of the Society of Women Engineers (SWE) and the American Society of Mechanical Engineers (ASME), Newport News, Virginia, 18 November 1996.

HARPER, Mark J., Associate Professor, "Radiological and Chemical Contamination in the Siberian Rivers—Yenisey and Angara," Engineering and Weapons Division Faculty, United States Naval Academy, 19 November 1996.

HARPER, Mark J., Associate Professor, "Radionuclear and Chemical Pollutants in the Angara and Yenisey Rivers of Siberia," *Arctic Nuclear Waste Assessment Program (ANWAP) Conference*, Snowbird, Utah, 6-10 May 1996.

HARPER, Mark J., Associate Professor, and Keith W. LINDLER, Associate Professor, "Material Selection and Design of a High Temperature Thermophotovoltaic Emitter," 32nd *Intersociety Energy Conversion Engineering Conference* (IECEC),

Honolulu, Hawaii, 27 July-1 August, 1997.

HARPER, Mark J., Associate Professor, and Martin E. NELSON, Professor, "Sampling, Characterization, and Proposed Remediation of Mixed Waste Contaminated Sites," Kirtland Air Force Base, Albuquerque, New Mexico, 13 December 1996.

JOHNSON, Bruce, Professor, ENS Edward CHAPMAN, USN, and Mrs. Nancy HARRIS, "Concerning the Electronic Distribution of ITTC Documents," Vol II, Proceedings of the 21st ITTC, Norway, 1997.

JOHNSON, Bruce, Professor, and Robert H. MAYER, Associate Professor, "Integrated Design of an Offshore Structure Enhanced with Windows-based Spreadsheets," ASEE `96 Conference, June, 1996.

KRIEBEL, David L., Associate Professor, "A Shoreline Risk Index for Northeasters," National Conference on Natural Disaster Reduction, Washington, D.C., 6 December 1996.

KRIEBEL, David L., Associate Professor, "Development of Load Factors for Combined Wind and Flood Loads," American Society of Civil Engineers Load Standards Committee, Portland, Oregon, 16 April 1997.

KRIEBEL, David L., Associate Professor, "Extreme Wave Crest Statistics," Joint Industry Workshop on Extreme Ocean Wave Characteristics, Houston, Texas, 7 November 1996.

KRIEBEL, David L., Associate Professor, "Extreme Wave Crest Statistics," Maritime Research Institute of The Netherlands, Wageningen, The Netherlands, 4 March 1997.

KRIEBEL David L., Associate Professor, "Extreme Wave Crest Statistics," Royal Dutch Shell Offshore Research Center, The Hague, The Netherlands, 5 March 1997.

KRIEBEL, David L., Associate Professor, "Wave-Current Loading on a Shallow Water Caisson," Seminar, Department of Civil Engineering, University of Delaware, Newark, Delaware, 19 November 1996.

KRIEBEL, David L., Associate Professor, "Wave Transmission Past Vertical Wave Barriers," 25th International Conference on Coastal Engineering, Orlando, Florida, 2 September 1996.

LINDLER, Keith W., Associate Professor, and Mark J. HARPER, Associate Professor, "A Concept Design for the Power Module of a T-58 Gas Turbine Thermophotovoltaic Generator," Knolls Atomic Power Laboratory (KAPL), Schenectady, New York, 26 July 1996.

MAYER, Robert H., Associate Professor, and Bruce JOHNSON, Professor, "Integrating Spreadsheet & Custom-Program Design Tools into an Underwater Vehicle Design Course," A summary of USNA Technical Report EW-15-96 by LT Alan Czeszynski, USN, ASEE Annual Conference, Washington DC, June 1996.

NELSON, Martin E., Professor, "A Field Measurement Approach to the Quantification of Depleted Uranium in Soil," Health Physics Society, Seattle, Washington, July 21-25, 1996.

NELSON, Martin E., Professor, "Cosmic Ray Soft Error Rates of 16 MB DRAMS at Sea Level and Aircraft Altitudes," HEART Conference, Las Vegas, Nevada, March 11-14, 1997.

NELSON, Martin E., Professor, "Single Event Upsets Induced by Pions in 16 Mb DRAM Chips," IEEE Internal Conference on Nuclear and Space Radiation Effects, Snowmass Village, Colorado, abstract submitted in February, 1997.

NELSON, Martin E., Professor, "Soft Errors Induced in High Density Memory Chips by Energetic Pions," Joint APS/AAPT Annual Meeting, Washington, D.C., April 18-21, 1997.

NUCKOLS, Marshall L., Professor, "Remotely Operated Underwater Vehicles," presentation given to Gifted and Talented Students at Crofton Middle School, 4 November 1996.

NUCKOLS, Marshall L., Professor, "Thermal Analysis for Using Phase Change Materials in Diver Thermal Protection," Naval Special Warfare Technology Program Review, Office of Naval Research, Panama City, Florida, 25 July 1996.

NUCKOLS, Marshall L., Professor, "Thermal Concerns in Life Support Systems Design," Engineering Short Course at the Coastal Systems Station, Panama City, Florida, 7 - 8 August 1996.

NUCKOLS, Marshall L., Professor, "Underwater Vehicles: Tools for Ocean Research," Keynote Speaker for the Maryland Society of Professional Engineers Meeting, Annapolis, Maryland, 16 January 1997.

NUCKOLS, Marshall L., Professor, "Work-of-Breathing and Life Support Systems," Technical workshop at Carderock, Maryland, entitled "Engineering Aspects of Human Powered Submarine Design," sponsored by the Foundation for Underwater Research and Education, 14 December 1996.

DEPARTMENT OF
WEAPONS & SYSTEMS ENGINEERING

Professor Robert DeMoyer
Chair

Research within the Weapons and Systems Engineering Department continues to provide the faculty with an opportunity to grow professionally and to keep abreast of rapidly advancing systems technology. In addition, every graduating Systems Engineering major participates in research, design, and development projects for the purpose of realizing practical applications of some of the theory which they have studied.

Every faculty member, both civilian and military, either participates in research in areas of interest to the U.S. Navy or supports midshipmen research programs in an advisory capacity. Faculty research areas currently include fuzzy modeling, magnetic bearings, metrology, robotics, ship power systems, and system identification.

This year there was a Trident Scholar in the Systems Engineering Department. He engaged in extensive research projects in lieu of several courses. His research topic was the development of a milling machine controller. One midshipman worked with a faculty advisor in an individual research course. He designed a controller for a pistol range targeting system.

Strong emphasis continues on the faculty-midshipman relationship during the individual research oriented capstone design course. Each midshipman is assigned both an administrative and a technical advisor. These advisors not only provide support of a technical nature, but also emphasize planning, scheduling, and effective oral and written presentation. Typical examples of midshipmen research projects include development of autonomous carts and boats, automatic target detection, magnetic levitation, and vibration control.

Funding for research continues to be diverse. This year sponsors included the Naval Academy Research Council, the Office of Naval Research, the Naval Research Lab, the Naval Surface Warfare Center, and the National Institute of Standards and Technology.

Sponsored Research

Characterization of 4-Terminal Pair (4TP) Capacitors

Researcher: Assistant Professor Svetlana Avramov-Zamurovic
Sponsor: National Institute of Standards and Technology

It is possible to describe 4-terminal-pair (4TP) circuits, when referenced as black boxes, using Z-matrix equations. These equations do not allow, however, for practical measurements of the 4TP devices to be made. Equations allowing for the practical measurement of 4TP impedances have been developed by YHP based on previous theory developed by R. D. Cutkosky of NBS (presently NIST). This work provides characterization of a set of 4TP standard capacitors, using the practical equations mentioned above, for use as a 4TP impedance. Characterization of the standard capacitors requires the appropriate driving-point-impedance measurements using calibration system that functions up to 1 mHz. A network analyzer and a 1 kHz capacitance bridge and application of regression algorithms to properly estimate resistance. Demonstration of the calibration procedure is performed. Once component values for the 4TP standard capacitors are known, calibration can be performed comparing the standards with 4TP impedances requiring test.

Software and procedures are developed that characterize the 4TP standard capacitors based on measurement using a network analyzer and a 1 kHz capacitance bridge.

Model and Simulation of the Combat Load

Researcher: Professor E. Eugene Mitchell
Sponsor: Naval Surface Weapons Center, Annapolis Detachment

In the design of the new ship power system, the main common supply is 600 volts d.c. Each compartmentalized section then processes its own power as per requirements.

The combat load is basically a switching power supply, much like is used in PC power supplies. These have unique characteristics, one of the most important being that they function as constant power loads. In particular, if the voltage drops 10%, almost instantaneously, in microseconds, the current increases 10%. This is a very nonlinear effect. Of primary concern was the effect of this negative resistance load on the stability of the entire ship power system.

The combat load was modeled and simulated. It was included in the complete ship board power system model.

Active Noise Control of a Magnetic Bearing Pump

Researcher: Assistant Professor George E. Piper
Sponsor: Naval Surface Weapons Center, Annapolis Detachment

Magnetic bearings offer unique advantages over conventional bearings. Unlike conventional bearings, there is no physical contact between the magnetic bearings and the rotor. With magnetic bearings, the rotor is suspended by forces generated by electromagnets. The rotor's position is regulated by controlling the current through the bearings electromagnets. The absence of physical contact between the bearings and the rotor reduce maintenance associated with mechanical wear and allows for higher rotation speeds. Further, the rotor dynamics can be controlled by altering the bearing current. Thus, in addition to their primary function of supporting the rotor, magnetic bearings can be used as non-intrusive actuators for vibration and noise control.

Recent work in this project demonstrated how magnetic bearings in a centrifugal pump system can function both as the primary bearings and as a fluid-borne noise control actuator. We showed that the pump's impeller could be moved back and forth producing pressure waves in the fluid by varying the bearing current. This is analogous to the armature movement of an audio loud speaker. Secondly, we demonstrated that fluid-borne noise in the pump system can be attenuated at certain frequencies by varying the bearing current in response to measured noise. Our work was performed on a small 4 HP prototype pump that was adapted for the study.

Our current work focuses on the direction in which the impeller is excited for noise control. In a typical pump configuration, the impeller is supported by two radial bearings and one thrust bearing. The use of magnetic bearings can provide multiple degrees of freedom of impeller motion.

Each radial bearing controls the impeller's position in two independent directions transverse to the impeller's spin axis. The thrust bearing controls the axial position of the impeller along the spin axis. This implies that the magnetic bearings can excite the impeller's motion in five directions for noise control. Our previous work discussed above focused only on exciting the axial motion of the impeller to attenuate noise. The current study investigates which degrees of freedom are best suited for noise control and if multiple degrees of freedom can be used.

Application of Set Membership for System Identification and Fault Detection and Isolation

Researcher: Assistant Professor John M. Watkins
Sponsor: Naval Academy Research Council (OMN)

The primary objective of this research is to develop techniques for system identification and fault detection and isolation which are based on set-membership estimation. System identification is the process of

developing mathematical models which describe the dynamic behavior of physical systems, such as a ship, a missle or a robot. Once developed, these models may be used for analysis, prediction or control of the dynamic behavior of the underlying physical system. Fault detection and isolation schemes are used to detect and identify failures that may occur in complex systems such as a submarine or an airplane. Fault detection and isolation schemes are often critical when safety and significant financial investments are at risk.

All real world systems are characterized by some degree of noise or uncertainty. Traditional estimation schemes assume that this noise or uncertainty satisfies certain statistical properties. These assumptions result in a single "best" estimate which may not satisfactorily describe the value which is being estimated. A different philosophy is to assume that this noise or uncertainty is unknown-but-bounded. This technique, which is known as set-membership estimation, seeks to find a set of estimates which is guaranteed to contain the "true" value. In this work, I am applying set-membershp estimation to the problems of system identification and fault detection and isolation.

Characterization of Noise in Pipe Systems

Researcher: Associate Professor Carl E. Wick
Sponsor: Naval Surface Weapons Center, Annapolis Detachment

Ships and submarines are concerned with all noise that is emitted by equipment and piping. This task was in support of an effort to more accurately characterize noise in piping systems, so that measures may be taken to reduce or eliminate radiated noise. Previous efforts have shown that past models do not do a very good job characterizing the standing wave patterns that can be measured in even simple piping systems. A new model was developed that uses reflection coefficient properties to describe standing wave patterns. This new model was programmed as an interactive Windows application and has been used to show that this approach more closely matches observed patterns. This project is continuing with NSWC personnel.

Independent Research

Fuzzy Model Based Control of Complex Plants

Researcher: Assistant Professor Kiriakos Kiriakidis

The well known Takagi Sugeno fuzzy model can be used to accurately approximate the dynamics of complex plants. This project addresses two control design problems associated with state space realizations of such fuzzy models. Firstly, we treat the stability robustness of fuzzy model based controllers against modeling uncertainty. Secondly, we develop observer-based control schemes and further investigate the behavior of estimated-state feedback. In both cases, we provide sufficient conditions that guarantee stability of the closed- loop. The results are demonstrated on the fuzzy model of a simulated gas furnace process.

The theoretical aspects as well as the applications of this project are equally important. Alongside other analytical tools we develop an LMI approach to the solution of associated control design problems. From the applications-oriented point of view, we aim to test the proposed methodology on an actual combustion experiment.

Research Course Projects

Advanced Controller Retrofit with Acoustic Emission Feedback

Researcher: Midshipman 1/C Roland R. Tink, USN
Adviser: Lieutenant Beth L. Pruitt, USN

Current advanced milling uses computer numerical control (CNC) to make complex shapes. These shapes are frequently created by computer aided design (CAD) and translated into a tool path by computer aided machining (CAM). This tool path defines the mill commands used to move the end mill to create the part. Since CNC technology today uses hardwired equipment, the mill command structure cannot be updated or modified without removing the controller. Modern milling techniques such as newer curve fitting algorithms cannot be implemented on older controllers without losing some resolution. A possible solution is the implementation of the personal computer (PC) in the shop floor. A PC can easily handle the computing tasks of mill control, while also having the flexibility of being upgradable in implementingthat control. New control codes or algorithms can be implemented by using new software, without the prohibitive cost of changing out expensive control equipment.

The additional advantage of utilizing the PC in the shop floor is the current research into Adaptive Controls (AC). AC represents an attempt by industrial reserarchers to optimize the milling process dynamically. Currently, mill technicians will optimize milling parameters such as depth of cut, feedrate, and spindle speed before any milling is done. During the milling process these parameters remain unchanged. The disadvantage of this situation is the requirement to set each parameter at its most conservative setting so as to allow the mill to safely remove material under all end mill interactions. The mill operates at worst case conditions during the entire milling process. Adaptive controls enable the mill to receive feedback on the milling process and change appropriate parameters. This dynamic control allows the mill to adapt to the current milling condition and fit milling parameters accordingly. In this project, an acoustic emission (AE) sensor returns strain information to the PC. This strain information is referenced to material removal, and from calculating the material removal rate, the PC will optimize feedrate. By adjusting the feedrate, the PC can speed up or slow down the end mill trajectory. This process will decrease overall milling time by allowing the mill to depart from worst case conditions during the milling process.

Redesigned Control of Pistol Range Targeting System

Researcher: Midshipman 1/C Matthew G. Horr, USN
Adviser: Professor Kenneth A. Knowles

The current turning target controller on the U.S. Naval Academy Pistol Range is antiquated, and its mechanical timers and relay switches are inaccurate and unreliable. The purpose of this effort was to thoroughly investigate the current system, and to design a replacement digital control box. The control box is to utilize solid state relay switches, a keypad, a liquid crystal display capable of printing out data and messages, and a central microcontroller. The current control system was extensively overhauled and placed into satisfactory temporary service. Much of the new controller design was completed and tested, but it remains incomplete.

Design Course Projects

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

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.

The results of academic year 1996-97:

Area Defense System
Midshipmen 1/C Brian S. Albon
and Adam M. Jackson, USN
Adviser: Commander John A. Hancock, USN

The Hustler: Billiards
Midshipmen 1/C Paul M. Allgeier
and Richard S. Ardolino, Matthew O. Scanlon, USN
Adviser: Lieutenant Scott D. Bohman, USN

Laser Light Show
Midshipman 1/C Laura G. Almdale, USN
Adviser: Commander John A. Hancock, USN

Modular Personal Comfort & Security System
Midshipmen 1/C Francisco J. Alsina
and Michael G. Doughty, USN
Adviser: Lieutenant Commander Christopher H., Jensen, USN

Swimming Pool Regulation
Midshipmen 1/C Robert H. Armbrester,
Stephen A. Everage and Jeremy J. Henrich, USN
Adviser: Lieutenant Thomas P. Bogan, USN

Poor Man's Cruise Missile
Midshipmen 1/C Benjamin F. Aton
Jason L. Cashman and Patrick D. Cronyn, USN
Adviser: Commander Peter F. Fyles, USN

Satellite Simulator
Midshipmen 1/C Keith A. Baravik,
David H. Belew and Charles A. McClenithan, USN
Adviser: Lieutenant Gregory C. Archbold, USN

Digital Laser Communications
Midshipmen 1/C Bruce E. Barker, Jr.
and Eric W. Roe, USN
Adviser: Lieutenant Scott D. Bohman, USN

Spacecraft Attitude Simulator
Midshipmen 1/C Bradley M. Barr,
Jaja J. Marshall and Mark A. Venzor, USN
Adviser: Lieutenant Gregory C. Archbold, USN

Rail Gun
Midshipmen 1/C Bartholomew Battista,
Keith P. Douglas and Aaron M. Rose, USN
Adviser: Lieutenant Commander Duncan F. O'Mara, USN

Methane Gas System
Midshipmen 1/C Robert J. Berg, Jr.
and Jason S. Hall, USN
Adviser: Major Gregory A. Morrison, USMC

Variable Transmission
Midshipmen 1/C Robert T. Bibeau
and Scott P. Tompkins, USN
Adviser: LCDR. Christopher H. Jensen, USN

Alarm Clock with Surprise
Midshipmen 1/C Anna A. Blaszczyk
and Arthur A. Hodge, USN
Adviser: Commander John A. Hancock, USN

Railroad Yard
Midshipman 1/C Peter V. Brahan, USN
Adviser: Commander Peter A. Fyles, USN

Football Tracker
Midshipmen 1/C Richard K. Brown, Jr.,
and Kevin S. Galloway, USN
Adviser: Lieutenant Scott D. Bohman, USN

Visual Robotic Putter
Midshipmen 1/C Mark C. Burns
and Hugh B. Edmondson, USN
Adviser: LCDR. Earl F. Goodson, USN

Sumo Wrestler
Midshipmen 1/C Bradley J. Butler
and Brian J. Sandberg, USN
Adviser: Lieutenant Beth L. Pruitt, USN

IEEE Micromouse Competition
Midshipmen 1/C Benjamin Chong,
Elizabeth A. Jenkins and Steven J. Nolen, USN
Adviser: LCDR. Earl F. Goodson, USN

Fingerprint Recognition
Midshipmen 1/C Joshua D. Clayton
and Christopher J. Polk, USN
Adviser: Major Gregory A. Morrison, USMC

Sumo Wrestler
Midshipmen 1/C Alvin C. Concepcion
and Randy C. Cruz, USN
Adviser: Lieutenant Beth L. Pruitt, USN

Dial-A-Control Home

Midshipmen 1/C Paige J. Danluck
and Jara D. Raisbeck, USN
Adviser: Lieutenant James H. Jennings, USN

Sumo Wrestler
Midshipmen 1/C Michael J. Darcy,
Vincent P. Fortunato and Matthew J. Percy, USN
Adviser: Lieutenant Beth L. Pruitt, USN

Systems Ball
Midshipmen 1/C Paul J. Datka
and Michael d. Russ, USN
Adviser: Captain Denise A. Mattes, USMC

Automated Bartender
Midshipmen 1/C Mark E. Dennison
and David E. Howe, USN
Adviser: Lieutenant James H. Jennings, USN

Walking Robot
Midshipmen 1/C Jill M. Dintaman,
Mike N. Ibrahim and Ariel S. Klein, USN
Adviser: Commander Peter A. Fyles, USN

Systems Ball
Midshipmen 1/C Robert S. Durkee
and Christian M. Mahler, USN
Adviser: Lieutenant Scott D. Bohman, USN

Magnetic Bearings
Midshipmen 1/C Stephen M. Fisher,
James R. Hoffman, Matthew G. Horr and
Kevin Luft, USN
Adviser: Commander Peter A. Fyles, USN

Systems Ball
Midshipmen 1/C Andrew P. Gladieux
and Aaron M. Lee, USN
Adviser: Commander John A. Hancock, USN

Autonomous Vacuum Cleaner
Midshipmen 1/C Scott B. Grossman
and Rita A. Pope, USN
Adviser: Lieutenant Gregory C. Archbold, USN

Modified Engineering Arm
Midshipmen 1/C Andrew R. Hunt
and William G. Michau, USN
Adviser: LCDR. Earl F. Goodson, USN

Signal Processing Using Remote Vehicles
Midshipman 1/C Kristian P. Kearton, USN
Adviser: Captain Denise A. Mattes, USN

Pool Shooting Robot
Midshipmen 1/C Andrew T. Kleeman,
Lloyd L. Smith and Mark R. Westmoreland, USN
Adviser: Lieutenant Thomas P. Bogan, USN

Golf Caddy
Midshipmen 1/C Richard J. Linhart, III
and Shawn M. McBride, USN
Adviser: Captain Denise A. Mattes, USMC

Systems Ball
Midshipmen 1/C Mark A. Litkowski
Michah D. Newton and, USN
Adviser: Lieutenant Thomas P. Bogan, USN

Systems Ball
Midshipmen 1/C Justin J. McAnear
and Tasha D. Westinghouse, USN
Adviser: LCDR. Duncan F. O'Mara, USN

Wind Sensor for Sailing
Midshipmen 1/C Charles C. McGill
and Christopher J. Pommerer, USN
Adviser: LCDR. Michael A.Pas, USN

Electronic Muffler
Midshipmen 1/C Sean D. Opitz
and Jon B. Voigtlander, USN
Adviser: LCDR. Duncan F. O'Mara, USN

Windshield Wiper Control
Midshipman 1/C Ian B. Paddock, USN
Adviser: Lieutenant James H. Jennings, USN

3-D Vision System
Midshipman 1/C Nirav V. Patel, USN
Adviser: Lieutenant Thomas P. Bogan, USN

Automated Aquarium
Midshipman 1/C Derek M. Paul, USN
Adviser: Major Gregory A. Morrison, USMC

Driver Safety Device
Midshipmen 1/C Scott T. Richert
and Thomas P. Sicola, Jr., USN
Adviser: LCDR. Michael A. Pas, USN

Automated Dart Launcher
Midshipman 1/C Eric A. Schuchard, USN
Adviser: LCDR. Christopher H. Jensen, USN

Spacecraft Attitude Simulator
Midshipmen 1/C Graham F. Sloan
and Blair A. Stevenson, USN

Adviser: Lieutenant Gregory C. Archbold, USN

Fuel Injection System
Midshipman 1/C Dustin H. Smiley, USN
Adviser: Lieutenant Commander Duncan F. O' Mara, USN

Infrared Gun Turret
Midshipman 1/C Michael E. Turner, USN
Adviser: Lieutenant Commander Michael A. Pas, USN

Publications

AVRAMOV-ZAMUROVIC, Svetlana, Assistant Professor, N. M. Oldham, M. Parker, and B. Waltrip, "Low Frequency Characteristics of Thermal Voltage Converters," *IEEE Transactions on Instrumentation and Measurement*, Ottawa, Canada (May 1997).

Low frequency errors of multi-junction thermal voltage converters are estimated using a simple model based on easily measured parameters. The model predictions are verified by measuring the converter's frequency characteristics using digitally synthesized source.

DWAN, Terrence E., Professor and Jerry W. WATTS, Professor, "Modular Simulation of a Steam Injected Gas Turbine Engine," *Proceedings of the 1996 Summer Computer Simulation Conference*, (July 1996) 275-280.

A preliminary dynamic model has been developed for a steam injected gas turbine engine. Available for the dynamic model development was a static equilibrium model of the same engine developed by Urbach, et al. The steam injected feature of this engine has three major benefits that make it very attractive. It has improved efficiency, high power density, and lower NO_x emissions. The higher power density leads to power burst capabilities of up to three times the power present for non-steam-injected operation. The pure water requirement prevents continued operation in the high power mode, but power bursts have great appeal for the pulse weaponry of the future. The lower NO_x emissions is very important in naval ship applications for improving air quality throughout the world.

KIRIAKIDIS, Kiriakos, Assistant Professor and Anthony Tzes, Associate Professor, "Robustness of Linear Systems Against Nonlinear Time-Varying Perturbations," *Preprints of the Thirteenth World Congress of IFAC*, San Francisco, CA, (June 1996), vol H, pp. 263-268.

Sufficient conditions for the robust stability of Hurwitz matrices under time-invariant uncertainties are extended to the nonlinear time-varying case. The obtained criterion, formulated as a convexz program, provides for the quadratic stability of a polytopic linear differential inclusion. The stability of the convex hull of time-varying vertex matrices is also treated. In two example cases, from the areas of fuzzy and intelligent control, the stability analysis of the control system, is performed using tools derived for the robustness of a corresponding nominal system.

KIRIAKIDIS, Kiriakos, Assistant Professor, Apostolos Grivas, Graduate Student and Anthony Tzes, Associate Professor, "Stability Analysis of the Takagi-Sugeno Fuzzy Model," *Proceedings of the Fourth European Congress on Intelligent Techniques and Soft Computing*, Aachen, Germany, (August 1996).

Parametric robust control techniques suggest synthesis tools for stabilization of the Takagi-Sugeno fuzzy system. The proposed method uses an eigenvalue--based robustness measure for stability results with reduced conservatism. Application examples on fuzzy models of nonlinear plants demonstrate the efficiency of the method.

KIRIAKIDIS, Kiriakos, Assistant Professor, Apostolos Grivas, Graduate Student and Anthony Tzes, Associate Professor, "A Sufficient Criterion for Stability of the Takagi-Sugeno Fuzzy Model," *Proceedings of the IEEE International Conference on Fuzzy Systems*, New Orleans, LA(September 1996), vol 1, pp. 277-282.

The nonlinear Takagi--Sugeno fuzzy model with offset terms is analyzed as a perturbed linear system. A sufficient criterion for robust stability of the linear system against nonlinear perturbations guarantees quadratic stability of the fuzzy model. The criterion accepts a convex program formulation of reduced computational cost compared to the common Lyapunov matrix approach. Parametric robust control techniques

suggest synthesis tools for stabilization of the fuzzy system. Application examples on fuzzy models of nonlinear plants demonstrate the efficiency of the method.

KIRIAKIDIS, Kiriakos, Assistant Professor, Anthony Tzes, Associate Professor and George Vradis, Associate Professor, "Active Control of Gaseous Systems: A Fuzzy Logic Approach," *Proceedings of the ASME Fluids Engineering Division (IMECE*), Atlanta, GA, (November 1996), FED-vol 242, pp. 61-67.

The active control problem of gaseous systems such as primary air atmospheric-suction, forced-draft supply of air for fuel combustion and other industrial gas handling units is addressed in this article. The objective is to regulate gas velocity, at particular locations within the system, so that appropriate mass flow rate is achieved. Using modal expansion and treating the high-order modes as unmodeled dynamics, the basic mass and momentum conservation laws reduce to a finite set of ordinary differential equations. To overcome the problem of estimating the model parameters or the extent of the parametric uncertainty, a variable structure controller is proposed. This controller utilizes a fuzzy logic rule base for on-line adjustment of the switching gain. The fuzzy rules create an adaptive law and tune this gain to the smallest value that verifies the sliding condition. Experimental results demonstrate the performance of the suggested mass flow rate control scheme, tested on a prototype air handling unit.

KIRIAKIDIS, Kiriakos, Assistant Professor and Anthony Tzes, Associate Professor, "Adaptive Robust Control by Set Membership Estimation and Switching: Stability and Performance Analysis," *Proceeding of the IEEE Conference on Decision and Control*, Kobe, Japan (December 1996) pp. 3743-3748.

Adaptive control of time-invariant plants, in the presence of unmodeled dynamics and bounded disturbances, via set membership identification is proposed. The set estimator maps the uniformly bounded normalized equation error on parametric error characterizing the modeled part of the plant.
Based on the set estimator and implemented by fuzzy logic, a switching control policy improves the system performance. At the same time, through stabilization against the parameter uncertainty, the policy renders the closed-loop modeled dynamics robust with respect to the equation error mechanisms.

KIRIAKIDIS, Kiriakos, Assistant Professor, "Stabilization of Nonlinear Plants Using Fuzzy Modeling," *Proceedings of the IASTED International Conference on Modeling and Simulation*, Pittsburgh, PA (May 1997), pp. 110-113.

A long standing problem in fuzzy model-based control is addressed. We seek conditions that guarantee stabilization of a nonlinear plant by a controller which renders its fuzzy model stable.

KNOWLES, Kenneth A., "Gravity Compensation Algorithm for Force-Reflecting Telemanipulators and Master Control Units," *Proceedings of IASTED/ISMM International Conference on Modelling and Simulation*, 107-109 (15-17 May 1997).

This paper describes a computationally efficient algorithm using Denavit-Hartenberg (D-H) coordinate transformations to compute the additional joint torques required to offset the gravity-induced torques caused by the weights of the individual outboard links of a rigid link manipulator supported by these joints.

OLDHAM, N., Svetlana AVRAMOV-ZAMUROVIC, Assistant Professor, M. Parker, and B. Waltrip, "Low Voltage Standards in the 10 Hz to 1 MHz Range," *IEEE Transactions on Instrumentation and Measurement,* 46, 2 (April 1997).

A step down procedure is described for establishing voltage standards in the 1 mV to 100 mV range at frequencies between 10 Hz and 1 MHz. The step down employs low-voltage thermal voltage converters and micropotentiometers. Techniques are given for measuring input impedance and calculating loading errors.

OLDHAM, N., Svetlana AVRAMOV-ZAMUROVIC, Assistant Professor, M. Parker, and B. Bell, "Exploring the Low-Frequency Performance of Thermal Converters Using Circuit Models and a Digitally Synthesized Source," *IEEE Transactions on Instrumentation and Measurement,* 46, 2 (April 1997).

Low-frequency errors of thermal voltage converters are described and estimated using a circuit model that includes easily measured parameters. A digitally synthesized source is used to confirm the estimated ac-dc differences in the 0.001 Hz to 40 Hz range.

PIPER, George E., Assistant Professor, "Active Feedback Noise Control of a Magnetic Bearing Pump," Noise Control Engineering Journal, (March/April 1997),
Vol 45, pp. 78-84.

This paper describes how active feedback control techniques were applied to attenuate fluidborne noise on an existing magnetic bearing pump. The principle, analysis, and experimental results of active feedback noise control are presented for single input - single output cases. Good correlation was shown between analysis, and test results. Two different controller designs are presented. The first design used plant inversion with loop shaping. The second design used a feedback loop within the controller itself. Time delays resulting from acoustic propagation decreased stability thus restricting the noise attenuation bandwidth. The first controller design demonstrated good noise attenuation over a narrow bandwidth. However, noise attenuation degraded for wider bandwidths. The second controller design demonstrated poor attenuation over a limited bandwidth.

PIPER, George E., Assistant Professor, Kevin J. WEDEWARD, Assistant Professor, "Direct Adaptive Control of Spin Stabilized Spacecraft During Thrust Maneuvers," *Proceedings of the IASTED/ISMM International Conference on Modelling and Simulation*, 1997, pp. 95-97.

This paper investigates the use of quaternion feedback, spin stabilization, and direct adaptive control for maintaining precise pointing of a spacecraft's thrust vector. During thrust maneuvers to change a spacecraft's velocity, it is crucial to keep the spacecraft's axis of thrust in its proper orientation. Misalignments between the thrust vector and the spacecraft's center of mass create torques that disturb the thrust vector's orientation. One of the simplest and most widely used methods of maintaining the thrust vector's orientation is to spin the spacecraft about its thrust axis. This technique is called sping stabilization. The spinning spacecraft provides gyroscopic stiffness keeping the thrust axis in a relatively fixed inertial orientation. Spin stabilization is generally accompanied by parasitic motions which need to be regulated in order to achieve precise pointing of the spin axis. Typically, nutation dampers are used to regulate body rates transverse to the spacecraft's spin axis while spin axis precession is adjusted open-loop in between thrust maneuvers.

With the development of efficient strapdown inertial reference systems, knowledge of the spacecraft's inertial orientation is available at all times. This facilitates the use of quaternions and body rates for feedback control of the spin axis orientation.

For effective control during thrust maneuvers, the controller must be robust to changes in the spacecraft's configuration and mass properties, both of which change drastically during thrust maneuvers. Direct adaptive controllers offer a promising solution to the robust control problem since they require no knowledge of the spacedraft's dynamics, are stable in the presence of disturbances, and are computationally simple. The adaptive laws directly adjust the controller gains based only on system performance providing global stability of the system. The paper presents the problem formulation, controller design, and computer simulation results of the investigation. Results demonstrate that robust control can be achieved with direct adaptive control laws.

PIPER, George E., Assistant Professor, Terrence E. DWAN, Professor, "System Identification of a Magnetic Bearing Pump for Fluidborned Noise Control - Part I," *Proceedings of the IASTED/ISMM International Conference on Modelling and Simulation*, 1997, pp. 98-100.

To facilitate noise control of a magnetic bearing pump, system identification of the plant is a crucial first step. In this paper we investigate the modeling of magnetic bearings for noise control. Presented in this paper are the problem statement, the experimental setup, and the preliminary results of the study. The data used in this study was taken from an operating magnetic bearing pump system. A time domain deconvolution technique was used to obtain a working model.

PIPER, George E., Assistant Professor, Kidambi V. Raman, Engineer, "Variable Structure Control of Spacecraft Nutation Dynamics," *Proceedings of the 1996 Summer Computer Simulation Conference, pp. 448-453*, 1996.

This paper investigates the use of variable structure control on spin stabilized spacecraft for nutation control. Nutation control involves the regulation of transverse body rates of a spinning spacecraft. Current nutation controllers lack robustness to changes in the spacecraft's configuration and mass properties, both of which change significantly during the ascent phase of the spacecraft mission. Variable structure controllers offer a promising solution to the robust nutation control problem since they are insensitive to changes in the spacecraft's parameters, are stable in the presence of disturbances, and are computationally simple. Variable structure controllers are based on the concept that motion is constrained to lie on a surface in the phase-space by using a switching control laws. Motion on this surface is invariant to plant parameters and is asymptotically stable. The paper presents the problem

formulation, controller design, and computer simulation results of the investigation. Results demonstrate that robust nutation control can be achieved with variable structure control laws.

PIPER, George E., Assistant Professor, "Visualizing Spacecraft Attitude Motion," *Proceedings of the Frontiers in Education Twenty-Sixth Annual Conference*, (1996). CAEME Center for Multimedia Educational and Technology, Univ of Utah.

This paper describes the Animated Space Motion Simulator (ASMOS) and how it can be used to enhance ones understanding of spacecraft attitude motion. ASMOS is a window-based program that has been developed for the MacIntosh personal computer. The program simulates general rigid body motion and uses animated 3-D graphics to provide insight into spacecraft attitude motion. ASMOS is simple and easy to use and is ideal for education use.

WATKINS, John M., Assistant Professor and Stephen Yurkovich, Professor, "Parameter Set Estimation Algorithms for Time-Varying Systems," *International Journal of Control*, 66, 5, pp. 711-731 (1997).

Parameter set estimation (PSE), a class of system identification schemes which aim at characterizing the uncertainty in the identification experiment, is philosophically different from traditional parameter estimation schemes which seek to identify a single point (model) in the parameter space. The literature has seen a good deal of attention paid to PSE techniques in recent years, primarily because it is projected that they will play a vital role in robust identification for control. An important step in current research along these lines is development of PSE algorithms for systems which are time-varying in nature; this is particularly true if the identified model set is to be used in an adaptive setting, such as for gain scheduling or auto-tuning. In this paper, we extend an ellipsoid algorithm for parameter set estimation of time-invariant systems to time-varying systems. We show how knowledge of dependencies in the parameter variations can be exploited to reduce the number of computations in the resulting algorithm. Finally, scalar bound inflation, a second strategy for PSE of time-varying systems, is optimized for volume, and a comparison of the two algorithms is made.

WATKINS, John M., Assistant Professor, and Stephen Yurkovich, Professor, "Set-Membership Strategies for Fault Detection and Isolation," *Proceedings of the CESA'96 IMACS Multiconference*, Symposium on Modeling Analysis and Simulation, Lille, France, (July 1996), vol 2, pp. 824-830.

By there very nature, set-membership identification algorithms have an inherent strategy for detecting faults in dynamical systems. However, for similar reasons, these algorithms have difficulty tracking (recovering) the parameters after a faults has been detected. In this paper, we will present two novel approaches for ``recovering'' the parameters after a fault has been detected by the Optimal Volume Ellipsoid algorithm for Time-Varying systems (OVETV). The first strategy, ellipsoid resetting, resets an ellipsoidal parameter set to a large ellipsoid which is guaranteed to contain the true parameter set.

The second strategy, ellipsoid projection, offers better parameter set volume properties, but is not guaranteed to recapture the true parameters. Examples will be given illustrating both approaches.

WATKINS, John M., Assistant Professor, and Stephen Yurkovich, Professor, "Fault Detection Using Set-Membership Identification," *Proceedings of the Thirteenth World Congress of IFAC*, San Francisco, CA (July 1996), vol I, pp. 61-66.

In this paper, two novel approaches for detection of faults in dynamical systems are presented. Both approaches are based on set-membership identification, a system identification strategy which seeks to identify a set of parameters rather than a single point estimate. The optimal volume ellipsoid algorithm (OVE) and the OVE algorithm for time-varying systems (OVETV) will be utilized for set-membership identification. The first detection strategy uses a consistency check which is integral to the OVE and OVETV algorithms. The second approach combines an ellipsoid intersection test with the OVETV algorithm.

WATKINS, John M., Assistant Professor, "Feedback Linearization of a Magnetic Levitation System," *Proceedings of the IASTED International Conference on Modeling and Simulation*, Pittsburgh, PA (May 1997), pp. 114-116.

Magnetic levitation systems are highly nonlinear and open loop unstable. Applications of magnetic levitation systems include levitation of high speed trains and frictionless bearings. Consequently, magnetic levitation systems provide a challenging test bed of practical importance. In this paper, feedback linearization and state feedback controllers are developed for a magnetic ball suspension system. Designs are developed to track

step changes in the desired ball position. Simulations results are presented, and a comparison of the nonlinear and conventional approaches is given.

WATTS, Jerry W., Professor, Terrence E. DWAN, Professor, "An Error Weighting Algorithm Minimizing the Effect of Outliers," *Proceedings of the IASTED/ISMM Internation Conference on Modeling and Simulation*, (May 1997) pp. 101-104.

A classical least square approach to the data filtering problem generally leads to a great deal of weight placed upon the outliers. For small sample sizes this outlier weighting leads to data rejection. A solution to the problem would be to select an error weighting which puts less weight on the outliers. A new error weighting scheme along with several appropriate examples is demonstrated in the paper.

WICK, Carl E., Associate Professor, George E. PIPER, Assistant Professor, Jerry W. WATTS, Professor and Svetlana AVRAMOV-ZAMUROVIC, Assistant Professor, " Sensors for a Weather Balloon: A Classroom Design Experience," *Proceedings of 1996 American Society for Engineering Education*, (23-26 June 1996). Proceedings published electronically on CD-ROM.

Undergraduate engineering students need meaningful design experiences in their course work. These experiences are necessary to allow them to see the practical implications of their courses, to consider the interplay between system components, and to also view external forces, economics, safety, environmental impact, and cost in a way that is not outside their own background. Accreditation organizations, ABET in particular, now require a "design continuum" in engineering programs. The continuum will take students through simple design exercises in lower-level courses and bring them through successively more challenging experiences to a "capstone" design shortly before graduation. We believe that this is a very good and necessary path that all engineering students should take to reach competence in their trade.

We have also found that it is very difficult to find realistic, simple, unconstrained design exercises for lower level engineering courses. In this paper we outline a project that was used in a junior-level sensors course for system s engineering majors. The project required each student to design a portion of the systems needed to successfully complete a balloon-borne environment sensing mission. In this mission a weather balloon is to carry a student designed instrument package to its maximum altitude, where the balloon will burst and the package will return to earth safely. Data gathered during the mission may be recorded in the instrumentation package for later playback or it may be telemetered back to earth receiving stations. W have found this type of exercise to be an excellent vehicle for discussing project management and the tradeoffs that are often necessary between cost, weight and complexity. In execution the students find that a relatively simple concept can be very complex, and enjoy the freedom to express themselves through original, and in some cases novel designs. The paper design may lead to actual construction of the vehicle and launch in later course work, or a student or student team will adopt the project for their own capstone design experience.

The course that this design exercise was used in is a course in the Systems Engineering Department of the United States Naval Academy that provides students with theoretical and practical aspects of closed-loop control. Fundamentals of statistical measurements, sensors, motors, motor drivers, closed-loop control are all subjects that are introduced in the classroom and reinforced in the laboratory through several practical experiments. Thus, the subject matter of the course provides a near perfect environment for an applied design project.

WICK, Carl E., Associate Professor, Murray H. Loew and Joseph Kurantsin-Mills, "Modeling and Simulation of the Illumination Effects for the Evaluation of Microvessels of the Conjunctiva," *American Journal of Physiology: Heart and Circulation Physiology*, 40, pp H1229-H1239 (1996).

This article presents the development of a comprehensive model of the illumination and reflection characteristics of conjunctival blood vessels in the human eye. The model was produced to help develop computerized systems to locate and track these blood vessels for early diagnosis of various cardio-vascular conditions.

WICK, Carl E., Associate Professor, "A Windows Based Simulator for Teaching Embedded Computer Operation," *Proceedings of the Twenty-sixth Annual Frontiers in Education Conference*, Salt Lake City, UT, (6-9 November 1996). Proceedings published electronically on CD-ROM.

This article presents a simulation of a family of RISC processors, which has been used in the department for teaching embedded computer concepts. The simulation

is discussed in detail as well as our experiences using the simulation in classroom and laboratory activities over a period of two semesters.

WICK, Carl E., Associate Professor, "An Interactive Simulation of Acoustic Wave Behavior in Pipes," to be published in the *Proceedings of the International Association of Science and Technology for Development*, Pittsburgh, PA (14-17 May 1997), pp. 104-106.

This article presents a Windows based simulation of the behavior of acoustic standing waves in pipes. The simulation allows the operator to adjust pipe termination reflectances and see the resulting standing wave patterns in frequency and in distance formats. The simulation was constructed as an alternative to lumped impedance models that have historically not performed well in modeling standing wave patterns in liquid filled pipes.

Technical Reports

MITCHELL, E. Eugene, Professor, "Model and Simulation of the Combat Load," USNA Report EW-21-96.

In the design of the new ship power system, the main common supply is 600 volts d.c. Each compartmentalized section them processes its own power as per requirements.

The combat load is basically a switching power supply, much like what is used in PC power supplies. These have unique characteristics, one of the most important being that they function as constant power loads. In particular, if the voltage drops 10%, almost instantaneously, in microseconds, the current increases 10%., This is a very nonlinear effect. Of primary concern was the effect of this negative-like resistance load on the stability of the entire ship power system.

The combat load was modeled and simulated. It was included in the complete ship board power system model.

Presentations

AVRAMOV-ZAMUROVIC, Svetlana, Assistant Professor, N. M. Oldham, M. Parker, and B. Waltrip, "Low Frequency Characteristics of Thermal Voltage Converters," IEEE Transactions on Instrumentation and Measurement, Ottawa, Canada , 19-21 May 1997.

DWAN, Terrence E., Professor and Jerry W. WATTS, Professor, "Modular Simulation of a Steam Injected Gas Turbine Engine," 1996 Summer Computer Simulation Conference, Portland, Oregon, 22 July 1996.

DWAN, Terrence E., Professor, An Error Weighting Algorithm Minimizing the Effect of Outliers," IASTED Modeling and Simulation Conference, Pittsburgh, Pennsylvania, 15 May 1997.

KIRIAKIDIS, Kiriakos, Assistant Professor and Anthony Tzes, Associate Professor, "Robustness of Linear Systems Against Nonlinear Time-Varying Perturbations," Preprints of the Thirteenth World Congress of IFAC, San Francisco, California, June 1996.

KIRIAKIDIS, Kiriakos, Assistant Professor, Anthony Tzes, Associate Professor and George Vradis, Associate Professor, "Active Control of Gaseous Systems: A Fuzzy Logic Approach," Proceedings of the ASME Fluids Engineering Division (IMECE), Atlanta, Georgia, November 1996.

KIRIAKIDIS, Kiriakos, Assistant Professor and Anthony Tzes, Associate Professor, "Adaptive Robust Control by Set Membership Estimation and Switching: Stability and Performance Analysis," Proceeding of the IEEE Conference on Decision and Control, Kobe, Japan, December 1996.

KIRIAKIDIS, Kiriakos, Assistant Professor, "Stabilization of Nonlinear Plants Using Fuzzy Modeling," Proceedings of the IASTED International Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, May 1997.

KNOWLES, Kenneth A., Professor, "Gravity Compensation Algorithm for Force-Reflecting

Telemanipulators and Master Control Units," IASTED/ISMM International Conference on Modeling and simulation, Pittsburgh, Pennsylvania, 15 May 1997.

PIPER, George E., Assistant Professor, Kevin J. WEDEWARD, Assistant Professor, "Direct Adaptive Control of Spin Stabilized Spacecraft During Thrust Maneuvers," Proceedings of the IASTED/ISMM International Conference on Modelling and Simulation, Pittsburgh, Pennsylvania, 15 May 1997.

PIPER, George E., Assistant Professor, Terrence E. DWAN, Professor, "System Identification of a Magnetic Bearing Pump for Fluidborned Noise Control - Part I," Proceedings of the IASTED/ISMM International Conference on Modelling and Simulation, 15 May 1997.

PIPER, George E., Assistant Professor, "Visualizing Spacecraft Attitude Motion," Proceedings of the Frontiers in Education Twenty-Sixth Annual Conference, 8 November 1996.

PIPER, George E., Assistant Professor, Kidambi V. Raman, Engineer, "Variable Structure Control of Spacecraft Nutation Dynamics," Proceedings of the 1996 Summer Computer Simulation Conference, 23 July 1996.

PIPER, George E., Assistant Professor, " Sensors for a Weather Balloon: A Classroom Design Experience," Proceedings of 1996 American Society for Engineering Education, 25 June 1996.

WATKINS, John M., Assistant Professor, and Stephen Yurkovich, Professor, "Set-Membership Strategies for Fault Detection and Isolation," Proceedings of the CESA'96 IMACS Multiconference, Lille, France, July 1996.

WATKINS, John M., Assistant Professor, and Stephen Yurkovich, Professor, "Fault Detection Using Set-Membership Identification," Proceedings of the Thirteenth World Congress of IFAC, San Francisco, California, July 1996.

WATKINS, John M., Assistant Professor, "Feedback Linearization of a Magnetic Levitation System," Proceedings of the IASTED International Conference on Modeling and Simulation, Pittsburgh, PA , May 1997.

WICK, Carl E., Associate Professor, "A Windows Based Simulator for Teaching Embedded Computer Operation," *Proceedings of the Twenty-sixth Annual Frontiers in Education Conference*, Salt Lake City, Utah, 6 November 1996.

WICK, Carl E., Associate Professor, "An Interactive Simulation of Acoustic Wave Behavior in Pipes," to be published in the Proceedings of the International Association of Science and Technology for Development, Pittsburgh, Pennsylvania, 16 May 1997.

DIVISION OF HUMANITIES AND SOCIAL SCIENCES

COL Patrick K. Halton, USMC
Director

DEPARTMENT OF ECONOMICS

J. Eric Fredland
Chair

Most faculty members in the Economics Department were actively engaged in research in 1996-97. Eight different faculty members made some 23 presentations at professional conferences, seminars, and other venues. There were six publications.

Karen Thierfelder, who was promoted to Associate Professor effective in August 1997, had another productive year. The Department nominee for the USNA Research Excellence Award, Dr. Thierfelder and her associates at the World Bank, the U.S. Department of Agriculture, and the Food Policy Research Institute worked actively on eight different projects relating to the application of computable general equilibrium models to international trade issues. Professors Little and Goodman teamed to do policy oriented research on military service members with working spouses, which resulted in several presented papers. Professor Bowman continued to pursue his work on the impact of education on the career success of military officers. Visiting Professor Adrian P. Kendry, on leave from the University of the West of England, was the third holder of the William J. Crowe Chair of the Economics of the Defense Industrial Base. An expert on the economics of the aerospace industry, Professor Kendry made a number of research presentations, and brought distinguished speakers to the Academy, in addition to teaching and assisting faculty and midshipman research. He returns for a second year in the position in 1997-98.

Six midshipmen who graduated with honors completed year-long research projects which are described below. In addition, each of the other 76 1/C majors in Economics completed an empirical research project in the required research seminar course in their final semester. The best of these papers is awarded the Frederick L. Sawyer Prize. This year's prize was won by Midshipman 1/C Shannon H. Durrett for his study entitled, "Evidence of Herding Behavior in the Mutual Fund Market."

Sponsored Research

Graduate Education and Impacts on Career Progression in URL Communities

Researcher: Professor William R. Bowman
Sponsor: Naval Postgraduate School

This study estimates the impact of graduate education on the likelihood to promote to Commander and Captain in major Unrestricted Line (URL) communities. The study focuses upon impacts of graduate education according to: (1) technical vs. non-technical graduate education; (2) acquiring graduate education before, or after, the O-4 promotion board; and (3) utilizing or not utilizing graduate education in later pay-back tours. Results of the study found that the majority of graduate education recipients in the surface community experienced equal or greater career progression than those not getting fully funded graduate education. Unfortunately, officers getting technical graduate education P-codes and later utilizing the acquired skills in pay-back tours experienced— on average— slower career progression than those without a graduate education degree. Mixed results were found in the aviation communities, where a greater percentage of P-coded officers were required to serve pay-back tours. The conclusion of the study suggests that URL community managers may not be structuring billet assignments in ways to

encourage line officers to leave the community to acquire P-code education and then to leave the community again to serve a pay-back tour in a P-code billet. The positive rewards, in terms of career progression, must be structured into URL career progressions to encourage better qualified line officers to attend the Naval Postgraduate School — especially in technical programs. The final report has been completed and submitted.

Do Lenders Evaluate Applicants Differently?

Researcher: Assistant Professor Darryl E. Getter
Sponsor: Naval Academy Research Council (OMN)

In order to identify as many credit-worthy borrowers as possible, it may be necessary for lenders to evaluate credit applicants differently. Even though lenders ask applicants for the same economic and personal information, lenders may weigh the information differently depending on the borrower. Because financial assets, job stability, and credit history vary among applicants, lenders may not be able to obtain a true evaluation of risk by applying the same universal criteria to everyone. But if lenders modify the criteria in order to get a better assessment of risk for a particular type of applicant, this may reduce the amount of credit-rationing in the consumer credit market. Although profit maximizing lenders still make efficient use of all information available to them, they may need to establish different lending standards so that credit-worthy borrowers with different economic characteristics are able to qualify for credit. This study uses information on credit rejection from the 1992 Surveys of Consumer Finances compiled by the Federal Reserve Board. Credit rejection models for households with different demographic characteristics are constructed. Three major findings result. First, lenders do not use the same criteria when they evaluate credit risk for households with different demographic characteristics. While credit history is always significant in the decision to grant credit, lenders look at cash flow and job stability for younger applicants as opposed to level of income and wealth for older applicants. Credit history is the most important determinant for credit rejection for non-white applicants. Second, relatively low wealth, high risk applicants from non-white and/or young households face a significantly higher probability of rejection than higher wealth, lower risk applicants from white and/or older households. Finally, empirical evidence suggests that the use of different lending criteria does not lead to a reduction of credit rationing in consumer credit markets. When the white and over forty households are fitted to the lending criteria estimated for the minority and under forty households, the wealthier households still face higher probabilities of credit rejection. Likewise, minority and under forty households faced lower probabilities of rejection when fitted to the criteria for white and over forty households. Hence, if the different lending standards are unable to distinguish between high and low risk borrowers, then taking race and age into account when evaluating credit requests actually contributes to credit rationing. Work from this project has been presented at two national meetings.

Analysis of the Whole Person Officer Selection System Experiment

Researcher: Professor Roger D. Little
Sponsor: Headquarters, U.S. Marine Corps
(Manpower Analysis, Evaluation and Coordination Branch)

Data on background, physical characteristics, demographics and performance of officer candidates at Quantico during the summer of 1996 were cleaned, compiled, and written into a data base which contains about 1700 observations on 40 characteristics. The data were used by seven midshipmen as part of their 1/C research seminar in Economics. Development of the data set, along with the student analyses constitute completion of the project.

Agriculture, Trade, and Exchange Rates in MERCOSUR

Researchers: Assistant Professor Karen E. Thierfelder
(with Mary Burfisher, U.S. Department of Agriculture
and Sherman Robinson, International Food Policy Research Institute)
Sponsor: Naval Academy Research Council (O&M)

In this paper, the authors analyze policy interactions in MERCOSUR, focusing on agriculture, a sector with high trade shares in all the member countries (Argentina, Brazil, Paraguay, and Uruguay). We analyze the effects of implementing MERCOSUR and identify the potential resulting changes in production and trade within the region. In this analysis, we consider the impact of full implementation of the agreement, without considering the phase-in process. Then, we examine the effects of macroeconomic linkages in this freer trade environment. Assuming that MERCOSUR is in place, we consider the effects of a devaluation by the U.S. We compare the effects of two alternative macroeconomic adjustment responses by Argentina-- adjusting domestic price or foreign capital flows. We describe structural changes in Argentina and the linkages through trade to Brazil. Finally, we consider the effects of a devaluation by Brazil, again with alternate macroeconomic adjustment policies in Argentina. Results of this work were presented at the seminar, "La agricultura, la alimentacion y los recursos naturales en el MERCOSUR hacia el ano 2020," Buenos Aires, Agrentina, September 12-13, 1996.

Independent Research

Graduate Education and Human Capital Development in a Hierarchical Organization

Researcher: Professor William R. Bowman (with S. L. Mehay, Naval Postgraduate School)

The objective of this study is to test the human capital theory that education increases productivity of the workforce. The majority of economic research has, to date, only studied the relationship of education and earnings — assuming higher earnings are due to greater productivity. Recent work involving training and productivity has cast doubt on human capital theory. Our data base of military officers allows us to test directly the relationship between education and worker productivity and finds immediate positive impacts — but these impacts become insignificant at higher ranks over longer periods following receipt of education. The study has been submitted for journal review.

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 examination. The data used for the analysis are the performances of 1/C 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 informing them that there were monetary prizes for the top three performers by four QPR groupings, the student in the other room received the same memorandum as they exited from the exam room. The empirical analysis tests the hypothesis holding ability measures constant. The ability measures include QPR in economics, overall QPR,

SAT score, performance in intermediate microeconomic and macroeconomics courses, numbers of economics courses completed, and others. The analysis is on-going.

Gender Differences in the Second Paycheck: An Exploration into the Labor Force Status and the Earnings of the Husbands and Wives of Service Members

Researchers: Professor Roger D. Little and Professor Rae Jean B. Goodman

Studies of family earnings traditionally have viewed the contributions of the working wife as constituting the "second paycheck." Historically, male earnings have been higher and husbands, as a result, have been considered "primary breadwinners." Analysis of secondary spousal earnings by gender has been virtually impossible because such a categorization would presume knowledge of internal family arrangements unavailable in survey data. Moreover, such arrangements may be transitory, due to temporary work, unemployment or health problems. Further, even if the primary earner were known to be male, for example, the diversity of jobs and compensations schemes offered by employers would pose constraints on empirical modeling which might bias results. Some of the above complications can be minimized by studying the spouses of active duty service members. By classifying the service member as the primary earner and the spouse as the secondary earner, the substitutability and/or complementarity of employment arrangements within the family can be consistently handled. The empirical analysis compares earnings and labor force participation (LFP) of a sample of civilian wives of military personnel with that of a sample of civilian husbands of military personnel. Results from the LFP equation include: (1) education level of female spouses is a significant factor in determining LFP, but this is not true for male spouses; (2) young children reduce LFP for both men and women; (3) race is a significant factor for female enlisted personnel. Results from the earning function include: (1) education is more important for female than for male spouses; (2) the payoff to education is greater for female spouses of officers than for female spouses of enlisted personnel; (3) age, as a proxy for labor force experience, is a significant factor for all categories. The research is on-going.

Agricultural Policies in the Western Hemisphere

Researcher: Assistant Professor Karen E. Thierfelder (with Mary Burfisher, USDA, and Sherman Robinson, International Food Policy Research Institute)

The goal of this research is to identify U.S. policies on agriculture in a Western Hemisphere Free Trade Area (WHFTA) that will be most effective in expanding U.S. agricultural export opportunities. The negotiation of free trade will take place in the context of ongoing, and profound changes in the domestic farm programs and agricultural trade policies of most countries in the region. Continued government intervention signals that, as in GATT and NAFTA, agriculture is likely to be a sensitive sector in the WHFTA negotiations. Furthermore, in this policy context, free trade will not necessarily generate the greatest benefits for U.S. farmers, in terms of export growth and higher rural wages. Our research objective in this project is to provide a systematic and comprehensive description and analysis of agricultural programs and trade policies in major Western Hemisphere countries. We will expand our computable general equilibrium (CGE) model of the U.S. and Mexico to include Canada. We will also incorporate Canadian agricultural policies. This research is in the preliminary stages; we are compiling the data base for Canada.

Labor Market Regulations, Trade Liberalization and the Distribution of Income in Bangladesh

Researcher: Assistant Professor Karen E. Thierfelder
(with Shantayanan Devarajan, the World Bank, and Hafez Ghanem, the World Bank)

Governments in low-wage developing countries attempt to maintain incomes for certain labor groups through policies such as severance-pay and minimum-wage requirements. The resulting labor market structure can impede the efficient allocation of resources following trade liberalization, restricting growth. In this paper we examine the effects of labor market rigidities using a general-equilibrium model of Bangladesh. When there are no labor market distortions, we find that the poorest households experience a real-wage increase following trade liberalization. The income distribution effects of trade liberalization change dramatically when there are either severance-pay regulations or minimum wages that benefit urban-formal workers. Then the poorest households must bear the burden of adjustment. However, when both sets of regulations are in effect, the net result is not very different from the case where there are no regulations. This paper has been conditionally accepted by the Journal of Policy Reform.

The Trade-Wage Debate in a Model with Nontraded Goods: Making Room for Labor Economists in Trade Theory

Researcher: Assistant Professor Karen E. Thierfelder
(with Sherman Robinson, International Food Policy Research Institute)

The Heckscher-Ohlin-Sameulson (HOS) model in international trade theory provides a powerful general-equilibrium paradigm for analyzing the impact of changes in trade on factor returns. In the HOS model, factor returns are determined solely by commodity prices, which are determined on large world markets. Changes in factor supplies affect the structure of production and trade, but not relative factor returns. In this framework, there is little room for labor economists who focus on partial-equilibrium analysis of supply and demand in factor markets. We extend the HOS model to include "nontraded" goods, distinguishing them theoretically from "nontradable" goods. The resulting 1-2-2-3 model applies to one country with two production activities using two factors of production but consuming a third imported good. We show that the HOS model is a special case of the 1-2-2-3 model when imports and domestic goods are perfect substitutes. In the 1-2-2-3 model, the magnification effects in the Stolper-Samuelson and Rybczynski Theorems are greatly qualified and changes in relative wages depend on changes not only in world prices, but also in factor endowments and in the balance of trade. Empirical sensitivity analysis indicates that wages are more sensitive to changes in factor supplies than to changes in prices or the trade balance. This article has been submitted to the Economic Journal.

The Effects of NAFTA in a Changing Environment

Researcher: Assistant Professor Karen E. Thierfelder
(with Mary Burfisher and Daniel Plunkett, U.S. Department of Agriculture,
and Sherman Robinson, International Food Policy Research Institute)

NAFTA was negotiated in an environment of domestic agricultural support. Mexico guaranteed the price of corn and beans while the U.S. had price supports for grains and oilseeds. Recently, the policy environment has changed. In 1996, the U.S. adopted the Federal Agricultural Improvement and Reform (FAIR) Act,

which eliminates price supports. Under the new U.S. program, farmers receive a direct income transfer which is not linked to production decisions. Also in 1996, Mexico announced additional farm programs to improve overall efficiency and competitiveness in agriculture. Most of the programs under the new Alianza para el Campo (Alliance for the Country side) relate to infrastructure and extension-type assistance, and are designed to improve agricultural productivity. Each country's domestic changes will affect trade and therefore production decisions in the partner country; furthermore the transmission linkages are stronger when trade barriers are eliminated. Independently, the Mexican peso crisis of 1994 has encourage an outflow, rather than an inflow of foreign capital. In this paper, we analyze each shock--NAFTA, PROCAMPO, and the FAIR act--independently. We describe the changes in agricultural output, trade, and migration that each shock introduces. Then we consider the policy shocks simultaneously to simulate the effect of NAFTA in the new, 1996 policy environment. Finally, we consider the sensitivity of our results to alternative assumptions about gains in Mexican agricultural productivity under the Alliance program, and to change in the world price for grains and oilseeds. This was an invited paper presented at the Tri-National Research Symposium conference, "NAFTA and Agriculture: Is the Experiment Working?" San Antonio, Texas, November 1, 1996. We are currently revising it to submit to a journal.

Linkage Effects from Processed Food Exports: A Comparison of Brazil, Mexico, and the United States

Researcher: Assistant Professor Karen E. Thierfelder
(with Mary Burfisher, U.S. Department of Agriculture,
and Sherman Robinson, International Food Policy Research Institute)

In this paper we provide an empirical perspective on backward linkages from processed agricultural export growth to farm output and employment in Brazil, Mexico, and the United States. These three countries offer particularly relevant case studies. One reason is that the perspective Western Hemisphere Free Trade Agreement (WHFTA) is likely to stimulate trade in processed foods, because the region's tariffs on many of these products are relatively high and the WHFTA will lower them among member nations. Second, the potential for expanded processed exports to stimulate farm output and employment offers the prospect of easing the transition of Western Hemisphere farmers to a free trade environment. We analyze the links between processed and raw agricultural sectors using a computable general equilibrium (CGE) model which includes the intermediate input relationships and changes in consumer income accounted for in an extended input-output model. This paper has been accepted for publication In Dennis Henderson, Jean Kinsey, Daniel Pick, and Ian Sheldon eds., *Global Policies in Processed Food: Theoretical and Practical Issues*, Westview Press, forthcoming. It was presented at the International Agricultural Trade Research Consortium Meetings, Minneapolis, MN, June 1996.

Marginal Cost of Public Funds

Researcher: Assistant Professor Karen E. Thierfelder
(with Shantayanan Devarajan, Delfin Go, and Sethaput Suthiwart-Narueput, The World Bank)

In evaluating a particular public expenditure, one needs to know the marginal cost of public funds--the sum of the marginal dollar raised from the private sector and the "marginal excess burden," or the change in the total welfare cost of taxation caused by increasing tax revenue by the dollar. This project seeks to derive heuristic guidelines for estimating the marginal cost of funds (MCF) in developing countries by, firs, explicitly calculating MCF's in six countries in Asia and Africa using computable general equilibrium (CGE) models and, second, comparing model-based estimates with those obtained from simple rules-of thumb. This research is in the preliminary stage.

Labor Market Transition Issues in Algeria

Researcher: Assistant Professor Karen E. Thierfelder
(with Habib Fetini and Jeff Lewis, The World Bank)

We develop a computable general equilibrium model of Algeria. The model will provide an empirical framework to analyze transition and employment issues. Algeria currently has a high level unemployment and a growing labor supply. Furthermore, privatization, restructuring of public enterprises, and civil-service reform will generate more unemployment in the short term. However, in the long term, the economy will operate more efficiently and one anticipates that unemployment will decrease. The questions become, how many workers can be hired in the private enterprises? How much additional unemployment is tolerable during the transition period? How cooperative will internal organizations such as unions be during the transition? What types of external aid policies can keep this unemployment at a tolerable level? This research is in the preliminary stage.

Research Course Projects

The Feasibility of Predicting Military Unemployment Compensation Expenditures

Researcher: Midshipman 1/C Matthew P. Laser
Adviser: Professor William R. Bowman

The Department of Defense spends hundreds of millions of dollars each year to provide unemployment compensation benefits to ex-military personnel. These payments are made according on a reimbursement basis to each state, but the transfer of expenditures is initiated by estimated payments to the states on a quarterly basis. These estimates are based on a simplistic formula derived by the U.S. Department of Labor, and generally result in quarterly pre-payments that exceed actual quarterly military unemployment compensation. In essence, each state is given money for a state-run program up-front of actual expenditures, and given more money than actually needed. When added up across each quarter and across all states, this current system in the Department of Defense of paying for unemployment compensation creates a form of "government waste" that widens the federal budget deficit unnecessarily.

An attempt was made in the study to derive a statistical forecast model of each state's quarterly military unemployment compensation expenditures, using a "pooled cross-section/time-series" multivariate regression model. Quarterly data was gathered from available Department of Labor's Bureau of Labor Statistics for the period 1990 - 1996, including such variables as: state labor force size and growth, state level of unemployment rates and employment growth. Alternative modeling specifications were tested to derive the best-fit of the quarterly data. In general, the models derived were not able to explain much of the variation in quarterly military unemployment compensation, suggesting that a state's regional labor market demand has little influence on the length of unemployment of ex-military personnel. The major suggestion made in the study for improving the power of the model is the need to use individual-specific data that would include background characteristics of those personnel making the transition from the military to the civilian work force. Similar models are required by each state under current federal labor legislation for regular unemployment programs used to identify individuals who are likely to need additional employment services when experiencing spells of unemployment. Such a lofty goal should also be applied to military personnel as part of the transition services currently available under legislation related to veterans.

Cost Efficiencies in the Rehabilitation Industry

Researcher: Midshipman 1/C Christopher Ornee
Adviser: Associate Professor Thomas A. Zak

Antitrust agency decisions to challenge proposed mergers frequently turn on whether the combined enterprise generates resource cost savings that exceed potential anticompetitive price effects. By examining both economies of scale and economies of scope for rehabilitation hospitals, this research provides insight into the likely effect on prices resulting from the ongoing consolidation of acute care and rehabilitation facilities. Controlling for location, case severity mix and ownership status unit cost equations are estimated with data from American Rehabilitation Association surveys. The paper reports the following results: 1) urban rehabilitation hospitals have lower unit costs; 2) there are diseconomies of scale for the average sized urban rehabilitation facility; 3) large "for-profit" facilities have higher costs than similar sized "non-profit" facilities; 4) there appear to be multi plant economies of scale - rehabilitation hospitals that are members of multi-unit chains have lower average cost; and 5) multicollinearity in the data makes it difficult to determine, with confidence, the existence of economies of scope that may arise from vertically integrating acute care and rehabilitation hospitals.

An Econometric Estimate of the Supply of Non-Prior Service Military Accessions

Researcher: Midshipman 1/C Peter Rybski
Adviser: Associate Professor Thomas A. Zak

Studies of military accession have forecast increasing difficulty for the military services in recruiting enlisted personnel. Three reasons are frequently mentioned: declining youth cohorts, less positive attitudes about military service, and a strong economy that offers more attractive civilian alternatives. Despite the cut backs in military forces, the ability to attract adequate numbers of high quality recruits remains an important policy issue. By estimating supply of military accession equations this paper finds that the most important factor is youth population. The estimated elasticity is not significantly different than one. This is believed to result from the manner in which recruiting goals are set. However, with rigid goals based on state populations, one should expect quality variations based on attitudes and economic conditions. This result is not supported by the data. Several explanations are offered: 1) the cross section equations used data from 1994 - there was little variation from state to state in economic conditions, thus reducing the likelihood of finding a significant result; 2) estimates using states rather than SMSAs as the unit of observation may further dampen variation in economic variables; 3) the inability to include measures of recruiting effort may bias the estimated impact of economic conditions downward. If one removes population from the equation, explanatory power declines appreciably, and the only significant variable suggests that it is easier to recruit high quality accessions in the southern states.

Hedonic Price Estimates of Colorado Ski Packages: Valuing Resort Amenities and Mountain Characteristics

Researcher: Midshipman 1/C David M. Traugott
Adviser: Associate Professor Thomas A. Zak

Using hedonic analysis, this paper attempts to determine whether ski package prices can be explained as functions of the lodging and ski mountain characteristics included in the package. The model utilizes the characteristic approach to demand, which assumes that certain goods are demanded for the bundle of desirable characteristics that the contain. Hedonic pricing is a method that allows one to value

embodied characteristics for which an explicit market does not exist by relating differences in characteristics to differences in price. The specific model developed here estimates implicit prices for characteristics associated with 1) the ski mountain, 2) the lodge, and 3) the individual rooms. The empirical results are not easily summarized because of the large number of characteristics employed in the estimates, but several variables can be used for illustrative purposes. First, the included characteristics account for approximately 60% of the variation in ski package prices. Second, everything else equal, 1) an increase of 100 feet of vertical drop adds $33.31 to the price of a package; 2) an additional inch of average annual snow fall adds $2.28 to the price; and 3) package price fell by $11.12 for each additional block that the lodge was from the ski lift. A more complete discussion of results, interpretations, limitations, and extensions is contained in the paper.

An Investigation of the Relationship Between Government Budget Deficits and Exchange Rates

Researcher: Midshipman 1/C Brian Wilson
Adviser: Professor Rae Jean B. Goodman

The connection between governmental budget deficits and exchange rates is of considerable policy importance. The simple story suggests that as deficits rise and governments fund expenditures by borrowing, interest rates rise. As interest rates rise two things happen: 1) private investment is "crowded out", reducing future economic growth, and 2) the home currency appreciates relative to foreign currencies thus lowering exports and raising imports. This paper focuses on the empirical significance of the latter by first, examining more complex linkages that argue for a more limited impact of deficits on exchange rates, and second, using IMF and OECD data, empirically estimating exchange rate equations for the United States, Canada, Germany, Japan, and the United Kingdom. The empirical results are ambiguous. In Japan and Germany, higher budget deficits are positively related to exchange rates as the simple model predicts. However, budget deficits are not found to be significantly related to exchange rates in Canada, the US and the UK. Severe data restrictions make it difficult to determine why the results varied by country.

NFL Point Spreads: A Test of the Efficient Market Hypothesis

Researcher: Midshipman 1/C Thomas J. Zerr
Adviser: Associate Professor Thomas A. Zak

A market in which prices always fully reflect available information is called "efficient." The Efficient Market Hypothesis (EMH) argues that markets never consistently over or under value a commodity or asset. New information will be fully incorporated, prices will change, and while estimates are not perfect, systematic errors will not be made. Clearly, transactions costs, information asymmetries and market imperfections can impede market efficiency. Because point spreads adjust in a manner similar to securities prices the EMH can be applied to the NFL betting market. If the market is not efficient, then a betting strategy or system can be constructed to profitably exploit the inefficiency. The empirical estimates use data from a 20 year period. While some betting "systems" have limited, short term success, no consistent inefficiencies appear. The only inefficiencies lasting as long as three years that exceed the transactions costs are underdogs playing at home in the last two months of the season. The limited success may either be an anomaly (even with a fair coin there is a positive probability of 5 consecutive heads) or, the market reacts to the system's success by adjusting and thereby removing the inefficiencies.

Publications

FREDLAND, J. Eric, Professor, Roger D. LITTLE, Professor, C.L. Gilroy and W.S. Sellman (Department of Defense), editors, *A Military of Volunteers: Yesterday, Today and Tomorrow,* (Washington D.C.: Brassey's), 1996.

In September, 1993, the Naval Academy hosted a major conference on the 20th anniversary of the all-volunteer force. The conference, which brought together researchers and practitioners in the field of military manpower, was jointly sponsored by the Academy and the Department of Defense. This edited volume includes 15 papers plus discussants remarks. Included are papers providing historical perspective, papers examining force management and social issues in today's environment, and papers relating to future challenges for the military in response to the changing world order.

HILDEBRANDT, Gregory G. (with Raymond E. Franck, Jr., Joint Military Intelligence College), "Competitive Aspects of the Contemporary Military-Technical Revolution: Potential Military Rivals to the US," *Defense Analysis*, Vol 12, No 3, 1996, pp. 239-258.

A consensus holds that a Military-Technical Revolution (MTR) is in progress. The authors believe that MTR's are inherently part of military competitions. The fundamental premise is that early innovators gain advantages that rivals must redress. The nature of rival response depends on such factors as national objectives, societal characteristics and the international environment, as well as on choices available and their relative feasibility. This paper presents a capabilities-centered analysis of potential military responses to the American Reconnaissance-Strike Complex. It first considers the contemporary MTR as the foundation of American military primacy. Then it outlines the structure of choices facing potential military rivals. First order estimates of the costs of fielding military capabilities similar to those employed in the 1991 Gulf War are provided, with China and an hypothetical post-NATO European alliance serving as notional rivals. Implications for military planners and policy makers are drawn.

MORRIS, Clair E., Professor, Review of Karl Aiginger and Jorg Finsinger, eds., *Applied Industrial Organization: Towards a Theory Based Empirical Industrial Organization*, (Boston and Dordrecht: Kluwer Academic Publishers, 1994), *Southern Economic Journal*, Vol 63, No 1, July 1996, pp. 273-274.

This review takes note of a significantly different approach to the study of Industrial Organization as an applied field within Economics. The traditional paradigm of "structure, conduct, performance" that is commonly used to explain market and firm behavior is eschewed by the 15 studies included here in favor of a starkly inductive, empirical approach with no pre-conceptions. The authors and the data they use are mostly European; only one study relates to the U.S. economy. The findings are not noticeably different from those of the studies that use a more traditional methodology, but the book is valuable for its insights into how new light can be shed on economic reality by the unique ways that questions are asked of the data.

MORRIS, Clair E., Professor, "Say's Law," in Thomas Cate, Geoff Harcourt, and David C. Colander, eds., *An Encyclopedia of Keynesian Economics*, (Cheltenham, UK: Edward Elgar), 1997, pp. 563-565.

Jean Baptiste Say was a late 18th century French economist noted for his contributions to Classical economic doctrine. His notion that "Supply creates its own Demand" became the foundation for the Classical position on the appropriate role of government in a free enterprise capitalistic society. The purpose of this study was to address the following questions: What is the principal tenet of Say's Law? in what ways does this Law differ from Say's Identity and Say's Equality? why did Keynes reject this Law? what are the policy implications of this Law? in what ways is this Law related to the New Classical and the New Keynesian models? Say's publications and the secondary literature that has been published on his work were reviewed for insights into the answers to these questions.

THIERFELDER, Karen E., Assistant Professor, (with S. Devarajan and H. Ghanem) "Economic Reforms and Labor Unions: A General Equilibrium Analysis Applied to Bangladesh and Indonesia," *World Bank Economic Review* Vol 11, No. 1 January 1997.

Noting the trend toward more independent trade

unions in developing countries, this article examines whether the presence of unions strengthens or weakens the benefits to be gained from economic policy reform. We show that the presence of "passive" unions--ones that choose their wage-employment contract given the firm's cost-minimizing strategy--increases the welfare gains from trade liberalization, because trade reform m lowers the wage premium enjoyed by the unionized sector, reducing a distortion in the labor market. These gains are amplified when the unions are "active," namely, when they negotiate a contract with the firm that is off its labor demand curve. Such a contract results in featherbedding--paying workers more than their marginal product--and trade reform reduces the amount of feather bedding. The policy implications for Bangladesh--a country with strong trade unions and a protected unionized sector--is that the benefits of further trade liberalization may be greater than otherwise predicted. In Indonesia, where both unionization and import tariffs are low, allowing greater independence to unions may preserve flexibility and reward workers better than the current minimum-wage policy.

THIERFELDER, Karen E., Assistant Professor, (with C. R. Shiells), "Trade and Labor Market Behavior in Computable General Equilibrium Models," in Joseph F. Francois and Kenneth A. Reinert, eds., *Applied Methods for Trade Policy Analysis*, (Cambridge, UK: Cambridge University Press) 1997.

The base data needed to construct computable general equilibrium (CGE) models usually show sectoral wage differentials, which pose a challenge for modeling based on perfectly competitive labor markets. The underlying behavior which generates the observed wage differentials can crucially influence changes in resource allocation and welfare resulting from domestic tax and tariff changes. In fact, depending on the behavior in the labor market and the pattern of protection, trade liberalization can actually reduce welfare, contradicting the results obtained using a model with neoclassical labor markets and no other distortions. To investigate these issues, we consider three possible explanations for sectoral wage differences--sector specific productivity differences, the presence of an efficiency wage sector in which producers pay a wage premium to eliminate shirking, and the presence of a union in one sector. We then construct a stylized, two-sector, CGE model and incorporate each of the three different interpretations of the wage differentials. We find that when the wage differentials are endogenous, policies that expand the high-wage sector also exacerbate the labor market distortion as the wage differentials increase. This dampens the welfare gains that otherwise arise when wage differentials are assumed to be exogenous.

Presentations

BOWMAN, William R., Professor, "Career Advancement of Minority Officers in the United States Navy " Western Economic Association International Conference, San Francisco, July 1996.

GETTER, Darryl E., Assistant Professor, "Are Lenders Tougher on Non-Wealthy Credit Applicants?" Western Economic Association International Conference, San Francisco, July 1996.

GETTER, Darryl E., Assistant Professor, "Are Household Credit Markets Efficient? Eastern Economic Association Annual Meeting, Washington DC March 1997.

GOODMAN, Rae Jean B., and Roger D. LITTLE, Professors, "Women Service Academy Graduates: Career and Promotion Expectations" U.S. Coast Guard Academy, "Leadership in a Gender Diverse Military" Conference, March 1997.

KENDRY, Adrian P. William J. Crowe Professor, "Aerospace Industry Restructuring in the UK and Europe" Western Economic Association International Conference, San Francisco, July 1996.

KENDRY, Adrian P. William J. Crowe Professor, "The Role of Government in the Future of the Aerospace Industry: A Transatlantic Perspective," National Convention of Aerospace Regions Conference, Blackburn, UK, March 1997.

LITTLE, Roger D., and Rae Jean B. GOODMAN, Professors, "The Spouses of Servicewomen: Socioeconomic Characteristics and Career Influence" Western Economic Association International

Conference, San Francisco, July 1996.

LITTLE, Roger D., and Rae Jean B. GOODMAN, Professors, "Gender Differences in the Second Paycheck: An Exploration into the Labor Force Status and Earnings of the Husbands and Wives of Servicemembers," Women's Research and Education Institute, Conference on Women in the Uniformed Services, Washington DC December 1996.

THIERFELDER, Karen E., Assistant Professor, (co-author), " Agriculture, Trade, and Exchange Rates in MERCOSUR," Conference, entitled "La agricultura, la alimentacion y los recursos naturales en el MERCOSUR hacia el ano 2020"(Agriculture, Food and Natural Resources in MERCOSUR to the Year 2020), Buenos Aries, Argentina, September 1996.

THIERFELDER, Karen E., Assistant Professor, (co-author) "The Trade-Wage Debate in a Model with Nontraded Goods: Making Room for Labor Economists in Trade Theory," Southern Economic Association annual meetings, Washington DC, November, 1996.

THIERFELDER, Karen E., Assistant Professor, (co-author) "the Effects of NAFTA in a Changing Environment," Tri-National Research Symposium conference, titled "NAFTA and Agriculture: Is the Experiment Working," San Antonio TX November 1996.

ZAK, Thomas A., Associate Professor, "Demand Uncertainty, Sunk Cost, and Defense Downsizing," Western Economic Association International Conference, San Francisco, July 1996.
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GETTER, Darryl E., Assistant Professor, "Survey Evidence on Consumer Credit Rejection and Application Patterns," Economics Department Seminar, University of Maryland, Baltimore Campus, March 1997.

GETTER, Darryl E., Assistant Professor, Consumer Credit: Broader Availability, Deeper Debt," Bank Administration Institute— Philadelphia Chapter, March 1997.

GOODMAN, Rae Jean B. Professor, "Gender Differences in the Second Paycheck: An Exploration into the Labor Force Status and Earnings of the Husbands and Wives of Service Members," Economics Department Seminar, Davidson College, February 1997.

KENDRY, Adrian P., William J. Crowe Professor, "The Seductive Subversion of European Economic Integration," Illinois Wesleyan University, February 1997.

KENDRY, Adrian P., William J. Crowe Professor, "The Impact of European Economic Integration on the USA," Keynote Address for International Week, Illinois State University, February 1997.

KENDRY, Adrian P., William J. Crowe Professor, "Comparison Between the US and UK Aerospace Industries," BBC Radio Lancashire, March 1997.

KENDRY, Adrian P., William J. Crowe Professor, "Sophistry, Calculation and Economics: The Seductive Subversion of European Integration," Chesapeake Association of Economic Educators, April 1997.

MORRIS, Clair E., "The Economics of Health Care," Bethesda Naval Hospital, August 1996 and Newport Naval Hospital, September 1996.

THIERFELDER, Karen E., Assistant Professor, (co-author) "The Trade-Wage Debate in a Model with Nontraded Goods: Making Room for Labor Economists in Trade Theory," International Economics Department Seminar Series, The World Bank, July 1996.

THIERFELDER, Karen E., Assistant Professor, (co-author), "Economic Reforms and Labor Unions: A General Equilibrium Analysis Applied to Bangladesh and Indonesia," Graduate Economics Seminar Series, Johns Hopkins University, November 1996.

DEPARTMENT OF ENGLISH

Professor Timothy D. O'Brien
Chair

During this academic year the English Department continued to be productive. Its faculty published several books; placed numerous scholarly articles, essays and reviews in significant journals; and delivered papers and chaired panels at important conferences.

The Naval Academy Research Council supported the research of twelve department members on such topics as the pivotal work of the African-American poet Michael Harper, the Vietnam veteran as protagonist in detective fiction, the short stories of Ernest Hemingway, and the nexus of violence and women in Chaucer's poetry. Two members of the department pursued research supported by prestigious outside awards: one from the Bibliographical Society of America, for work on the eighteenth-century music trade; and another from the National Endowment for the Humanities' Fellowships for College Teachers for work on kinship and violence in Anglo-Saxon poetry.

Independent research and creative work also flourished within all ranks of the department. Officers worked on such projects as a much needed critical edition of a seventeenth-century play by George Granville, the inextricable connection between literary studies of the Victorians and the pedagogy of composition, and the emerging literature of the Southwest; a student explored the metrical development of T.S. Eliot's poetry; and professors pursued projects ranging from the traditional literary ones--scholarly editions of poetry and studies of short stories--to the non-traditional ones such as a study of Roadside Theatre and its reconfiguration and preservation of the oral culture of Central Appalachia. In all, the department's teacher/ scholars published a major book of original research, five editions or anthologies, and fifteen articles or essays; and as a group they presented an average of about three conference papers per month during the academic year.

This scholarly and creative activity and its fruition in publication, presentations, and even performances all signal the vitality of the English Department's faculty, a vitality sustained in part by institutional funding but also by the close connection in the lives of the department's faculty between such professional activity and teaching. Clearly, this connection can only benefit the Naval Academy in providing the midshipmen with the best possible education.

Sponsored Research

Modernism's Banned Books

Researcher: Associate Professor Allyson Booth
Sponsor: Naval Academy Research Council

This project is designed to investigate the ways in which World War I created absences in modernism. During the war the British government amended its Defense of the Realm Act in such a way that, according to Samuel Hynes, "it became an offence to utter, in any form, an opinion that might be construed as prejudicial to the conduct of war." An examination of books censored because of military concerns should display some of the paths along which modernism was prevented from developing, thus providing some fresh illumination of the paths along which it traveled. The investigator will explore such works as Norah James' Sleeveless Errand, Miles Malleson's 'D' Company and Black 'Ell, as well as background material on the Defense of the Realm Act.

Tamara de Lempicka: The Politics of Deco and Decadence

Researcher: Associate Professor Laura Claridge
Sponsor: Naval Academy Research Council

In spite of a retinue of prestigious prizes, of a continuing history of high selling prices, and the scholarly imprimatur of Germain Bazin (curator of the contemporary art section of the Louvre) and Francoise Gilot's insistence that her husband, Picasso, admired the artist, Tamara de Lempicka gets no respect from the general art community. Most surveys of twentieth century art do not even cite her existence, and the majority of studies of women artists also omit Lempicka entirely. The object of this investigation, than, is to collect material related to Lempicka and to develop a theoretical background to the art of biography. This work will serve as the foundation for the first critical biography of this neglected but major modernist artist.

Abandoning Answers: Shaw's Portrayal of Women

Researcher: Associate Professor Anne Marie Drew
Sponsor: Naval Academy Research Council

The objective of this study is to examine four representative Shaw plays in an attempt to identify his apparent move away from misogyny and his experimentation with dramatic spaces. As his career developed, George Bernard Shaw grew increasingly adept at resisting the misogynistic impulse to define women; moreover, he overcame his tendency to provide answers to the "woman question." A self-proclaimed feminist, Shaw reveals in his plays a growing awareness that advocacy doesn't mean imposing solutions. Moreover, Shaw's ability to abandon his need for providing the dramatic answer reflects his lack of misogyny. A change in his dramatic structures and spaces corresponds with his leaving off answers. His later plays especially demonstrate his willingness to rest in uncertainty.

Passing the Flame: Michael Harper's Role in the Legacy of Modern African American Poetry

Researcher: Professor Fred M. Fetrow
Sponsor: Naval Academy Research Council

This project will examine the role of Michael S. Harper as the linch pin in the ongoing continuum of modern African American poetry. As promoter and celebrant of his own literary ancestors (notably Sterling Brown and Robert Hayden), Harper has also served as both role model and tutor for those younger poets to follow. Harper's poetry bridges the divide between the generation of poets before him and those aspiring to follow him. By teaching and inspiring those aspirants with his own example and the attention he directs to the historical resources available in the lives and work of Brown and Hayden, Michael Harper sustains the history he forwards. For all of these reasons a study of his role in this progression is also a study of the evolution of African American poetry in modern and contemporary literary history.

Japanese and Japanese-American Literature

Researcher: Associate Professor Bruce E. Fleming
Sponsor: Naval Academy Research Council

The objective of this project is to arrive at an understanding of the development of Japanese literature as it began to break away from the Chinese, and to begin the second major period of Japanese novelistic production in the twentieth century. The primary work consists of reading and studying, first

scholarly overviews, then primary texts in translation with their accompanying scholarly apparatus. A secondary purpose in this study is to discover how the explanations for the development of the Japanese novel reflect upon the prevailing view of the English novel as having developed in the seventeenth century as a result of market forces. A study of the Japanese novel is likely to call into question any theoretical generalizations that insist on the particular necessity of Western conditions for the development of **?**realistic" fiction.

John Lawrence's Journal: An Edition

Researcher: Associate Professor C. Herbert Gilliland, Jr.
Sponsor: Naval Academy Research Council

Assigned to the African Squadron, the *USS Yorktown*, had as its mission interdiction of the slave trade. In carrying out this mission, the *Yorktown* captured three slavers, one of which, the *Pons* had over 800 slaves on board. Master's Mate John C. Lawrence was the junior officer of two officers and ten enlisted men assigned as prize crew to the *Pons*. Some of the most poignant entries in Lawrence's 140 page journal deal with accounts of his observations upon the *Pons*. As valuable as these accounts are, and as intelligent and well-written as the entire journal is--it is also valuable for another reason: it can serve as a window into the operating U.S. Navy of the 1840s, with of course special focus on the African Squadron. The objective of this investigation, then, is to prepare an edition of this hitherto unpublished (indeed, unknown) document. This work will involve verification of the text, some normalization of spelling and punctuation, and the addition of an introduction, notes, and maps and illustrations.

Violence and the Construction of Kinship in Anglo-Saxon Heroic Story

Researcher: Professor John M. Hill
Sponsor: Naval Academy Research Council

Much scholarly commentary on kinship and violence in Germanic heroic poetry turns excitedly on the supposed drama of a conflicted protagonist choosing between kinship ties and obligations to his lord, or else choosing between two different lords or else near and far kin. Dramas of this sort are usually thought to lie at the heart of several episodes in Beowulf. Another view, however, sees these conflicts as part of a supposed movement away from egalitarian kinship ties to those of hierarchical lordship. The purpose of this project is to explore the limitations of these conventional explanations of group entanglements and reformations in Anglo-Saxon poetry A preliminary investigation shows that time and time again the vaunted conflict of loyalties does not really exist--this because neither kinship nor lordship ties are automatic or monolithic.

The Shadow of Vietnam in American Detective Fiction

Researcher: Professor Philip K. Jason
Sponsor: Naval Academy Research Council

This investigation explores detective literature of the 1980s and 1990s in which the protagonist is a Vietnam War veteran. The aim is to discover the connection between his wartime experience and his style of performance within this occupation. The study will pursue representations of the residual effects of the war experience on the outlook of those connected with our systems of law and justice. The most recent wave of literature responsive to America's involvement in Vietnam includes a body of detective fiction centered on middle aged protagonists whose memories of Vietnam, as well as their sense of "lessons learned," influences their present outlook, conduct, and sense of self. Although some investigators have explored pulp

fiction representations of post-Vietnam masculinity, no one has yet explored this theme in the more literary treatments of popular genre fiction. A special interest will be the presentation of and perspectives on paramilitary culture. First, the investigator will define and locate the relevant material, selecting for analysis works by those authors who are sophisticated cultural critics and accomplished artists. Works by James Lee Burke, Michael Connolly, and James Crumley clearly fit the criteria. The chief characters and plot situations in these works will be contrasted and compared with particular attention to attitudes toward authority, victims, criminals, women, family, cadre, and country.

A Critical Study of Mary Gordon's Fiction

Researcher: Associate Professor Eileen Tess Johnston
Sponsor: Naval Academy Research Council

This project is a study of the thought and work of Mary Gordon, a highly acclaimed contemporary American writer. Part of this study appeared in the journal *Christianity and Literature* (Winter 1995) as an article on Gordon's novel *Final Payments*. The study traces Gordon's development as a writer of fiction and as a memoirist from several perspectives: 1) Her aesthetic, religious, social, and political ideas; 2) the Irish immigrant tradition in America; 3) the Christian tradition, especially its Roman Catholic dimension; 4) the tradition of fiction by and about women; 5) the perspective of ideas about houses, domestic spaces, and shelter, the central symbolic complex pervading Gordon's writing. 1996 research focused on a new turn in Gordon's writing towards the memoir and on her second novel, *The Company of Women*, and its relation to desert spirituality and the foundations of Christian monasticism and the mediating influence on Gordon of a more nearly contemporary writer, Thomas Merton.

The British Music Trade in the Late Eighteenth-Century

Researcher: Associate Professor Nancy A. Mace
Sponsor: National Endowment for the Humanities, the Bibliographical Society of America

Although music publishing is important in the history of eighteenth-century theatre, music, literature and the print trade, scholars have virtually ignored this area. Beginning with a collection of thirty lawsuits in the Public Record Office, London, which are hitherto unknown to scholars, the researcher is studying the music trade in the late eighteenth century--the relationship between book- and musicsellers, their conflicts over copyright, and their business practices. A database of musicsellers and others named in the suits has been developed and all materials have been transcribed.

Tuckahoe

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

This project focuses on the formative years of Frederick Douglass, who grew up in Talbot County and Baltimore. Research into Douglass' three autobiographies and other appropriate sources will serve as sounding-boards for a fifty-poem cycle called Tuckahoe. This cycle of poems, some in free verse and others in strict iambic pentameter, explores the natural landscape and its influence on Douglass. We do not know the details of Douglass' life along the Tuckahoe River, and we know only slightly more about his life at Wye House, the center of the Lloyd plantation. Though recent psycho-biographers have not hesitated to speculate on their subjects' childhoods in supposedly factual biographies, the researcher feels that the poetic form is much fairer to the nature of the imaginative reconstruction of a life formed by a particular

environment.

Hemingway's Sophisticated Artistry: The Short Fiction

Researcher: Charles J. Nolan, Jr.
Sponsor: Naval Academy Research Council

Since the Hemingway papers at the John F. Kennedy Library in Boston have been opened to scholars, the direction of Hemingway studies has changed dramatically. Five new biographies, several of them in multiple volumes, have served to correct our often stereotyped perception of Hemingway the man. At the same time, we have been able to look at Hemingway the artist from a new perspective. The wealth of manuscript material has allowed us to follow Hemingway through the various drafts of his stories so that we can now see how he shaped the finished texts. Because of this opportunity, the criticism in recent years has reflected our changing view of the Hemingway canon. Building on both the criticism and the now available manuscripts, the researcher examined one of the stories, **?**A Pursuit Race" that has been particularly enigmatic. The researcher's recent work on **?**A Simple Enquiry" and **?**Ten Indians" served as a model for the kind of exploration. In each case, close attention to troublesome places in the text revealed the complexity of Hemingway's artistry in these seemingly simple and straightforward narratives. The result of this research is an article entitled **?**Hemingway's Puzzling Pursuit Race," now under review for possible publication at Studies in Short Fiction.

Women and Violence in Chaucer

Researcher: Professor Timothy D. O'Brien
Sponsor: Naval Academy Research Council

This project was designed to investigate a recurring motif in Chaucer's narratives: the unexpected, sudden association of women with violent events. The project involved a careful reading of Chaucer's narratives in the light of analogues and sources as well as an extensive reading of anthropological and psychological theories concerning violence and human behavior. Much of that work has been completed, though study of scores of secondary sources is ongoing. The study has produced one paper of about twenty pages, "Fire and Blood--'Queynte Imaginings in Diana's Temple," which analyzes the visitation by Emelye in the "Knight's Tale" to Diana's temple.

Independent Research

The She-Gallants

Researcher: Lieutenant Commander Cara D. Akerley

This is a critical edition of *The She-Gallants* by George Granville, later Lord Lansdowne. Originally produced in London in 1696, this first work of a new author failed and no critical work has been done on it. Despite its failure, the work presents examples of a number of characteristics that were typical of the era as well as laying the foundation of types of comedy to come. The edition is being submitted as a Ph.D. dissertation at the University of Maryland.

Dissertation

Researcher: Lieutenant Colonel Howard E. Barton Jr.

In this dissertation the researcher intends to show the connection between literature studies and composition by concentrating on the essays of the great Victorian writers such as Arnold, Newman, and Pater. He intends to show that their way of seeing their world and their methods of writing are similar to the seeing and writing of the most respected essayists of today. The purpose is to determine better ways for instructors to use these methods in classroom writing instruction.

Play and Survival in William Kennedy's *Billy Phelan's Greatest Game*

Researcher: Professor Neil Berman

The epigraph to William Kennedy's *Bill Phelan's Greatest Game* is taken from Johan Huizinga's *Homo Ludens*, the seminal book on the play element in culture. Although the novel clearly focuses on several sporting and game motifs, such as bowling, pool, poker and horseracing, Kennedy's interest in play transcends all of these and elevates the gaming environment to the level of survival. In so doing, he collapses the artificial dualisms between play and seriousness, play and work, and play and reality. Bill Phelan, a small-time hustler who has inherited his father's sporting spirit, must adapt his "play" to an ambiguous but deadly serious kidnaping scenario in order to survive the political bossism and gangster mentality of 1930's Albany, New York. This project is a direct outgrowth of HE360 taught in the fall of 1997.

It's All Right to Be Woman

Researcher: Assistant Professor Anne M. Ellis

The researcher is developing a journal-length article on the history and practice of It's All Right to Be Woman Theatre.

Hawaiian Sugar Plantation Life

Researcher: Assistant Professor Anne M. Ellis

Ongoing research into Hawaiian sugar plantation life, 1896-1920, for projected study of intercultural interaction among immigrant plantation workers.

New York City Fringe Theatre Festival

Researcher: Assistant Professor Anne M. Ellis

Researching the history, planning, and performances of the First Annual New York City Fringe Theatre Festival (August 1997) for a projected journal article.

Performing Appalachia

Researcher: Assistant Professor Anne M. Ellis

An examination of the history, theory, and practice of Roadside Theater in its work to record, preserve, and reconfigure the history and oral culture of Central Appalachia, in the context of and in opposition to the larger cultures of the South and of the United States.

Chaucer's Economic Paradigms

Researcher: Lieutenant Colonel Kent Esbenshade

The drafter of this dissertation deals with Geoffrey Chaucer's use and transformation of Medieval economic paradigms in selected tales from the *Canterbury Tales*.

The Internet and Its Potential

Researcher: Associate Professor Mary D. Howland

The researcher is gathering information about the linguistic features of the World Wide Web as an information resource. Work needs to be done so that students will have the necessary tools to evaluate what they find on the Internet.

Tuckahoe

Researcher: Associate Professor Robert D. Madison

"Tuckahoe" is a cycle of fifty poems examining the childhood and youth of Frederick Douglass on the Eastern Shore of Maryland.

Army Life in a Black Regiment

Researcher: Associate Professor Robert D. Madison

An edition of Thomas Wentworth Higginson's *Army Life in a Black Regiment* for Penguin Classics.

Hemingway's Short Stories

Researcher: Professor Charles J. Nolan Jr.

"Hemingway's Short Stories" is a generic title covering research into various Hemingway texts.

A History of Presidents Hill in Annapolis

Researcher: Professor Michael P. Parker

The area of Annapolis now known as Presidents Hill lies between West Street, Taylor Avenue, and the old Baltimore, Washington, and Annapolis Railroad right-of-way. It consists of four streets: Munroe Court, Madison Place, Hill Street, and Jefferson Place. The neighborhood was first developed by the Brewer family in the early 1890s as a fashionable suburb of Annapolis; the crash of 1893, however, sent real estate prices plummeting, and the remainder of the lots were developed on a less pretentious scale. In the early 1900s Presidents Hill was the home of many small businessmen and craftsmen, including some who went on to become significant forces in the Annapolis commercial community. Two mayors of Annapolis lived in Presidents Hill, another, current mayor Alfred A. Hopkins, has close family links to the community. The neighborhood began to change dramatically in the 1960s as the traditional family and social networks that held it together were eroded; the availability of Title 8 low-income housing moneys led to a marked increase in rental property in the neighborhood. In 1984 Presidents Hill was included in the Annapolis

Federal Register Historic District, and it has become increasingly subject to gentrification over the last

decade. This history will trace the chronicle of Presidents Hill from its founding up to the present day, relying on interviews with long-time residents, newspaper accounts, and property records. A building-by-building survey of the community's architectural and historic landmarks will complement the narrative.

An Edition of the Poems of Edmund Waller

Researcher: Professor Michael P. Parker

Although one of the most accomplished and influential poets of the seventeenth-century, Edmund Waller has remained largely neglected by modern critics. This neglect is due primarily to the lack of a reliable standard edition of his works. The most recent edition, that of George Thorne Drury, was published over one hundred years ago, in 1892, and it fails to meet the exacting standards of editorial practice established by W. W. Greg, Fredson Bowers, and Thomas Tanner in the twentieth century. Several scholars have begun new editions of Waller over the past seventy-five years, but none has been brought to completion. Most recently, Philip R. Wikelund of Indiana University labored over an edition from 1954 until his death in 1989. The researcher, in collaboration with Professor Timothy Raylor of Carleton College, has taken over Wikelund's work. The first stage of the project entails producing a census of Waller editions and manuscripts as well as a complete bibliography of secondary works on Waller. The second stage is to reexamine Wikellund's theory of the Waller copy-text: his choice of the 1664 edition may not conform to modern editorial practice.

This project is large in scale and will take a number of years to complete, but the result will be a major contribution to modern scholarship on the seventeenth century.

Songs in the Night
Ceremonies of the Horseman

Researcher: Professor John C. Wooten

The researcher continues to work on two novels. The first, *Songs in the Night,* is in the final stages of revision. The second novel, *Ceremonies of the Horseman,* is as yet unfinished.

Research Course Projects

T. S. Eliot and Metrics

Researcher: Midshipman 1/C Chad Van Someren
Adviser: Professor David A. White

Midshipman 1/C Van Someren undertook an extensive study of the metrical development of the poetry of T. S. Eliot. The study began with close analysis of Eliot's use of rising duple meter in his early poetry and his attempts to break away from that pattern to the use of free verse in his middle period verse such as "The Hollow Men." Close critical examination was then given to Eliot's use of a new four-stress line in his *Four Quartets* and in his adaptation of that line to a three stress line with caesura in his later drama.

Publications

ARBUTHNOT, Nancy P., Associate Professor, *An American Artist in World War II: Jason Schoener at Eniwetok Atoll*, Needham Heights: Simon & Schuster, 1996.

A catalogue to the collection of World War II watercolor paintings by the American landscape artist Jason Schoener, this book is also an introduction to the artist and an overview of American military work and leisure life on a Marshall Island staging area for the war in the Pacific.

BOOTH, Allyson, Associate Professor, *Postcards from the Trenches: Negotiating the Space Between Modernism and the First World War*, New York: Oxford University Press, 1996.

This book traces the relationship between the British Great War culture and modernist literature and architecture. By drawing on a wide range of materials and looking at the places where they overlap, I try to uncover ways in which modernism is deeply embedded in a broader Great War culture.

CHILDS, Matthew, Lieutenant USN, "T. S. Eliot." *Angelus* (October 1996), pp. 46-48.

A discussion of poetry in general and specifically T. S. Eliot's poetry as it relates to modernity and faith in the modern world. Poetry is shown to be directly connected to the divine spark in man--intellect, logo, the Word--and therefore to be of prime importance in restoring our "lost unity of mind" as Richard Weaver puts it. Eliot is used as the best example of the success of poetic form and Christian ideology in the deconstructed and faithless world.

DREW, Anne Marie, Associate Professor, *365 Meditations for Teachers*, Nashville: Abingdon Press, 1996.

Wrote the March, April and May meditations for this book--which is an inspirational book for teachers.

DREW, Anne Marie, Associate Professor, "And the time for it was Gone: Jessie's Triumph in night Mother." *Marsha Norman: A Casebook*. Ed. Linda Brown. New York: Barland Press, 1996.

This article discusses the main character's decision to commit suicide in the Pulitzer Prize winning play 'Night Mother."

FLEMING, Bruce E., Associate Professor, "Confessions of An Apollonian Male," *Dance View* 14 (Autumn 1996), pp. 33-34.

An essay considering, from a personal standpoint, the Nietzschean dichotomy of "Apollonian" and "Dionysian" as it applies to a number of contemporary dance and theater works. The piece suggests that this dichotomy may be applied to the arts of the late twentieth century. Most of these, taking their cue from their Romantic forebears, are relentlessly Dionysian, that pole of the arts which privileges individual expression over societal norms. Some practitioners of the arts are, however, more Apollonian, producing "cooler" art forms. An example is the choreographic work of George Balanchine.

FLEMING, Bruce E., Associate Professor, "In Praise of Interesting,'" *Dance View* 14 (Fall 1996), pp. 30-31.

An essay considering some of the possible reactions audience members may have to dance performances, and specifically a defense of the otherwise luke-warm reaction of saying that a performance has been "interesting." This contrasts to saying on one hand that it has been wonderful, or the work a masterpiece, and on the other that the performance has been abysmal and the work dreadful. Interesting is somewhere in the middle, and usually denotes qualified approval. The essay defends this middle ground by taking as its example two recent dance pieces, Mark Dendy's "Symmetries" and Val Caniparoli's "Lambarena," performed by the San Francisco Ballet.

FLEMING, Bruce E., Associate Professor, "Text and Transmission," *Dance View* 14 (Winter 1996-Spring 1997), pp. 7-11.

The transmission of dance works is fundamentally different from that of other works of art. The text in painting is the single object hanging on the wall before us; the text in literature is a play or novel that is not identical with any of its printed instantiations. Some works come to be only in performance, such as music. Nonetheless in the case of each art form save dance we are able to speak of "the" text, "the" work. This is not

the case in dance.

Until recent decades, dance works have been passed on without the intermediary of any text at all, by dances or choreographers teaching other dancers. The result has been a great degree of latitude in fidelity, and moreover a lack of any concept of fidelity, as there is no original text to be closer or further away from. The essay gives examples of the many variations all permitted under the name of familiar ballets, such as "Swan Lake" or "The Nutcracker."

In recent decades, notation systems have been developed; the most prevalent of these is video. The essay explains why video is simply an interpretation of the dance work rather than a text in the literary sense, and points out some of its disadvantages. Finally a correlation is made between the kind of Modernist works developed in the twentieth century and our increasing interest in the concept of fidelity to a choreographer's vision, and an increasing sense of the textlessness of dance.

FLEMING, Bruce E., "Youth, Age, and Tom Cruise," *Dance View* 14 (Winter 1996-Spring 1997), pp. 62-63.

A consideration of some aspects of dance and movie performances usually neglected in criticism: the fact that dancers and movie stars are young. The essay uses as its example the well-received "Harlem Nutcracker" of Donald Byrd to explain how works privilege youth not only in the fact of dancers' biological ages, but thematically as well. Paralleled to this is the way movie stars such as Tom Cruise become icons: audience members are in fact caught up in an experience of collective looking. Knowledge that this face belongs to a movie star is part of the attraction. In a similar way, the worship of youth in the dance concert hall is a collective experience.

FLEMING, Bruce E., Associate Professor, "Black is Beautiful," *Village Voice* (10 December 1996), p. 99.

HILL, John M. Professor, "The Social Milieu in *Beowulf*." In Robert Bjork and John D. Niles, ed. *A Beowulf Handbook*, pp. 170-184.

The world dramatized in *Beowulf* is built out of four social axioms of exchange regarding feud or else cooperation: continuing gift exchange prevents feud and builds friendships; ending gift exchange and friendship invites a state of way; ongoing feuds must be prosecuted with a definitive settlement in mind; settling feuds violently is a given unless the acts of violence in fact countenance more than settlement. Within this matrix, gift giving, revenge, grand banqueting, martial service, legalistic obligation all have their socially functional, honorable places.

JASON, Philip K., Professor. *The Critical Response to Anais Nin.* Westport: Greenwood Press, 1996.

This is the first retrospective gathering of criticism about Anais Nin's work. Surveying a sixty-year period, the collection groups responses into four categories: Nin's short fiction, her novels, her diaries, and her public persona. Articles have been chosen and arranged to present arguments about Nin's artistic achievement, the psychoanalytic underpinnings of her art, the nature of her feminism, and the issue of candor in her diaries. Critics include Edmond Wilson, William Carlos Williams, Maxwell Geismar, Karl Shapiro, Patricia Meyer Spacks, Henry Miller, and Erica Jong. The volume also includes an introductory essay, a chronology, and an extensive bibliography of criticism.

JASON, Philip K., Professor, "The Burden of Self: Some Thoughts on *The Early Diary of Anais Nin, 1927-1931*," *Anais: An International Journal*, 15 (1997), pp. 71-6.

This diary volume indicates Nin's self-doubts about her abilities as a fiction writer at an early stage in her career. Wondering whether or not her habit of airy-writing has trapped her into egocentric patterns, Nin reveals fears about her limitations of sympathetic imagination. She even goes so far as to begin a double journal, the second version called the "Diary of Imagy" in which she records wishes and fancies as if they actually occurred. This attempt to free herself from immediate events and conscious concerns only complicated her narcissistic impulses. Nin's commitment to the diary enterprise sacrifices life itself: she must always find time for it. Moreover, people and events must be sought for their potential as diary material. Though the diary remained the most significant source of Nin's fiction, it eventually became the masterwork that overwhelmed the fiction.

JASON, Philip K., Professor, "The Men in Nin's (Characters') Lives," collected in *Anais Nin: Literary Perspectives*, edited by Suzanne Nalbantian. London: Macmillan, New York: St. martin's Press, 1997, pp. 143-54.

Nin's inability to draw credible, interesting, rounded male characters in her fiction is a serious limitation.

Because her self-declared subject is human relationships, her portraits remain out of balance because of this failure of both her narrators and female protagonists to see men clearly and fairly. Nin's tendency toward abstraction, in the case of these characters, becomes a tendency toward caricature. These male figures tend to fall into four categories: fathers, sons, homosexuals, and nonentities. There seem to be no equal partners, though portions of her "Jay" portrait (a character based on Henry Miller) come close to this desired dimension. Otto Rank's views expressed in his late essay "Feminine Psychology and Masculine Ideology" provide keys for understanding Nin's difficulty in delineating a partner for the "new woman" her art fabricates with such success.

JASON, Philip K., Professor. Untitled Memoir in *Recollections of Anais Nin*. Edited by Benjamin Franklin V. Athens: Ohio University Press, 1996.

This memoir describes the author's impressions of Anais Nin during the early 1970's. The occasion for their acquaintance was the author's interest in preparing a collection of Nin's work, the *Anais Nin Reader*, which was published in 1973. The recollection includes descriptions of several meetings, an appraisal of Nin's personality and conduct in her later years, and a sketch of the process of negotiating trust and specific decisions regarding the contents of the *Reader*.

JASON, Philip K., Professor. *Open Door: A Poet Lore Anthology 1980-1996*. Bethesda: Writer's Center Editions, 1997.

This co-edited collection draws upon seventeen volumes (four issues each) of *Poet Lore*, our nation's oldest continuously published poetry magazine. The book is presented as a significant representation of contemporary poetry, with special consideration given to narrative poetry and translation. The other editors are Roland Flint, Geraldine Connolly, and Barbara Goldberg, each of whom worked with Philip K. Jason for several years as editor of the magazine. The collection includes work by such major poets as Sharon Olds, Howard Nemerov, Linda Pastan, Paul Zimmer, William Matthews, Albert Goldbarth, Brendan Galvin, and the Israeli poets Yehuda Amichai and Moshe Dor. The book was recently distinguished as an "April Pick" in *Small Press Review*.

JOHNSTON, Eileen Tess, Associate Professor, **?**Beautiful things made new': Transformations of Keat's *Hyperion* in Tennyson's 'Morte d'Arthur' and 'The Passing of Arthur," *Tennyson Research Bulletin,* forthcoming in 1997.

In their epic fragments, Keats and Tennyson both address the passing of old, established divine and social orders and break off on the verge of new, unfamiliar ones. Tennyson's characters, especially King Arthur, often speak and act like Keats's, and Tennyson's language and imagery echo and mirror Keats's hauntingly. Tennyson's consistencies with as well as his departures from Keats illuminate continuities and changes between Keat's Romantic and Tennyson's Victorian tempers.

MACE, Nancy A., Associate Professor, "Haydn and the London Music-Sellers: Forster V. Longman & Broderip." *Music & Letters* 77 (1996), pp. 527-41.

Scholars have often questioned the attribution of two piano trios (Hob. XV:3-5) to Haydn, but they have had no concrete evidence to prove their suspicions. This article summarizes the facts revealed in two recently discovered suits in the Public Record Office, London. These two suits, complete with two depositions given by Haydn, confirm that Haydn did not write the trios and that they were, instead, composed by his former student Ignace Pleyel. Furthermore, the documents suggest that British music-sellers hid this fact to increase the sales of the trios.

MADISON, Robert D., Associate Professor, ed., John H. Rhodes's *The History of Battery B.* Baltimore: Butternut and Blue, 1997.

In 1894 Rhodes published his history of Battery B. Of the First Rhode Island Light Artillery during the Civil War. The present edition includes a new introduction covering the composition and publication of the work and extending the biographies of the principle personages of the battery. The present edition also includes extensive photographic material not included in the original.

WHITE, David A., Professor, "Why Read Literature?" *The Angelus* (October, 1996), pp. 5-8.

This article provides a brief overview of the purpose of art and literature in particular and examines the two major ideas consistently put forward as its purpose--to entertain and to instruct. The article then looks at the importance of the story and storytelling in specific

literary forms in an age of screens and images. Examples are provided from both sacred and classical sources, as well as suggestions for contemporary reading.

Presentations

ARBUTHNOT, Nancy P., Associate Professor, "Perspective in Painting and Poetry," Associated Writing Program Annual Conference, Washington, DC, 6 April 1997.

ARNOLD, Karen L., Visiting Assistant Professor, "The Seduction of Place: Madness in *Wide Sargasso Sea*" and "No Looking Back: Eleanor Pruitt Stewart's *Wyoming*" NEH Reading and Discussion Series Lectures, Miller Library, Ellicott City, Maryland.

ARNOLD, Karen L., Visiting Assistant Professor, "Negotiating Madness in Kate Chopin's *Awakening*," NEH Reading and Discussion Series Lectures, Kensington Library, Kensington, Maryland.

ARNOLD, Karen L., Visiting Assistant Professor, "*Snow Falling on Cedars*: The Past as Text and Trap," NEH Reading and Discussion Series Lectures, Germantown Library, Germantown, Maryland.

ARNOLD, Karen L., Visiting Assistant Professor, "Race, Reality, Conspiracy in *I am the Cheese* and *Roll of Thunder Hear My Cry*," NEH Reading and Discussion Series Lectures, Brentwood Library, Maryland.

ARNOLD, Karen L., Visiting Assistant Professor, "Lyricism and Despair in Tillie Olsen's *Yonnondio*," NEH Reading and Discussion Series Lectures, Kent Island Library, Stevensville, Maryland.

ARNOLD, Karen L., Visiting Assistant Professor, "Eudora Welty's Cinematic Eye" and "No Looking Back: Eleanor Pruitt Stewart's Wyoming," NEH Reading and Discussion Series Lectures, Towson Library, Towson, Maryland.

BARTON, Howard E. Jr., Lieutenant Colonel USA, "Writing Across the Curriculum--Bridging the Gaps," Conference of Federal Academies, West Point, NY, 28 September 1997.

BERGMANN, Harriet F., Professor, "Intergenerational Group Biography and Women's Education in 19th Century Boston and Cambridge," Women's Biography Section, American Studies Association Convention, Kansas City, KA, November 1996.

BOOTH, Allyson, Associate Professor, "He Do the Police in Different Voices': *Our Mutual Friend* and *the Waste Land*," Carolinas Symposium on British Studies, Myrtle Beach, South Carolina, 5 October 1996.

BRESLIN, Christopher R., Major USMC, "Sigrid Undset," Monthly Meeting of Society of Saint Maximos, Baltimore, Maryland, 18 April 1997.

CAMPBELL, James R., Lieutenant USN, "Seeking evidence of the hand of God in the world:' Transforming Destruction in *The Crossing*," Conference on Emerging Literature of the Southwest Culture, El Paso, Texas, 14 September 1996.

CHILDS, Matthew D., Lieutenant USN, "Lectures on T. S. Eliot, *Moby Dick* and Flannery O'Connor, Summer Book Camp, Winona, Minnesota.

FETROW, Fred M., Professor, "Demonizing the Devil: The postlapsarian World of Zora Neal Hurston's 'Sweat,'" American Women Writers of Color Conference, Ocean City, Maryland, 13 October 1996.

FETROW, Fred M., Professor, "Allusions to Art and the Art of Allusion in the Celebratory Poems of Michael Harper," Celebrating Harper: A Conference and Festival in Honor of Michael Harper, Bowdoin College, Brunswick, Maine, 26 October 1996.

GILLILAND, C. Herbert, Associate Professor, "Just Give Me the Facts: Influences on Individual Choices of Learning Strategy," Teaching and Learning in the Next Century: Conference for the Federal Service Academies, West Point, new York, 27 September 1996.

JASON, Philip K., Professor, "Nin's Fiction or Her Diaries: A Delicate Balance," Modern Language Association, Washington DC, 28 December 1996.

JASON, Philip K., Professor, "Blame It on the 'Nam

Detective Fiction," Popular Culture Association, San Antonio, Texas, 28 March 1997.

MADISON, Robert D., Associate Professor, "Black Walden: Thomas Wentworth Higginson's Civil War," NEMLA, Philadelphia, Pennsylvania, 5 April 1997.

MADISON, Robert D., "Westerly in the Rebellion," Westerly Public and Memorial Library, Westerly, Rhode Island, 30 May 1997.

NOLAN, Charles J., Jr., Professor, Chair of Panel, College English Association, Baltimore, Maryland, 3 April 1997.

NOLAN, Charles J., Jr., Professor, Chair of Panel, Northeast Modern Language Association, Philadelphia, Pennsylvania, 4 April 1997.

WHITE, David A., Professor, "Petrarch and the Poetry of the Self," Dietrich Von Hildebrand Institute, Lake Garda, Italy, 3 July 1996.

WHITE, David A., Professor, "Chaucer and the Idea of Pilgrimage," Dietrich von Hildebrand Institute, Lake Garda, Italy, 5 July 1996.

WHITE, David A., Professor, "A Survey of Medieval Dramatic Forms," Dietrich von Hildebrand Institute, Lake Garda, Italy, 6 July 1996.

DEPARTMENT OF HISTORY

Professor Robert Artigiani
Chair

Members of the USNA History faculty represent a wide range of disciplinary specialties, and their research and publications are gaining increasing attention in many fields and languages. Four members published books, reporting researches in Civil War history, East Asian history, and theories of cultural transformation. Fourteen articles were published, ranging over a whole gamut of American and European topics, as well as subjects in Middle Eastern History and philosophical implications of contemporary science. Faculty publications were in four languages and appeared in the United Kingdom, Denmark, Japan, Austria, Latin America, and Germany, along, of course, with the United States. Some of the most prestigious journals printed faculty research contributions, including The Catholic Historical Review, Ancient World, and Technology and Culture. University presses from Japan to SUNY and the University of Texas published our results, as did research establishments like the Konrad Lorenz Institut in Austria. Twenty-one presentations were made to scholarly audiences, as well. Nineteen different research projects are currently being advanced, with outcomes expected in the forms of presentations and articles, monographs, and interpretive syntheses.

Midshipmen were also very actively engaged in research projects. Honors students pioneered using new models borrowed from contemporary science to interpret historical phenomena, reconstructed accurate pictures of the underground railroad, performed detailed studies of major diplomatic events from different perspectives, a significant Cold War failure, and a major Civil War battle. Other midshipmen studied immigration in Peru and Brazil, Civil War leadership, and Winston Churchill's negotiating style. Midshipman 2/C Gregory Malandrino wrote a paper which won a prize from the League of World War I Aviation Historians, while Midshipman 1/C Eric Reid's Honors thesis is a finalist in the Barksdale Prize competition for the best American undergraduate research project. All of these projects contribute to regularly taught courses. Although research accomplishments are in themselves valuable, the degree to which faculty are engaging midshipmen in research projects of mutual interest and integrating their results in classroom activities is especially gratifying.

Sponsored Research

Sheriffs, Lord-seeking, and the Norman Settlement of the South-east Midlands

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

Between 1066 and 1086 approximately ninety per cent of the landed wealth of England, excluding that which belonged to the Church, changed hands as a result of the Norman Conquest. The project identified and analyzed the mechanisms whereby control over lands in Bedfordshire, Buckinghamshire, Cambridgeshire, Hertfordshire and Middlesex passed from native landholders to Norman newcomers. It focused in particular on two aspects of this process: 1) the role played by William the Conqueror's sheriffs, and 2) how customs of Anglo-Saxon lord-seeking facilitated and helped shape the Norman settlement of the south-

east midlands. It was found that William's sheriffs in these counties were well positioned and dispositioned to profit from the powers of their office and the turmoil of the times. They did not transform the office of sheriff. Indeed, they performed the same duties as had their English predecessors, but in a radically different social and legal climate. The sheriffs built their holdings and aided their friends in acquiring their estates using mechanisms and powers of their office that had been exercised by their Anglo-Saxon predecessors. They were particularly successful in snatching the lands of sokemen and lesser thegns. In short, by using the procedures and forms of Anglo-Saxon law and custom to pursue aggressively the lands and authority over men they claimed by right of their English antecessors, the Normans erected a new tenurial world upon the foundations of the old.

The Spiritual Value of Sight According to Abbot Peter the Venerable

Researcher: Assistant Professor David F. Appleby
Sponsor: Naval Academy Research Council (OMN)

I studied the writings of Abbot Peter the Venerable (1122-1156) focusing on the abbot's understanding of the role of the senses in the spiritual progress of the Christian believer. Although his outlook reflected the western ascetic tradition in which purification and ascent often seem to entail a cautious, even diffident, approach to the senses and the body, his discussion of the Eucharist reveals a markedly different attitude. What he wrote about the communicant's response to the sight, touch and taste of the bread and wine of the sacrament shows that the Abbot was swept up in one of the most important Accordin cultural developments of the twelfth century, namely a fundamental reassessment of the status of the physical and sensory aspects of the human person. His willingness to incorporate sensory perception into his understanding of Man's return to God shows that the accepted picture of Peter as little more than a Benedictine conservative requires serious qualification. The editors of Mediaeval Studies are now considering an article titled "The Priority of Sight According to Peter the Venerable" for publication.

Roman Records and the Comparative Study of Literacy

Researcher: Professor Phyllis Culham
Sponsor: Naval Academy Research Council (OMN)

This multi-year project had previously resulted in a number of publications and has now entered a new phase as the investigator knits her case studies into a chronological (albeit non-narrative) study of the development of literacy and documentation in the Roman Republic. In this project she uses the Roman evidence to answer questions generated by scholars studying literacy within various disciplines but also examines the Roman data by using different models derived from the modern social sciences and literary criticism. The project thereby tests the models of literacy themselves by examining how well they account for the Roman data.

The Military and Society in Modern Peru

Researcher: Professor Daniel M. Masterson
Sponsor: Naval Academy Research Council (OMN)

This sponsored research project is a revised and updated manuscript of my previously published study of Peruvian civil-military relations entitled, *Militarism and Politics in Latin America: Peru from Sanchez Cerro to Sendero Luminoso.* This analysis goes beyond the original study, which was published by Greenwood Press in 1991, to include a discussion of the regime of President, Alberto Fujimori in Peru from

1990 to the present. It is based on research conducted in Lima, Peru and the United States during the past five years. Particular attention is devoted to the counter-terrorism campaign against Sendero Luminoso, President Fujimori's relationship with the armed forces, an analysis of the improving economy, and an overview of the recent border conflict with Peru's northern neighbor, Ecuador. The revised and updated manuscript has been submitted for publication to Scholarly Resources publishers of Wilmington, Delaware.

A People Go to War: The Urban Home Front in the Confederacy

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

This is a work-in progress that investigates the impact of secession, mobilization, invasion and occupation upon four selected Southern cities: Atlanta, Richmond, Charleston, and New Orleans. Each city had a different experience during the war and for that reason, provide an excellent window into an area frequently neglected by historians. Indeed, the Southern cities began the war as purely symbolic targets, but the exigencies of war forged them into actual strategic centers in the military sense of the term. By 1865, war had created modern urban-industrial centers in the South.

Gender, Property, and Voting Rights in Colonial Virginia

Researchers: Assistant Professor John G. Kolp and Terri L. Snyder (The Huntington Library)
Sponsor: Naval Academy Research Council (OMN)

Historians have long recognized that despite the absence of legal privilege, women were central to political life in colonial America including helping candidate husbands treat and entertain voters, receiving attention from candidates during campaigns, and advising their husbands on which way to vote. Yet their role as owners and conveyors of property could have had an even greater impact on local politics. Because only adult males who owned 100 acres of unimproved or 25 acres of improved land could vote in eighteenth-century Virginia, the property men received from mothers, sisters, and especially wives could have been crucial in male enfranchisement. The extent to which women's property contributed to the enfranchisement of men has never been fully explored.

This project sought to explore this question and to complete the research and writing of a conference paper on women's property and men's voting rights accepted for delivery in Fall 1996. During summer 1996, material collected on female property transfer by project co-author, Terri Snyder, was merged with a large data base on voter participation and behavior collected as part of several earlier projects. In addition to exploring the many ways women, as political outsiders, contributed to the political culture of local communities, the quantitative analysis demonstrated that nearly one-fifth of the male electorate owed some if not all of their political rights to women. Project completed; manuscript submitted 1 September 1996 and reproduced in a pre-conference proceedings. The paper entitled "Gender, Property and Voting Rights in Eighteenth-Century Virginia" (see under Presentations), was presented to the conference on The Many Legalities of Early America, 23 November 1996, in Williamsburg, VA. The paper will undergo modest revisions during summer 1997 and will probably appear as a chapter in a book on early American legal history to be published in 1999 by the Institute of Early American History and Culture, Williamsburg, VA.

The Battleship Paradigm and the American Naval Profession, 1890—1943

Researcher: Assistant Professor William M. McBride
Sponsor: Naval Academy Research Council (OMN)

This long-term research project examines the naval profession's technologically-based strategic paradigm based on the battleship between 1890—1943. This project seeks to assess the rise and duration of socio-technical strategic .models within the U.S. Navy prior to World War II and will eventually extend to the period after 1945. Research this year focused on the period from 1934-1943.

Nadir Shah And The Rise of Modern Persian Historiography, Part II

Researcher**:** Associate Professor Ernest Tucker
Sponsor**:** Naval Academy Research Council (OMN)

The project is a continuation of my project on the historiography of Nadir Shah, an important 18th century ruler in Iran and Central Asia. Four years ago, I began analyzing an important 18th-century Iranian royal chronicler, Muhammad Kazim Marvi, which research resulted in the publication of a journal article. In the summer of 1994, I turned my attention to Mirza Mahdi Khan Astarabadi, another important historian of the time. An analysis of the work of Mahdi Khan is a key to understanding this transition period of Iranian historiography, and my research in summer 1995 focused on a detailed re-reading of his works.

In the summer of 1996, I was able to complete research on the main chronicles of Nadir Shah, and to fill in the bibliographical picture through extensive research on Russian, Persian, and eighteenth-century European sources at the Library of Congress. In the fall of 1996, I was on sabbatical, which enabled me to begin writing the monograph manuscript, slated for completion in spring, 1998.

Pandora's Keepers: The Atomic Scientists and Their Creations

Researcher: Assistant Professor Brian VanDeMark
Sponsor: Times Books/Random House, Naval Academy Research Council

The objective of this multi-year research project will be to produce a comprehensive, balanced, full-length collective biography of the top Manhattan Project scientists (e.g. Oppenheimer, Teller, Fermi, etc.). It will be a work primarily of history rather than of science. It will emphasize the human story rather than the better known and more often told science story, and will explore such questions as: What made these scientists tick? How they did they relate to one another? How did they react to and come to understand what they created? And what do their experiences have to teach us today and in the future?

Zeng Guofan (1811-1872) and the Last Scholar-General of Late Imperial China

Researcher: Assistant Professor Maochun Yu
Sponsor: Naval Academy Research Council (OMN)

This is the second phase of research done on this topic, which the research is planning to turn into a manuscript. Zeng Guofan was the first ethnic Chinese scholar who was ever granted by the Manchu rulers of Qing Dynasty to organize and command a standard army, which ultimately crushed the Taiping Rebellion (1850-1864); his military strategy and intellectual impact has had resounding echoes in the 20th century China.

In the summer of 1996 the researcher embarked upon the task of reading the voluminous files of the Zeng Guofan collection at the China Division of the Library of Congress in Washington, DC. Particularly valuable were his diaries and family letters. The

complex make-up of Zeng's inner world was particularly fascinating. The time originally allotted for this research was unexpectedly extended due to the poor quality of the faded diaries and letters, most of them were written in Chinese brush pen in a wild running style (caoshu, a type of Chinese calligraphic characters executed swiftly and with cursive strokes flowing together like a messy bowl of spaghetti). However, by the end of the summer approximately 70 percent of the archival research in Washington, DC should be finished.

Independent Research

Moral Communities: A Social and Cultural History of Early Modern Europe

Researcher: Professor Thomas E. Brennan

Most people's lives were profoundly shaped by their communities. The village, town, province, neighborhood, parish, guild, market, and church gave a range of identities and roles to their members. Communities provided protection, partnership, identity, and participation. They controlled their members through fiscal liability, legal restraint, and moral obligation. Yet it is important to recognize that communities were fundamentally artificial and culturally constructed. To the realities of physical, or professional proximity were added layers of legal, economic, and cultural significance, often imposed by outside forces. Community is, therefore, an ambiguous concept, with multiple and shifting significance. Nevertheless, communities enjoyed a moral status that gave them broad power over the lives of their members, and much of recent social and cultural history--whether of the family, economy, religion, witchcraft, popular culture, or political culture--is the study of individuals in their communities.

This study examines the nature and function of European communities from the various perspectives that have been contributed by the "new" cultural, as well as the now quite established social history. It draws on Western European examples to arrive at a synthetic analysis of communal dynamics, beginning with the physical and legal existence of communities of various types, and following with different manifestations of community dynamics and values. It surveys the conditions of material life, the hierarchical and sexual dynamics of social life, the organization of economic life, and the symbolism of political life. The analysis remains conscious throughout of the gendered nature of communities, noting the ways in which public and private spheres are distinguished and in which the opportunities for male and female participation are delineated.

The Japanese in Latin America, 1897 to the Present

Researcher: Professor Daniel M. Masterson

This project, being coauthored with Ms Sayaka Funada of the University of Tokyo, is an analytical survey of the first century of Japanese immigration and settlement in Latin America. Presently under contract with Westview Press, this study is based upon field research in Argentina, Brazil, Chile, Mexico, Paraguay, Peru, Japan and the United States. It offers a comparative analysis of Japanese immigration patterns in North America as well as the major receiver nations in Latin America. When completed in January 1998, this book will be the only comparative analysis of Japanese immigration in Latin America through the 1990's to appear in any language. Previous studies are limited to one country and tend to be highly specialized. This analysis draws upon immigration records in Japan and the Latin America nations, Japanese language newspapers, the diplomatic records of Mexico, Peru and the United States, and a wide range of interviews with the Japanese immigrants themselves.

Discovering the Signs: Social Images of the Deaf

Community in Nineteenth Century France

Researcher: Professor Anne T. Quartararo

This research project is a synthetic study of the social and cultural forces that created the Deaf community in nineteenth century France. 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 perspective. The researcher is studying the concept of social deviance in terms of charity and public assistance. In the second part of the project, the researcher is studying the emergence of Deaf community associations, initiatives for Deaf education and the role of leading activists to improve the condition of Deaf people. In the third part of the study, the researcher is looking at the uses of language and the exclusion of sign language from schools that educated the Deaf in the late nineteenth century. In addition, the role of Deaf-run congresses, Deaf associations and newspapers will be analyzed to understand the emergence of Deaf culture. The researcher has had another publication in a compilation of work on world-wide deaf communities published in December 1996. In addition, the researcher has had a paper accepted for presentation at the Association for the Study of Modern and Contemporary France in Great Britain for September 1997 .

Davis and Johnston at War

Researcher: Professor Craig L. Symonds

This is one of eight articles to be included in a volume entitled Jefferson Davis and His Generals published by Oxford University Press under the general editorship of Gabor Boritt of Gettysburg College. The article argues that the poor working relationship between Confederate President Jefferson Davis and his principal field general in the western theater, Joseph E. Johnston, was a major factor in Confederate defeat. Davis was nearly obsessive in his need to be kept fully informed of army decisions and movements, but Johnston reported only infrequently and became associated with Davis's political foes thus undermining his credibility and effectiveness.

This essay will be presented as a paper at a conference in Gettysburg on 30 June, and published along with essays by David Herbert Donald, James McPherson, Emory Thomas, Steven Woodworth, and others.

No Margin for Error: Davis, Johnston, Wigfall and Confederate Defeat

Researcher: Professor Craig L. Symonds

This article focuses on the question of the causes of Confederate defeat. It surveys the traditional explanations, especially the notion that the South was merely overwhelmed by sheer numbers, and concludes that the lack of political unity was a major factor. In particular it details the political liaisons and unofficial influence groups that affected not only the relationship between the president and his generals, but the politics of the Confederacy as a whole.

It is scheduled for inclusion in an anthology entitled The Art of Command edited by Steven Woodworth, and scheduled for publication in the Spring of 1998 by the University of Nebraska Press.

The Atlanta Campaign Revisited

Researcher: Professor Craig L. Symonds

This article addresses the historiographical issues that have swirled around the campaign for Atlanta in the Spring and Summer of 1864. In particular, it re-visits the whole question of the strategies employed by the Federal commander, William T. Sherman, and his Confederate opponents, Joseph E. Johnston and John Bell Hood. Its principal argument is that Johnston's space-for-time strategy was not seized upon by him until the campaign was well underway.

The article is scheduled for inclusion in an anthology on the Atlanta Campaign edited by Keith Bohannon which will be published later in 1997.

U.S. Navy

Researcher: Professor Craig L. Symonds

This is a 1500-word entry for the Encyclopedia of the Mexican-American War to be published by Simon and Schuster in 1997. It chronicles the role of U.S. Naval forces in the war with Mexico 1846-48, and focuses particularly on the amphibious landing at Vera Cruz that launched Winfield Scott's campaign to Mexico City.

The Civil War Recollections of Major Ellis Spear of the 20th Maine"

Researcher: Professor Craig L. Symonds

Major Ellis Spear was the second in command of the famous 20th Maine regiment commanded by Joshua Lawrence Chamberlain. Though this regiment gained tremendous fame both at the time and especially since the publication of recent books on the exploits of the regiment at Gettysburg, Spear's memoirs have never been published. This project will publish both his memoir (written in the 1890's) and the diary on which it is based. The researcher's role in this project was to organize the material for publication and add approximately 200 footnotes.

Confederate Admiral: The Life of Franklin Buchanan, USN, CSN

Researcher: Professor Craig L. Symonds

Franklin Buchanan was the first superintendent of the U.S. Naval Academy. In addition, he served as second in command of Matthew Perry's expedition of Japan in 1853-54. Perhaps his greatest notoriety, however, was his service in the Confederate Navy where he was the senior admiral and commanded both the Virginia (Merrimack) and the Tennessee (at Mobile Bay). This project is a full-length (100,000 word) biography of his life which will explore his accomplishments as a naval officer, but also his motives as a reformer in the 1840s, his resignation for the Navy in 1861, and his service as Confederate admiral. The Naval Institute Press has contracted to publish the book in 1999.

The Origins of the Elihu Root Staff Reforms

Researcher: Associate Professor William R. Roberts

From 1901–1903 Secretary of War Elihu Root introduced three important staff reforms in the United States Army. The first—the creation of a staff detail system—has gone largely unnoticed by historians. The other two reforms—the creation of the Army War College and the creation of the General Staff—have attracted more attention, but have yet to be treated as integrally related parts of a larger whole. This research project will not only correct that oversight, but also inquire into the reasons for reorganizing military administration in the early twentieth century.

To these ends, it has been necessary to make a careful examination of the nineteenth-century administrative system in the army and how it operated. This examination has revealed that long before the Civil War, a vigorous debate over the structure and duties of the central staff system took place in the United States Army. This debate lasted for the remainder of the century and culminated in the Root reforms. Careful study of the principal arguments in this longstanding, internal debate over the central staff has begun to reveal how some of them eventually proved even more important than the German General Staff in shaping crucial aspects of the Root reforms.

Research Course Projects

International Immigration Agreements and the Japanese of Peru and Brazil, 1899-1938

Researcher: Midshipman 1/C Thomas Shea,USN
Adviser: Professor Daniel M. Masterson

Using Department of State records extensively, Midshipman Shea explored the consequences of the 1908 Gentlemen's Agreement and the 1924 Immigration Act which curtailed Japanese Immigration to the United States. The restriction of Japanese immigration to the United States, brought pressure to bear upon the leading industrial nations of the world to address immigration quotas after World War I. It also shifted the focus of Japanese immigration in the Western Hemisphere from North America to the South American nations of Peru and Brazil in particular.

Japanese Immigration patterns in Brazil and Peru continued to be influenced by United States policy toward Japan until Pearl Harbor. This study examines the evolution of this process among the Japanese of Peru and Brazil.

Tennessee During the Civil War and The Leadership of General Nathan Bedford Forrest

Researcher: Midshipman: 1/C Marcel MacGilvray, USN
Adviser: Professor Mary A. DeCredico

These two independent study courses examined Civil War era Tennessee, a state deeply divided over secession and war and the general leadership of one of Tennessee's most famous sons, Nathan Bedford Forrest. Based on archival material collected in Nashville and Memphis, Midshipman MacGilvray explored the divisive military engagement of Fort Pillow (April, 1864) and how issues of command and race factored into the battle and later historical accounts.

Churchill as Negotiator: An Assessment at the Quebec Conference of 1943

Researcher: Midshipman 1/C Christopher Rogers, USN
Adviser: Associate Professor N. W. Ellenberger

This History Honors thesis charted the objectives and negotiating strategies of British war leader Winston S. Churchill at the First Quebec Conference (QUADRANT) held in August 1943. This Anglo-American meeting was the first at which the cross-channel invasions by allied forces was an agreed policy, and the last at which Soviet leader Josef Stalin would be absent from allied consultations. A careful reconstruction of Churchill's daily thoughts and actions leads to the conclusion that the prime minister had clear priorities, a realistic understanding of the strengths and weaknesses of Britain's negotiating position, and achieved remarkable success in securing specific concessions from the Americans.

The Underground Railroad and the Lewis Family: A Study in Motives

Researcher: Midshipman 1/C Sam Zager, USN

Adviser: Professor Mary A. DeCredico

This senior History Honors thesis studied one family's involvement in the Underground Railroad during the 1840s and 1850s. The Lewis family of Chester County, Pennsylvania, actively aided fugitive slaves in escaping to Canada. The project, based almost entirely on the family papers located in the Swarthmore College Library, detailed how women transcended their traditional domestic roles in order to aid the abolition and anti-slavery movements.

Publications

ABELS, Richard, Professor, "English logistics and military administration, 871-1066: The Impact of the viking wars." In Anne Nørgård Jørgensen and Birthe L. Clausen, eds. *Military Aspects of Scandinavian Society in a European Perspective AD 1-1300*. Publications from The National Museum Studies in Archaeology and History, Vol. 2. Copenhagen, 1997, pp. 256-65.

ABELS, Richard, Professor, "Bookland and Fyrd Service in Late Saxon England," in Stephen Morillo, ed., *The Battle of Hastings: Sources and Interpretations*. Woodbridge, Suffolk: Boydell and Brewer, 1996.

Professor Morillo requested a revision and up-dating of an article on the nature of Anglo-Saxon military obligation on the eve of the Norman Conquest that had been originally published in *Anglo-Norman Studies* 7 (1985). The revisions and up-dating added about four (dense) pages relating to the study of the composition of King Harold's forces at the Battle of Hastings.

ABELS, Richard, Professor. Review of N. J. Higham. *An English Empire: Bede and the Early Anglo-Saxon Kings*. In *Albion* 28 (winter 1996), pp. 658-660.

What is often obscured by King Harold's defeat at Hastings is that he possessed a sophisticated and effective military administrative system. The elaborate logistical arrangements hinted at in the folios of Domesday Book had their origin in military and administrative developments that stretched back two centuries. That Alfred and his successors developed governmental machinery for the provisioning of troops reflects a key fact of Anglo-Saxon military history: that, with the exception of the misnamed 'Reconquest' of the Danelaw, Anglo-Saxon kings from Alfred to Harold Godwineson fought defensive wars upon their own soil. They did not have the luxury of following Vegetius's advice to live off of the enemy's territory. Rather, they had to create administrative mechanisms that would allow them to expropriate the wealth and agricultural surplus their subjects for the defense of the kingdom. The nature of the viking threat was such that English success depended upon the ability of its central government to maintain naval and land forces over extended periods of time. The mobility of the enemy dictated the development of a network of fortified towns and the maintenance of an impressive bridge and road system for military transport. The result was the emergence of a military administration that, arguable, was as sophisticated as its more celebrated civil counterpart.

APPLEBY, David F., Associate Professor, "Spiritual Progress in Carolingian Saxony: A Case from Ninth-Century Corvey," The Catholic Historical Review 82 (October 1996), pp. 599-613.

This article addresses one aspect of the aftermath of the military conquest and forced conversion to Christianity of the pagan Saxons during the late eighth and ninth centuries. Although it has become customary to emphasize the simplification and syncretic character of the Christianity of the ninth-century Saxons, it can be shown that by mid-century at least some Saxons were conscious of their own spiritual progress in the new faith. The argument is that the Translatio sanctae Pusinnae (written sometime between 862 and 875) presents a retrospective image of recent Saxon history which takes on meaning when understood against the background formed by the events described in Einhard's Vita Karoli (written between 817 and825\26) and by the Translatio sancti Viti (written soon after 836). The author of the Translatio sanctae Pusinnae affirmed the nobility of the Saxon people and asserted that the Saxon monks of Corvey and nuns at nearby Herford had now attained the spiritual maturity necessary to accept Paul's "solid food."

ARTIGIANI, P.R., Professor, and others, Changing

Visions New York: Praeger, 1996. (Also published in U.K.)

A transdisciplinary study of the origins, roles, and evolution of mental representations or "cognitive maps" involving biology, psychology and history is provided.

ARTIGIANI, P.R., Professor, "Societal Computation and the Emergence of Mind," Evolution and Cognition, 2 (1996), pp. 2-15.

Concepts from information theory are applied to the mind-body problem, suggesting that a process tracking the relationship between social complexity and self-consciousness is reasonable.

ARTIGIANI, P.R., Professor, "Send Me Your Refuse: The U.S. Constitution as Trash Collector", The American Journal of Semiotics, 11(1996) pp. 249-76.

The role of the Constitution is shown to facilitate the evolution of American society by providing the process by which previously excluded or marginalized people are assimilated and social complexity thereby increased. By providing rules for the making of rules, the Constitution enables "noise"--which in one anthropological tradition is called "trash"--to become "information" or functionally effective participants in American society.

ARTIGIANI, P.R., Professor,(in Japanese) "View From The Part", Review of Contemporary Thought 24 (1996) pp. 190-197.

Values, ethics and morals (VEMs) are shown to be shared symbols permitting individual members of human societies to acquire a system-level perspective.

ARTIGIANI, P.R., Professor, ""Contemporary Science and the Search for Symmetry in Nature and Society," Symmetry: Culture and Society 7 (1996) pp. 231-46

Patterned processes in societal self-organization are derived from recent scientific theories, and their potential for regrounding contemporary consciousness in nature is examined.

CULHAM, Phyllis, Professor, "Fraud, Fakery, and Forgery: The Limits of Roman Information Technology," *Ancient World*, Vol 27, no. 2 (1996), pp. 172-83.
Roman inscriptions in stone and bronze are deceptively solid texts. Modern scholars have assumed for more than a century that whatever they read in such permanent media must be trustworthy. Yet there is extensive evidence that the texts so engraved were condensed, excerpted, modified (even in date), and generally treated in a cavalier fashion. Such casual handling provided permitted Roman leaders of the last generation of the Roman Republic to generate alleged "public documents" almost at will. This article identifies a few of these ancient "frauds" and suggests that there must be many more.

CULHAM, Phyllis, Professor, "Gender and Negotiating Discourse: Mediated Autobiography and Female Mystics of Medieval Italy," *Sex and Gender in Medieval and Renaissance Texts*, Barbara K. Gold, Paul Allen Miller, and Charles Platter, eds., New York: State University of New York Press, 1997, pp. 71-89.

Margherita of Faenza, Margherita of Cortona, Umilta of Faenza, and, most influentially, Angela of Foligno, "negotiated" their biographies by narrating their lives and analyzing their spiritual understanding orally to men who then wrote down the accounts which survive. They then participated to different degrees and in different ways in shaping the written versions of their remarks. This study examines psychological, deconstructionist, and historicist approaches to the texts which survive and concludes that an archaeological method modeled on Foucault offers the most thorough understanding of these women's goals and methods.

DECREDICO, Mary A., Professor, *Mary Boykin Chesnut: A Confederate Woman's Life* (Madison, WI: Madison House Publishers, 1996).

This biography explores one of the South's most famous diarists: Mary Boykin Chesnut. Born into one of the wealthiest families in South Carolina, and wed into another, Chesnut traveled among the elite circles in Charleston, Camden, and Washington, D.C. Her husband's position as U.S. Senator and later, military aide to Jefferson Davis, allowed Chesnut to observe some of the key events of the Civil War period. Chesnut's life and her observations provide an unparalleled view of the Southern elite and the war that destroyed that elite.

MCBRIDE, William M., Assistant Professor, "The Unstable Dynamics of a Strategic Technology: Disarmament, Unemployment and the Interwar Battleship", ***Technology and Culture*** 38 (1997), pp. 386-423.

This article examines the various dynamic forces which affected the U.S. Navy's battleship-based strategy during the inter-war period (1921-1941). Within a Kuhnian paradigmatic framework and using Fleckian intellectual models, the author examined the dominance of the battleship as the nation, and the navy's, strategic technology during the New Era and New Deal. This paper compares the strategic world view, domestic, economic and military policies of the Republican administrations, especially Herbert Hoover's, with that of archnavalist and battleship aficionado Franklin Roosevelt. The author brings to light the historically marginalized use of New Deal public works, beginning with the National Industrial Recovery Act of 1933, to shore up the battleship technological hierarchy within the navy. This article also discusses the unexpected international effects of Roosevelt's use of economic recovery funds for naval construction: Japan's withdrawal from international naval limitation treaties and a hardening position vis-a-vis the United States's role in East Asia.

QUARTARARO, Anne T., Professor, "Celebrating Abbé de l'Epée's Birthday: Investigating Cultural Ritual in the French Deaf Community in the Early Twentieth Century," in Collage: Works on International Deaf History, ed. Renate Fischer and Tomas Vollhaber. Hamburg: Signum Press, 1996, pp. 233-241.

The purpose of this article was to analyze the response of the French Deaf community in the context of the birthday celebrations that it constructed in remembrance of the the Abbé de l'Epée. In 1912, the community recognized the bicentennial of the priest's birth by organizing a special gathering of the Deaf from Europe and the United States. This particular celebration was a way for the French Deaf to define their social and cultural place inside of the larger French society. This article discusses the early birthday celebrations for Epée, the epic image created of this educator of the Deaf, the particular meaning of the bicentennial celebration itself.

SYMONDS, Craig L., Professor, Stonewall of the West: Patrick Cleburne and the Civil War. Lawrence, Kansas: University Press of Kansas, 1997.

This is a full-length biography of a Confederate major general commonly reputed to have been the most effective division commander in the southern armies. A native of Ireland, Cleburne immigrated to America in 1850 and settled in Helena, Arkansas, where he became first an apothecary and then a lawyer. Though never a slaveholder, he identified with the slaveholding class in Helena and became the political associate of fire-eater Thomas Hindman. When the Civil broke out in 1861, he formed a company of volunteers and was elected its captain. Rising quickly to the rank of major general, he fought in most of the important western campaigns from Shiloh to Atlanta. Cleburne is best remembered for his proposal that the Confederacy free its black slaves, arm and train them, and put them in the army. His proposal created a firestorm of protest among Confederate officers and within the Confederate government, and may well have contributed to his failure to be promoted to lieutenant general and corps command. His life thus casts important light not only the military history of the Civil War, especially in the western theater, but also on the causes and meaning of the war itself. Published in April 1997, this book is the Main selection of the History Book Club for May.

TUCKER, Ernest S., Associate Professor, "The Peace Negotiations of 1736: A Conceptual Turning Point in Ottoman-Iranian
Relations," *Turkish Studies Association Bulletin* 20: 1 (1996), pp. 16-37.

Article growing out of an earlier NARC research project which explains how the Ottoman-Iranian peace negotiations of 1736 mark the beginning of the creation of a *de jure* system of nation-state recognition in the early modern Middle East.

VANDEMARK, Brian, Assistant Professor, "A Way of Thinking: The Kennedy Administration's Initial Assumptions about Vietnam and Their Consequences," in Lloyd C. Gardner, ed., *Vietnam: The Early Decisions* (Austin: University of Texas Press, 1997).

An analysis and interpretation of the Kennedy Administration's approach to Vietnam, which examines the intellectual mindset and geopolitical assumptions that governed President Kennedy's and his advisers' approach to Indochina during the years 1961-1963, and explores the consequences which flowed from their decision making.

Yu, Maochun, Assistant Professor, *OSS In China and Prelude to Cold War*, (new Haven and London: Yale University Press, : 1 March 1997)

This book deals with World War II in Asia. It became possible to write due to the unprecedented opening of the OSS archives in Washington, DC and the gradual availability of Chinese wartime intelligence materials.

The focus of the book was to illustrAte the symbiotic relationships between intelligence field operations and strategic policy in a war theater that was both confusing and challenging. The book portrays the complicated intelligence warfare among the Americans, the British, the Chinese Nationalists, and the Chinese and Soviet Communists. It also tells the experience and consequences of intense inter-service rivalry and OSS's tenacious struggle for command independence.

Presentations

ABELS, Richard, Professor, "Sheriffs, lord-seeking and the Norman settlement of the south-east midlands." Twentieth Annual Battle Conference. Battle, Sussex, England. 27 July 1996.

ABELS, Richard, Professor. "Royal Succession and the Growth of Political Stability in Ninth-Century Wessex." American Historical Association, New York, NY. 5 Jan. 1997.

ARTIGIANI, P.R., Professor, "The Science of Complexity and the Meaning of History" Social Science History Association, New Orleans La., 12 October 1996.

ARTIGIANI, P.R., Professor, "Evolutionary Systems And the Concept of 'Mind'" George Washington University, 16 April 1997

ARTIGIANI, P.R., Professor, "Leadership and Uncertainty: The Science of Complexity and the Lessons of History", SecNav Conference on the Future of the Navy, 26 April 1997, Navy Memorial, Washington D.C.

CULHAM, Phyllis, Professor, "Complexity on the Romano-British Frontier," Annual Meeting of the Social Science History Association, New Orleans, Louisiana, 16 Oct., 1996.

CULHAM, Phyllis, Professor, "Power or Paranoia?: Roman Expansionism in the Republic and Empire," Spring Colloquium, New York Classical Club, New York, New York, 9 May, 1997.

MASTERSON, Daniel M., Professor, "Little Time Left to Negotiate: The Peru-Ecuador Border Conflict in Historical Perspective," Second Inter-American Affairs Conference, University of North Florida, Jacksonville, Florida, October 1996

MASTERSON, Daniel M., Professor, "Terrorism and Counter-Terrorism in Peru: The Fuijimori Administration and the Campaign Against Sendero Luminoso, 18th Annual MACLAS conference, United States Naval Academy, Annapolis, Md., April 1997.

KOLP, John G., Assistant Professor and Terri Snyder (Huntington Library), "Gender, Property, and Voting Rights in Colonial Virginia," Conference on The Many Legalities of Early America; sponsored by the Institute of Early American History and Culture and the Institute of Bill of Rights Law; Williamsburg, Va., 23 November 1996.

KOLP, John G., Assistant Professor, "From Across the Seas: European Immigrants," part of a public lecture series, The First of Three Centuries of Prince George's County, sponsored by the Maryland Humanities Council and Prince George's Community College; Fort Washington, MD, 6 November 1996.

KOLP, John G., Assistant Professor, "Voting and Elections in Colonial Virginia and Maryland," dinner talk given before the Society of Colonial Wars of the State of Maryland, Baltimore, MD, 25 March 1997.

SYMONDS, Craig L., Professor, "'A Plan Which We Believe Will Save Our Country': Patrick Cleburne's Proposal to Free the Slaves." Mississippi Valley Civil War Symposium, St. Louis, Missouri, 28 September 1996.

SYMONDS, Craig L., Professor, "The Battle of Midway." Lecture sponsored by Phi Alpha Theta in conjunction with the dedication of the Midway monument, 30 September 1996.

SYMONDS, Craig L., Professor, "War and Politics: Jefferson Davis, Joseph E. Johnston and the Defense of Richmond." Conference on Virginia in the Civil War held at the Virginia Military Institute, Lexington, VA, and sponsored by the Blue and Gray Educaton Association, 18 October 1996.

SYMONDS, Craig L., Professor, "Joseph E. Johnston and the Peninsular Campaign." Marine Corps Combat Development Command, Quantico, Virginia, 12 December 1996.

SYMONDS, Craig L., Professor, "Stonewall of the West: Pat Cleburne at Missionary Ridge." West Palm Beach Civil War Symposium, sponsored by the Civil War Education Association, 6 February 1997.

SYMONDS, Craig L., Professor, "'If We Are to Die': The Death of the Army of Tennessee at Franklin." Deep Delta Civil War Symposium, Southeast Louisiana University, 30 May 1997.

TUCKER, Ernest S., Associate Professor, "Karnal 1739: History, Self, and Other in Afsharid Iran and Mughal India," Middle East Studies Association Annual Meeting, Providence, RI, November, 1996.

VANDEMARK, Brian, Assistant Professor, "How Clausewitz Speaks to Us on Vietnam," ROTC Fellowship Program, US Military Academy, West Point, June 1996.

VANDEMARK, Brian, Assistant Professor, "Vietnam, 1965-1975," McCormick Tribune Foundation/US Naval Institute Program, Chicago, March 1997.

YU, Maochun, Assistant Professor, "China: Superpower of tomorrow?", Smithsonian Associate Program, Washington DC, 22 October 1996.

YU, Maochun, Assistant Professor, "The Web of Modern Chinese History," Radio Free Asia, with ten pieces of history of modern China. Broadcast in pseudonym over China. Washington, DC, July-November 1996.

YU, Maochun, Assistant Professor, Faculty Colloquim, USNA: "Chinese Nationalism in Historical Perspective: Hong Kong and Beyond," USNA, 19 March 1997.

YU, Maochun, Assistant Professor, "The Life and Legacies of Deng Xiaoping," The Pacific News Service (PNS, Radio) on Deng Xiaoping upon his death, 20 March, 1997.

YU, Maochun, Assistant Professor, "China and the Beginning of the Cold War: New Ssources from the Other Side," The Cold War International History Project, Woodrow Wilson International Center for Scholars, Washington, DC, 5 May 1997.

YU, Maochun, Assistant Professor, "Intelligence Operation Duringthe Marshall Mission to China, 1945-1947," at the Symposium, "Re-examining the Marshall
Mission to China, 1945-1947," exington, Virginia Military Institute, 19 October 1996.

DEPARTMENT OF LANGUAGE STUDIES

Professor Sharon Dahlgren Voros
Chair

During the 1996-1997 academic year, the Language Studies Department continued to conduct important research in a wide variety of fields and foreign languages. The highlight of the research year was the publication of Luckács After Communism: Interviews With Contemporary Intellectuals by Professor Eva Corredor, along with two books accepted for publication La casa de los linaje: oficios y gentes marginados en el entremés barroco español [The House of Lineages: Occupations and Marginalized Groups in 17th-Century Spanish Short Plays] by María Castro de Moux, and Fontanes innere Reisen in die Unterwelt [Fontane's Inward Journeys into the Underworld] by Sylvain Guarda. Faculty members produced a total of 3 sponsored research projects, 15 Independent Research Projects, 12 published articles, and 37 presentations at professional societies, both national and international, including Spain, France, and Wales.

In the field of language acquisition, the Annapolis Interactive Video Project continued to create interactive video lessons for Spanish and establish plans to develop lessons for all languages taught in the department. Associate Professor Penelope M. Bledsoe and Elsa M. Gilmore presented a half-day workshop at the Association of Teachers of Spanish and Portuguese on the "Preparation of Collaborative Learning Materials for the Intermediate Spanish Classroom" including the use of digitized video. In addition, a totally new project was begun with Professor John Hutchins (ret.) and Professor Emeritus Guy Riccio (ret.) on programs from the Televisión Azteca that reflect more critical approaches to Mexican society. Lieutenant Samuel Atencio Guerrero, exchange officer from the Mexican Navy, assists in this project. Lessons are planned for intermediate and advanced courses using these native-speed materials and adapting them to classroom concerns for authenticity of language and timeliness of subject matter with real-life situations and conflicts.

While the Language Studies Department does not offer a major in foreign languages, it has a strong minors program with over 126 minors in all languages among the 1997 graduates who have elected to pursue advanced studies in language, literature, culture, history and area studies. Over 45% of these minors have taken majors in Group I and Group II, thus providing a depth of experience beyond an education in technological fields for these midshipmen in a concentrated area of the Humanities. Group III majors continue to pursue minors in foreign languages and excel in their knowledge of other cultures beyond the borders of the US. The Language Studies Department also offers immersion programs with the Cox Fund Overseas Summer Programs, internships at U. S. embassies in France and Spain, and an summer-cruise exchange with the French Naval Academy in Brest. Graduates of the Class of 1997 with minors in foreign languages will bring to the Navy and Marine Corps not only valuable linguistic skills but also in-depth knowledge of the regions of the five areas offered, Spanish, French, German, Russian, and Japanese.

Sponsored Research

Digitized Video-Based Cooperative Lessons for Intermediate Spanish

Researcher: Associate Professors Penelope M. Bledsoe and Elsa M. Gilmore
Sponsor: Curriculum Development Project

During the Spring, the researchers obtained special copyright authorization from SCOLA to tape, convert to digitized video format, and utilize the broadcasts for stated purposes. The researchers reviewed

approximately 30 hours of tape and selected appropriate video segments from this corpus.

The researchers (with the assistance of Lieutenant Samuel Atencio Guerrero, exchange officer from the Mexican Navy) produced transcripts of the video segments. The researchers then digitized the selected video segments and created 10 cooperative video lessons. All of the selected segments and accompanying lessons complement the FS201-FS202 syllabus topics culturally and linguistically. Five lessons are completed, four of which have been integrated into the Intermediate Spanish curriculum this Spring.

The research and some of the materials produced as the result of this funded project were incorporated into a half-day workshop on the theory and preparation of materials for cooperative learning. The workshop was presented at the national congress of the American Association of Teachers of Spanish and Portuguese, 7 August 1996.

Jacques Derrida's Exorceanalysis

Researcher: Professor Eva L. Corredor
Sponsor: Naval Academy Research Council (OMN)

The purpose of this study was to demonstrate the existence of a significant link between the questions that have preoccupied the noted philosopher Jacques Derrida and the development of his "deconstructivist" theory. During the tenure of this award, the researcher engaged in a systematic survey of Derrida's work, particularly of his more recent L'Ethique du don, De l'esprit, and Spectres de Marx, compared to his earlier De la grammatologie, La Dissémination, Glas, Marges de la philosophie, La Carte postale, De Socrate à Freud et au-delà, and L'écriture et la différence, which supported her hypothesis that Derrida in each of his works practices a kind of intellectual and critical "exorceanalysis," a rather nihilistic critique of social, political, and cultural phenomena that could be perceived as a threat to the individual. The aging Derrida's recent works, in particular, reveal his need to "deconstruct" inheritance, legacy, the judgment of history, ethics, and death with a poignancy that reflects more clearly the philosopher's deepseated worries than did his youthful and adventurous deconstructive beginnings. This research has led to several conference presentations. It is also part of a research on Derrida begun in the Fall of 1995 and ongoing in 1997.

The New Wave in Kazakh Cinema

Researcher: Associate Professor Ludmila Pruner
Sponsor: International Research Exchange for American Scholars(IREX)
Matching Recognition Grant by USNA Academic Dean

The purpose of this research was to study studio archives and movies at the All-Russian Research Institute of Cinema (VNIIK), All-Russian Institute of Cinematography (VGIK), and the Center for Cinema Studies (Kinotsentr). During her trip to the Kazakh film studio archives, in Almaty, Kazakhstan, the researcher interviewed filmmakers related to Soloviev's workshop and the Alem Film Association. The comparative method used for this study focused on the interrelation between Kazakh national, the main stream Russian and the so called New Wave Kasakh cinema. Videos and printed materials were selected that would a) support the national historical background of the Kazakh movement, b) assist in the re-examination of the Socialist realist background of the New Wave in Kazakh cinema, c) demonstrate the interrelationship between the New Wave, the main stream Soviet cinema and Western postmodernity, and d) scrutinize the main trends of Eurasian cinema, and compare ethnographic and folkloric elements of Russian and Kazakh cinema.

This project will significantly enrich the study of Russian and Eurasian cinema. It represents the first comprehensive research on the New Wave Kazakh Cinema of the last two decades.

Independent Research

The Uses and Exploitation of the Impersonal Pronoun SE in Spanish

Researcher: Associate Professor Penelope M. Bledsoe

The researcher is continuing her book-length study on the impersonal pronoun in Spanish and its various uses. She is dedicating part of the study, at least two chapters, to the pragmatic exploitation of the impersonal pronoun in written and spoken Spanish. The research is intended to produce a book on the theory of how language is used as well as on the practical application of the theory for teaching and learning this structure. In addition to theoretical and practical applications, exercises stressing the use of the impersonal pronoun structure in Spanish will be included at the end of each chapter. In a pragmatic framework, the study will explore the occurrence of the impersonal se-structure in certain social and cultural contexts as an effort of the language user to shift responsibility and/or blame off a logical subject.

Three chapters of this proposed book have already been prepared in the form of presentations made at conferences and one published article. They include: variability of constituent ordering, non-equivalency of the 'passive' se and the agentless passive, and pragmatic exploitation of the 'impersonal' se to sustain certain sociolinguistic principles of communication.

Perspectives on the Use of English in the Intermediate Foreign Language Classroom: A Survey of Student and Teacher Views

Researchers: Associate Professors Penelope M. Bledsoe and Elizabeth Knutson

Through the distribution of surveys to intermediate students and instructors and the compilation of the results of these surveys the researchers have reached some conclusions on the perceived use of L1 (native language) in the foreign language classroom and some consensus of when both students and instructors feel the need to communicate or have communication take place in the students' L1. The researchers then posit possible gains and losses to foreign language acquisition through the occasional use of students' L1 in communication in the foreign language classroom.

A presentation of the findings of this research project has been accepted for the Modern Language Association Annual Meeting in Toronto, Canada, 27-30 December 1997. The researchers will continue to prepare the results of the research and their findings for publication in Foreign Language Annals in the Fall of 1997.

Chantal Chawaf: Evolution of a Literary Ethic

Researcher: Associate Professor Marianne Bosshard

The goal of this project is to complete a book-length critical analysis of the oeuvre of Chantal Chawaf, one of the better known contemporary French women novelists whose work is an artistic embodiment of contemporary French thought and culture. Upon completion, this book will be published by the Editions Rodopi, Amsterdam, Holland, in their monograph series on contemporary French writers, "Collection monographique Rodopi en littérature française contemporaine." It will contain six chapters as follows: (1) the literary ethics of the author, (2) her poetics, (3) the theme of the maternal, (4) the topic of the "Other" and the quest for identity, (5) the reformulation of ancient myths as they appear, in a new form, in Chawaf's novels, and (6) the sociological aspects of her oeuvre.

The researcher has written five of the six chapters and plans to complete the book manuscript by the end of May, 1997.

Ethical Confrontations at the Time of the Millennium

Researcher: Professor Eva L. Corredor

The researcher has been confronting the theories of the linguistic, deconstructivist philosopher Jacques Derrida with those of the materialist dialectician and sociocritique György Lukács with regard to their commitment to ethical values. This has led her to explore the supposedly shared origins of the two philosophies that in the past two-three decades have been regarded as diametrically opposed to each other. The researcher examined the "auto-visions" of each of the theoreticians and their projections as to the survival of their own theories. This has led her to envisage the reasons for the current resurfacing of Lukács's theories and concepts within the critical discourse of the end of the century.

This research is part of an ongoing study of the work of Jacques Derrida begun in 1995. Parts of the results of this research have been presented at professional meetings in 1996-97.

The Post-1989 Hungarian Cinema

Researcher: Professor Eva L. Corredor

The post-1989 era has prompted a particularly fertile production of cinematography in the newly liberated Republic of Hungary. Since December 1996, the researcher has engaged in a study of this new cinema with respect to its form and topic that reflect the social and political preoccupations and the changes that have occurred within recent years. More intensive research will be carried out during a study tour to Hungary in May-June of this year in preparation of a session organized for the yearly congress of the Modern Language Association of America in Toronto, 27-30 December 1997.

Russia's Orphans: A Cultural Anthropological Study

Researcher: Assistant Professor Clementine Creuziger

This study focuses on the plight of various kinds of marginalized children in urban Russia, including orphans, children with some family ties in special boarding homes and street children. After a presentation of data on marginalized children in Russia within a global context and background to the study, this paper proceeds to an investigation of the changing cultural views adults have of marginalized children since World War II. Changes in views have led to a change in the lifestyles of unwanted children in Russia, which further contributes to criminal activity and poverty on the streets of Moscow and St. Petersburg.

The data was collected via participant observation research in the summers of 1992 and 1994 as well as library research conducted in the summer of 1996. The study was sponsored by a Kennan Institute Research Scholarship awarded by The Woodrow Wilson International Center for Scholars under the Program for Study of Eastern Europe and the Independent States of the Former Soviet Union (TITLE VIII), administered by the U.S. Department of State's Bureau of Intelligence. The results of this research have been accepted for publication in the journal Childhood, currently in press.

During the summer of 1997, this project will be developed further to focus more deeply on gangs and street children in urban Russia.

God's Bad Experiment: Russian Notions of Victimhood

Researcher: Assistant Professor Clementine Creuziger

This study is based on a series of life histories collected from 1991 to 1996 in St. Petersburg and Moscow. The personal quotes about memories and feelings of victimhood are directly taken from the people's stories included in the researcher's book Childhood in Russia: Representation and Reality (Lanham, MD: University Press of America, 1996).

Victimhood, as felt by many Russians today, is not one which is easily accepted as a necessary part of life. Today, after the fall of the Soviet regime, it is no longer one which sparks a feeling of being the chosen martyrs for God, but one that arouses sadness and anger. In this paper, the researcher shows through excerpts from a collection of life histories, how victimhood is in fact felt, digested and realized in contemporary Russia. Many of the accounts quoted throughout this paper have been selected not simply for their factual renditions of experiences, but also for the mood they evoke. It is this researcher's belief that, deeply embedded in the experience of victimhood, is a feeling, an attitude or a common way of expressing the actual events. It is this mood, created by the style of rendition that unites people in their self-definition.

After a presentation of the history of victimhood in Russia, this study turns to actual contemporary descriptions by Russians of their lives and feelings of deprivation. It is the researcher's intent to demonstrate, through the people's renditions, the unity evoked by a mutual feeling of victimization and the resulting experience of victimhood. The results of this study will be submitted for publication in the fall of 1997.

Toward an Infrastructure for Web-Based Instruction Delivery in Language Courses

Researcher: Associate Professor William H. Fletcher

This project continues developing the software and hardware infrastructure for delivering multimedia lesson materials to language learners in the laboratory, classroom, and dormitory room via the World Wide Web, ultimately through a browser-based user interface. During the academic year, this researcher designed and programmed a tutorial authoring and delivery program, FLASHER, which gives the learner specific feedback on entry errors and provides online help. Features to be added to the program in summer 97 are automatic download and update of tutorials via the Web, automatic score reporting to instructors, and support for "Real Audio" compressed sound files and MPEG digital video. The researcher also developed tutorials on selected grammar topics in German (verb forms, adjective endings, relative clauses) and Spanish (verb forms). Addressing another need, input and printing of foreign characters, he also programmed "CharPad," a text editor for easy input and printing of foreign characters in all Windows programs, and the companion program "MailPad," for sending e-mail messages with foreign characters. Feedback from the midshipmen and from other users who have downloaded this software via the Internet testifies to its usefulness. This researcher intends to provide Cyrillic font support in this program this summer, and will work toward replicating the functionality of USNA's current interactive video instructional model for lesson delivery via the Internet.

Elements of Theoretical Linguistics in Priscian's Institutiones

Researcher: Associate Professor Audrey Gaquin

An examination of Priscian's Institutiones, the last great Roman grammatical treatise, shows that this work made available to Priscian's medieval successors certain fundamental theories on the nature of language. The theoretical material is found in the presentations of the different levels of language and

the definitions of the noun and verb; these discussions stress the role of the communication context in governing language production, and affirm the predominance of the semantic component of language in determining linguistic paradigms and practices. Priscian defines the semantic component as a set of semantic wholes, which are broken down into their component parts and matched with linguistic forms in order to produce language. This monograph, which was sponsored by a NARC/OMN grant in the summer of 1989, is a re-working of the researcher's dissertation and will be published by John Benjamins in their Studies in the History of Linguistics series. The monograph consists of a series of case studies of the development of Priscian's theory of semantic wholes in his theoretical discussions. The researcher hopes to be able to submit this manuscript for publication by December 1997.

France's Regional Languages and the New Europe

Researcher: Associate Professor Audrey Gaquin

In this study, the researcher analyzes the reasons for France's refusal to sign the European Charter for Regional and Minority Languages drawn up by the Council of Europe and signed by all member nations of the Council except France and Greece. Because of new developments in French policy concerning the Charter, research continued through 1996. The results will be submitted for publication to the French Review in May 1997.

Euromosaic and France's Endangered Languages

Researcher: Associate Professor Audrey Gaquin

In this study, the researcher discusses current French language policy with respect to France's non-immigrant languages in view of the recommendations of the Euromosaic report recently issued by the Office of Official Publications of the European Community.

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

This researcher is continuing her long-term project on the work of this well-known and prolific Chilean dramatist. During l996-1997 she read two papers "End of the Century Obsessions: de la Parra's The Dead Father" and "The Dead Father: Ekphrasis and History". The first paper was presented at the national congress of the American Association of Teachers of Spanish and Portuguese; the second, at the international theatre conference which is sponsored each year by the University of California/Irvine and Gestos, and which this year focused on "visual constructions of identity." In addition, her article "Gardel: tango y cultura popular en Matatangos" ("Gardel: Tango and Popular Culture in Tangokiller") has been accepted for publication in the September 1997 issue of Hispania.

A Construct Validity Investigation of a Japanese Version of an Academic Self-Concept Scale for College Students

Researcher: Assistant Professor Chie M. Paik

For a sample of approximately 300 subjects taken from a Japanese university in Japan, the twofold purpose of

this study is to obtain evidence of the internal-consistency reliability and construct validity of scores on each of five dimensions of a Japanese version of an academic self-concept measure entitled Dimensions of Self-Concept (DOSC), for H, Japanese version. The steps involved in the study are (1) the development of a Japanese version of DOSC, (2) administration of the questionnaire, and (3) statistical analysis to determine the reliability and construct validity of the questionnaire. The researcher has developed a Japanese version of DOSC. The university in Japan, which will participate in this study is yet to be identified. The data analysis will follow immediately after the administration of the questionnaire. The findings of the study may yield an understanding of the dimensions of self-concept in cross-cultural settings, which will assist in determining whether the constructs underlying self-concept are comparable in different cultural groups.

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-length study 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 analysis 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 16th century printings used
in establishing the base text and discusses many versions of the works. A corrected the interrelationships that exist between the version of the continuations in modern script follows. Editorial, literary, and linguistic notes comprise the next section which ends with a glossary of medieval Spanish terms and one of proper names. Included in this study is an extensive bibliography of primary and secondary source materials on Spanish and European 15th-century didactic poetry. The manuscript has been accepted for publication by Studia Humanistica.

Computer-Aided Listening Comprehension and Grammar Instruction for Intermediate Spanish

Researcher: Professor Gladys M. Rivera-La Scala

The purpose of this project is to create lessons using the Dasher software authoring and delivery system to enhance the acquisition of listening comprehension and grammar skills in midshipmen taking Intermediate Spanish. The content of these lessons will be coordinated with the Lab Manual for the Al Corriente textbook currently used in FS201 and FS202. Text, sound and images will be integrated throughout. Midshipmen taking this course will be able to complete their assignments while receiving immediate feedback on their work and, after completing each exercise, a score. They will have the flexibility of repeating the exercises at will until mastery has taken place. The plan is for making about 50 lessons available to over 150 midshipmen in the fall of 1997, and another 50-60 for the spring of 1998. The work on this project has been on-going from June 1996 to the present.

Publications

BLEDSOE, Penelope M., Associate Professor, "Subject Inversion in Spanish and Narrative Style: A Case Study of Los de Abajo," Reflections on the Conquest of America: Five hundred Years After. Proceedings of the Fifth Biennial Northeast Regional Meeting of the American Association of Teachers of Spanish and

Portuguese, ed. William Forbes, Durham, NH, 1996, pp. 35-45.
The researcher studied and analyzed the narrative style of Azuela in the composition of Los de Abajo as direct, dynamic and active, characterized by an S-V-O sentence structure to advance the plot. Likewise, we have seen how, and for what reasons, Azuela stops or halts the progression of the plot by recurring to an inverted (V-S) sentence structure which has the effect of backgrounding the verbal activity and focusing the subject NP. It was shown that the inverted structure is a narrative device with which the author introduces entities into the discourse and locates them in the narrative. The study offers an explanation of the function of the inversion at the sentence level and the discourse level and presents examples of how it is exploited by Azuela to accomplish the stated narrative tasks.

BOSSHARD, Marianne, Associate Professor, "Marie Redonnet et Chantal Chawaf: Divergences et convergences dans deux écritures engagées," Thirty Voices in the Feminine, ed. Michaël Bishop, Amsterdam: Editions Rodopi, 1996, pp. 174-181.

In this essay, the researcher analyzed the topics of identity, violence, isolation and non-communication in the writings of two contemporary French women authors whose oeuvres, at first sight, seem to have nothing in common. Influenced by Kafka and Beckett, Redonnet's style and imaginary universe are diametrically opposed to Chawaf's regressive, introspective language. In spite of these differences, however, the two writers address similar issues. The researcher has focused on the manner in which both writers deal with these issues.

BOSSHARD, Marianne, Associate Professor, "Françoise Chandernagor," Dictionnaire Littéraire des Femmes de Langue Française, eds. Christiane P. Makward and Madeleine Cottenet-Hage, Paris: Karthala, 1997, pp. 120-122.

This article offers a critical analysis of the oeuvre of Françoise Chandernagor whose publication of L'Allée du Roi in 1981 earned the author two distinguished literary prizes. In her subsequent works, a voluminous trilogy entitled Leçons de ténèbres, the author paints a satirical portrait of the political, intellectual, and artistic milieux during the presidency of Valéry Giscard d'Estaing. In her analysis, the researcher pays particular attention to the treatment of female characters and their development throughout the author's work.

BOSSHARD, Marianne, Associate Professor, "Annie Cohen," in Dictionnaire Littéraire des Femmes de Langue Française, eds. Christiane P. Makward and Madeleine Cottenet-Hage, Paris: Karthala, 1997, pp. 145-148.

This essay offers a critical appreciation of the oeuvre of a less well known contemporary French woman writer who, since 1980, has published seven novels, several texts of poetry and drawings, as well as numerous articles in a variety of literary journals. The researcher analyzes the literary development of this author who, like Hélène Cixous, was born and raised in Algeria, and who participated in the MLF movement in France in the late 1960's.

BOSSHARD, Marianne, Associate Professor, Review of "Caster, Sylvie, La Petite Sibérie," The French Review 70.5 (April 1997), pp. 747-748.

This short essay constitutes a critique of Sylvie Caster's recent novel on the life of a deformed child born into the milieu of a French suburban working class family. The researcher has put this late novel of Caster, a former journalist of "Charlie-Hébdo," in the context of the entire oeuvre of the author, pointing out the continuity in Caster's literary itinerary.

CASTRO DE MOUX, María E., Associate Professor, La casa de los linajes: oficios y gentes marginados en el entremés barroco español (Occupation and Marginal Groups in 17th Century Spanish Short Plays). New Orleans: University Press of the South, 1997.

A study of marginal groups as represented in 17th-century Spanish short plays with emphasis on stereotypes and the portrayal of Blacks, Gypsies, Moors, Italians, Portuguese, and French. Renaissance concept of laughter and humor as a way to unveil truth and to dramatize unfair treatment of Blacks is seen in early plays. Plays are analyzed through the Bakhtinian theory of the carnavalesque in literature. Research was based on 17th and 18th century editions many of them unknown to 20th century readers.

CASTRO DE MOUX, María E., Associate Professor, "Parodia literaria y caricatura de la Corte: nobleza y realeza en el Entremés del Conde Alarcos," Mira de Amescua en candelero. Actas del Congreso Internacional sobre Mira de Amescua y el teatro español del siglo XVII, Granada, 27-30 de octubre de 1994 (Literary Parody and Court Caricature: Nobility and Royalty in the Conde Alarcos Short Story, Mira de

Amescua in the Limelight. Proceedings of the International Congress on Mira de Amescua and 17th Century Spanish Theater, Granada, 27-30 October 1994), eds. Agustín de la Granja y Juan Antonio Martínez Berbel, Granada, Spain: Universidad de Granada, 1996, pp. 57-75.

A study of a 17th-century Spanish short play parodying a medieval ballad as a way of criticizing corruption during the Regency of Queen Mariana de Austria (1665-1675).

CORREDOR, Eva L., Professor, Lukács After Communism: Interviews With Contemporary Intellectuals. Durham and London: Duke University Press, 1997.

In this book, the researcher addresses the continued relevance of György Lukács's theories after the collapse of communism in Soviet Russia and Eastern Europe. The study includes ten interviews with a diverse group of international scholars, who each have been influenced by Lukács. The researcher challenges these theoreticians to reconsider the Lukácsean legacy and to speculate on the prospect of his theories in the coming decades. The interviewees featured in this collection --Etienne Balibar, Peter Bürger, Terry Eagleton, Fredric Jameson, Jacques Leenhardt, Michael Löwy, Roberto Schwarz, George Steiner, Susan Suleiman, and Cornel West-- respond to the researcher's questions on a broad array of literary and political topics including present views on gender, race, and economic relations. The introduction contains a biographical synopsis of Lukács and an analysis of a number of Lukács's most important theoretical concepts. The book provides insights into Lukács as a philosopher and theorist, while offering anecdotes that capture him in his role as teacher-mentor. It illuminates the ongoing vitality of Lukács's work and offers a critical reappropriation.

CREUZIGER, Clementine, “God’s Russian Experiment: Hope in the Wake of Deconstruction of Gender and Religious Identity” in The Anthropology of East Europe Review, Autumn 1997, vol. 15, No. 2.

CREUZIGER, Clementine, “Russia’s Unwanted Children: A cultural anthropological study of marginalized children in Moscow and St. Petersburg” in Childhood: A global journal of child research, vol 4, no 3, August 1997.

CREUZIGER, Clementine, Childhood in Russia: Representation and Reality, Lanham: University Press of America, 1996.

GILMORE, Elsa M., Associate Professor, "El discurso de la iluminación escénica en Ojos para no ver," Matías Montes Huidobro: acercamientos a su obra literaria (Stage Lighting as Discourse in Eyes to be Blind With, Matias Montes Huidobro: Critical Approaches to his Oeuvre), eds. Jorge Febles and Armando González-Perez, Lewiston: Edwin Mellen Press, 1997, pp. 49-58.

This article relies upon the semiotic studies of Erika Fisher-Lichte and others to study aspects of lighting distribution, intensity, kinesis, and chromatic quality in Matías Montes-Huidobro's play Eyes to be Blind With. The study demonstrates how these categories are utilized as elements of a highly symbolic code which reiterates, expands, and at times, is the principal vehicle through which the drama conveys its intensely political, anti-totalitarian message.

GUARDA, Sylvain, Associate Professor, *Schach von Wuthenow*, *Die Poggenpuhls*, *Der Stechlin*: Fontanes innere Reisen in die Unterwelt (Fontane's Inward Journeys into the Underworld). Würzburg: Verlag Königshausen & Neumann, 1997.

Much has been written on the leitmotif and the symbol as two shaping principles of Fontane's poetic imagination. However, no study has yet explored their meaningfulness in relationship with the death of several protagonists, which conveys a distinctively ritualistic character to Theodor Fontane's oeuvre. As a constant reminder, death lurks about through objects such as sepulchers, graves, and tombstones and, more importantly, through the puzzling suicide [not "Selbstmord" or "Suizid" but "Frei"-"tod" (free death) in German] or the seemingly natural death of one of the major protagonists.

A thorough textual analysis of three major play-novels, Schach von Wuthenow (1882), Die Poggenpuhls (1896), and Der Stechlin (1898) not only yields insight into the novelist's poetic imagination and individual creativity but also reveals that death constitutes the core of a commemorative ritual. Couched in the dialectics of the Old (Testament) and the New (Testament), this ritual enables the novelist to recapture his childhood by bridging time-realms (present and past), i.e. abrogating chronological time, and to express his ambivalent stance toward 19th century Wilhelminian society. The play-novel Schach von Wuthenow proves most suited to demonstrate

Fontane's journey into the Hades and regression into his childhood. This ritual, an elaborate mnemonic device, is carried through many novels, including the last two novels Die Poggenpuhls and Der Stechlin, in which the novelist no longer refers to his childhood but to his adolescent years. By contrasting the first with the last two works, the study brings to light Fontane's inner progression from the Old (Testament) to the New (Testament) and, at the same time, his familiarity with Jewish theosophy and its rituals.

The final chapter synoptically concludes that the last two novels are no longer to be viewed as realistic entertainment of the time, as many Fontane-scholars have contended in recent years, but as two parts of a cabalistic thaumaturgy (Miracles) that commemorates and celebrates life. In tying Fontane's artistic ritual to Jewish theosophy, the study convincingly clears the novelist of any antisemitism.

This publication was supported by a USNA Faculty Development Grant in 1996.

KNUTSON, Elizabeth, Associate Professor, "Literary Pragmatics and the Concept of Readability," Readerly/Writerly Texts, 3.1 (Fall/Spring 1995), pp. 89-103.

This article studies the concept of readability as defined by a variety of approaches within the field of literary criticism. At issue are theories of text intelligibility and definitions of literariness. The article explores how readers construct meaning and attach significance to literary texts.

KNUTSON, Elizabeth, Associate Professor, "Le Fantôme de l'Opéra: le charme de la supercherie" ("The Phantom of the Opera: Illusion's Deadly Spell"), The French Review 70.3 (February 1997), pp. 416-26.

This article analyzes the play between rationalism and the fantastic in Gaston Leroux's early twentieth-century novel. The interest and ambiguity of the text lie in an apparent conflict between the narrator's explicit claim to demystify the legend and the narration itself which, on the contrary, prolongs the enigma of the phantom and celebrates the pleasure of the horror genre.

KNUTSON, Elizabeth, Associate Professor, "Reading with a Purpose: Communicative Reading Tasks for the Foreign Language Classroom," Foreign Language Annals 30.1 (Spring 1997), pp. 49-57.

Recent reading research has shown that reading comprehension is a function of both text- and reader-based factors. This article focuses on the reader-based factor of purpose, beginning with a review of research which demonstrates that reading texts with a particular purpose or perspective facilitates comprehension and increases reader interest. The article suggests approaches to the teaching of texts which provide learners with purpose, including student-generated text collections, communicative tasks with reading components, and pre-reading tasks for readings in literature or civilization. Finally, the article argues that the concept of purpose provides a useful organizing principle for the coordination of reading instruction across the foreign language curriculum.

VOROS, Sharon Dahlgren, Professor, "Love, Women, and Wit: Calderón's Secret Stairwell in El escondido y la tapada (The Hidden Lover and the Veiled Lady), The Calderonian Stage: Body and Soul, Century, ed. Manuel Delgado, Lewisburg, PA: Bucknell University Press, 1996, pp. 208-224 and 259-262.

This book chapter examines seventeenth-century staging conventions and techniques as revealed in the linguistic structure of Calderón's comedy, El escondido y la tapada. The play's textual referents to concrete elements of architecture and space, its stage history, and its spatial descriptions give evidence of this dramatist's stagecraft. The researcher concludes that this work was definitely written for the popular play houses and not specifically for court performances. Calderón also gives information that include references to spatial relationships among actors on the stage itself. Since acting conventions have been lost, the researcher attempts to reconstruct not only staging of comedies in which women play a central role, but also acting conventions as reflected in the Calderonian discursive practice.

VOROS, Sharon D., Professor, "Lope de Vega and the Feminist Debate in La prueba de los ingenios," Texto y Espectáculo. Proceedings of the Fifteenth International Golden Age Theater Symposium (8-11 March 1995) at the University of Texas, El Paso, ed. José Luis Suárez García, York, South Carolina: Spanish Literature Publications Company, 1996, pp. 104-116.

This article discusses the ways in which Lope de Vega includes traditional Scholastic debates regarding the nature of woman. Lope draws extensively on both pro- and anti-feminist positions while integrating the debate structure into his dramatic discourse. Instead of a male character who defends feminine intellect, Lope uses a female, but complicates the plot to include

homoerotic discourse, all part of a ruse to win back a lover (male) by seducing the rival (female). Gender confusion serves a dramatic function, as does the academic debate on the suitabilty of women to rule and to wage war, still issues not resolved today. While Lope intends to entertain the audience, he nevertheless raises questions of gender and identity that refute Aristotelian notions of biological determinism.

Presentations

BLEDSOE, Penelope M., Associate Professor, "Preparation of Collaborative Learning Materials for the Intermediate Spanish Classroom," half-day workshop presented in collaboration with Associate Professor Elsa M. Gilmore, Annual Conference of the American Association of Teachers of Spanish and Portuguese, Orlando FL, 7 August 1996.

BLEDSOE, Penelope M., Associate Professor, "Collaborative Video-viewing and the Discussion of Cultural Issues," Conference on Learning and Teaching in the 21st Century, United States Military Academy, West Point, NY, 27 October 1996.

CASTRO DE MOUX, María E., Associate Professor, "Imágenes alquímicas en Las órdenes militares o Pruebas del Segundo Adán de Calderón de la Barca" (Alchemical Images in The Military Orders or Proofs of the Second Adam by Calderon de la Barca), Congress of the Association for Hispanic Classical Theater, Almagro, Spain, 9-12 July 1996.

CASTRO DE MOUX, María E., Associate Professor, "Fuego alquímico en La estatua de Prometeo de Calderón de la Barca" (Alchemical Fire in Prometheus' Statue by Calderón de la Barca), Annual Meeting of the Association for Hispanic Classical Theater, El Paso, TX 6-9 March 1996.

CASTRO DE MOUX, María E., Associate Professor, "Humor, mitología y política en Feliciana Enríquez de Guzmán" (Myth, Humour and Politics in Feliciana Enríquez de Guzmán), A Conference on Women Writers of The Spanish Golden Age and The Latin Colonial Period, Lubbock, TX, 10-12 October 1996.

CASTRO DE MOUX, María E., Associate Professor, " La púrpura de la Rosa de Calderón de la Barca: mito, emblemas y alquimia en una fiesta palaciega" (The Purple of the Rose by Calderón de la Barca: Myth, Emblems and Alchemy in Court Festivities), Louisiana Conference on Hispanic Languages and Literatures (LA CHISPA), Tulane University, New Orleans, LA, 27 February-1 March 1997.

CASTRO DE MOUX, María E., Associate Professor, "Feliciana Enríquez de Guzmán y el canon literario" (Feliciana Enríquez de Guzmán and the Literary Canon), Symposium on Women Writers and the Literary Canon, University of Vigo, Vigo, Spain, 23-27 April 1997.

CORREDOR, Eva L., Professor, "After Postmodern Experimentation: A New Ethical Discourse for the Millennium," International Conference on Literature and Ethics, University of Wales, Aberystwyth, Wales, UK, 4-7 July 1996.

CORREDOR, Eva L., Professor, chair of session, "Questions for Critical Theory," International Conference on Politics and Languages of Contemporary Marxism, University of Massachusetts, Amherst, MA, 8 December 1996.

CORREDOR, Eva L., Professor, "Lukács, Derrida, and the Question of Inheritance," International Conference on Politics and Languages of Contemporary Marxism, University of Massachusetts, Amherst, MA, 7 December 1996.

CORREDOR, Eva L., Professor, "Derrida, Lukács, and Beyond: (Auto)Visions," International Conference on Narrative, University of Florida, Gainesville, FL, 3-6 April 1997.

CORREDOR, Eva L., Professor, "Lukács at the End of his Century," Conference on 1000 Years of Hungarian Education: Toward the Second Millennium, 22nd Annual Conference of the American Hungarian Educators Association, University of Maryland, University College, College Park, MD, 17-19 April 1997.

CREUZIGER, Clementine, Assistant Professor, "Russia's Unwanted Children: A Cultural-Anthropological Study," invited speaker at The Kennan Institute's Ongoing Workshop, The Woodrow Wilson Foundation, Washington, DC, 19 December 1996.

CREUZIGER, Clementine, Assistant Professor, "God's Bad Experiment: Russian Notions of Victimhood," Annual Conference of the American Anthropological Association, San Fransisco, CA, 20 November 1996.

CREUZIGER, Clementine, Assistant Professor, "Russia After the Presidential Elections: Political, Economic, and Social Priorities," U.S. Department of State POLICY FORUM, Washington, DC, 31 July 1996.

FLETCHER, William H., Associate Professor, "Dutch: Germanic Roots, Historical Development, Selected Aspects of the Modern Language, with a Glance at Afrikaans," invited lecturer in graduate course "Survey of Germanic Languages," University of Maryland, College Park, MD, 21 April 1997.

GAQUIN, Audrey P., Associate Professor, "The Study of France's Regional Languages and Cultures at the Secondary Level: a Model Unit", Conference of the American Association of Teachers of French, Lyon, France, 17 July 1996.

GILMORE, Elsa M., Associate Professor, "Preparation of Collaborative Learning Materials for the Intermediate Spanish Classroom," half-Day workshop presented in collaboration with Associate Professor Penelope M. Bledsoe, Annual Conference of the American Association of Teachers of Spanish and Portuguese, Orlando, FL, 7 August l996.

GILMORE, Elsa M., Associate Professor, "Obsesiones finiseculares: El padre muerto de Marco Antonio de la Parra" (End-of Century Obsessions: Marco Antonio de la Parra's The Dead Father), Annual Conference of the American Association of Teachers of Spanish and Portuguese, Orlando, FL, 12 August 1996.

GILMORE, Elsa M., Associate Professor, "Marco Antonio de la Parra's The Dead Father: Ekphrasis and History," Conference on The Visual Construction of National, Social and Ethnic Identities in Theatre and Other Visual Arts, University of California at Irvine, Irvine, CA, 20-22 February 1997.

KNUTSON, Elizabeth, Associate Professor, "Student-Centered Approaches to Working with Texts," U.S. Military Academy Conference on Teaching and Learning, West Point, NY, 27 September 1996.

KNUTSON, Elizabeth, Associate Professor, chair of session, "Literacy and Foreign or Second-Language Learning: Theoretical and Curricular Viewpoints," Modern Language Association Annual Convention, Washington, DC, 28 December 1996.

KNUTSON, Elizabeth, Associate Professor, "Writing as Thinking: Foreign Language Literature and the Pedagogy of Process," Northeast Modern Language Association Annual Convention, Philadelphia, PA, 4 April 1997.

PAIK, Chie M., Assistant Professor, "The Development and Validation of a Japanese Version of an Academic Self-Concept Scale," Conference of the Northeastern Educational Research Association, Ellenville, NY, 23 October 1996.

PAIK, Chie M., Assistant Professor, "Integrating the Four Language Skills: A Communicative Approach to Teaching Japanese," The Japanese Language Education Committee of the Japanese American Association of New York, NY, 22 March 1997.

PAIK, Chie M., Assistant Professor, "A Japanese Language Curriculum in the United States for the 21st Century," Eleventh New England Language Pedagogy Workshop, Amherst, MA, 14 June 1997.

PRUNER, Ludmila, Associate Professor, "National Women's Presence in Graphic Arts and Cinema of Central Asia and Azerbajan," The 28th National Convention of the American Association for the Advancement of Slavic Studies (AAASS), Boston, MA, 16 November 1996.

PRUNER, Ludmila, Associate Professor, chair of session and discussant, "What We Have to Celebrate: Recent Developments in Russian Cinema and Television," 28th National Convention of the American Association for the Advancement of Slavic Studies (AAASS), Boston, MA, 17 November 1996.

PRUNER, Ludmila, Associate Professor, "Russian History Through Art and Cinema," lecture at the Broadneck Senior High School, Annapolis, MD, 15 October 1996.

PRUNER, Ludmila, Associate Professor, "The World of Akhmatova: Life and Work of a Russian Poet (1889-1966)," two-part lecture in HE506 Honors English course, English Department, USNA, Annapolis, MD, 1 and 3 October, 1996.

PRUNER, Ludmila, Associate Professor, "Andrei

Tarkovsky's The Mirror," lecture on the semantics of the cinematic language of the internationally acclaimed Russian filmmaker, in HE506 Honors English course, English Department, USNA, Annapolis, MD, 19 November, 1996.

PRUNER, Ludmila, Associate Professor, Organizer of session, "Interdisciplinary Approaches to Cinema," Annual Convention of the American Association of Teachers of Slavic and East European Languages (AATSEEL), Washington, DC, 27-30 December 1996.

VOROS, Sharon D., Professor, "Una representación venezolana de Medora de Lopoe de Rueda," Association for Hispanic Classical Theater Symposium on Performance, Almagro, Spain, 9 July 1996.

VOROS, Sharon D., Professor "Armesinda's Dream: Leonor de la Cueva y Silva's Challenge to the Patriarchy in La firmeza en la ausencia," First Annual Conference on Women Writers of the Middle Ages and Spanish Golden Age, Texas Tech University, Lubbock, TX, 10 October 1996.

VOROS, Sharon D., Professor, "Sisterhood and Discretion in María de Zayas, Ana Caro Mallén and Leonor de la Cueva y Silva," South Atlantic Modern Language Association (SAMLA), Savannah, GA, 8 November 1996.

VOROS, Sharon D., Professor, "An Indigeneous Performance of Sor Juana's Allegory on Conquest of Mexico," Modern Language Association Annual Meeting, Washington, DC, 28 December 1996.

VOROS, Sharon D., "An Indigeneous Performance of Sor Juana's El divino Narciso: A 1992 Performance of the Grupo Tarumba, Mexico City," Spanish Golden Age Theater Symposium sponsored by the Association for Hispanic Classical Theater and the University of Texas at El Paso, El Paso, TX, 5 March 1997.

DEPARTMENT OF POLITICAL SCIENCE

Professor Stephen E. Frantzich
Chairman

This year's research in Political Science has contributed to both the discipline and the policy-making process. Political science is a multi-faceted field focusing on divergent geographical regions and a variety of human behaviors. Research activity in the Political Science Department reflects this range of endeavor. Methodologically our faculty is also diverse. One can find examples of inductive analysis, empirical data manipulation, case studies, documentary analysis and field experimentation. In keeping with the emerging information superhighway, many of our faculty became facile in using computer databases and the Internet to support their research. Political Science faculty have published widely this year in numerous formats and have been actively sought out for professional presentations and policy-making forums. Convinced of the value of independent research, our faculty have sponsored a large number of student research projects.

The five books published by departmental faculty reflect the diversity of the discipline. An edited international relations text has become a standard in its field. One specialized trade book on C-SPAN provides the first inside look at this new medium. Another series of books represent our faculty's commitment to improving knowledge about teaching methodology. A number of additional book length projects are in preparation. Above and beyond publishing books, departmental faculty have represented their competence through a series of journal publications and conference presentations. One faculty member testified twice before Congress, while others were called on for radio and television appearances.

Aside from publishing, research support serves as a measure of outside validation of faculty efforts. This year departmental faculty received external research funding from sources as diverse as the United States Air Force, Johns Hopkins University, the Swedish Social Science Research Council, and a variety of publishers.

Two members of the faculty were chosen for prestigious foreign research grants and one serves as an advisor to the White House. Working closely with faculty advisors, three students completed extensive honors theses, and four others did independent research projects. These projects allowed students to build on their regular course work and participate in the true research experience.

A perusal of departmental research efforts indicates extensive activity on the part of all members of the faculty. Those with less extensive research output this year have other projects in the pipeline. Research is alive and well in the Department of Political Science. The knowledge and excitement of research spills over into the classroom where faculty can use their research to educate and stimulate students.

Sponsored Research

The Divided Community: Prayer in the Public Schools of Platteville, Colorado, 1925-1929

Researcher: Professor Karl A. Lamb
Sponsor: Naval Academy Research Council

To what degree must a community be united on a fundamental issue to remain viable? This case study provides one answer to such a question. Platteville was a small town divided between Protestants and

Catholics on the question of Bible-reading in the public school. The Ku Klux Klan marched on Main Street in 1920; in 1927, the Colorado Supreme Court ruled Bible reading could be required if alternate instruction was provided for the Catholic students. The project involved travel to Colorado to conducting archival research and interviews.

How Do Environmental Issues Contribute to Regional Insecurity?

Researcher: Professor Helen Purkitt
Sponsor: INSS-Air Force Academy; U.S. Army Environmental Units

This study is designed to summarize how Africans and Americans define the same set of environmental issues that may promote future violent conflict in both Southern Africa and the Horn of Africa. The sponsors of this study view this study as a prototype for how to monitor emerging environmental issues that may threaten future security in regions of Africa. The results of this research will be summarized as graphical displays on an unclassified web page and will attempt to enlist the participation of African colleagues to contribute to this effort to develop "shared problem representations" of emerging environmental threats to regional security. Interview data for this project will be collected, coded, and displayed in graphical form on an unclassified web page during the 1997/8 academic year. Several upper-class FPS midshipmen will assist in compiling and coding the data for this project.

Teaching Guidance for FP130

Researcher: Associate Professor Eloise F. Malone
Sponsor: Curriculum Development Grant

Developed guidance for teaching FP130 and an instruction set for using the INTERNET. The guidance provides scholarly, pedagogical and administrative advice for new instructors. The INTERNET assignment represents summer work searching the net for useful sites that midshipmen and faculty can use to supplement teaching activity.

America at Odds

Researcher: Professor Stephen Frantzich
Sponsor: West/International Thompson Publishers

A multi-media educational tool to be distributed on CD-ROM and the World Wide Web which provides students with an in-depth and balanced look at twenty controversial issues in American politics. The researcher is responsible for conceptual design, substantive content and educational evaluation.

Independent Research

Examining the 'Authoritarian Advantage' in Southeast Asian Development

Researcher: Associate Professor Stephen D. Wrage

The objective of the proposed research and writing is to examine the argument that the suspension of civil liberties and the suppression of civil society in Malaysia and Singapore has been essential to the task of development and has been justified by that development.

Analysis of the Mainland Chinese Leadership

Researchers: Professor Rodney D. Tomlinson
(with Prof. Emeritus Daniel T.Y. Lee)

The Chinese Leadership project is now in its 22nd year. The data base was revised and updated in July-August with additional bios added in December 1996. The Peoples' Liberation Army (PLA) continues to display a remarkable spectrum of activities, reported last year, ranging from efforts to modernize arms to branching into non-military activities like TV satellite antenna manufacture, commercial diesel engines and even textiles and retail outlets. Depending on the military district, PLA Commanders can be found diversifying PLA factories to produce consumer goods as sources of revenue (and personal enrichment). This trend looks to continue with the recent concession by the central government to permit another year of literally unbridled economic expansion.

Editing the Letters of Charles H. Fowler

Researcher: Professor Rodney G. Tomlinson

This project involves editing 110 letters, about 1100 pages of handscript. All letters have been edited and the first set of page proofs reviewed by the publisher's acquisitions editor. More than 300 background footnotes have been added and approximately 100 photos are being incorporated into the manuscript. Editing has reduced book length to approximately 435 pages. The book has been reviewed by two of three referees and its final version will be at the publisher in July 1997. Charles H. Fowler served in Teddy Roosevelt's navy from 1906-1910. Joining in 1906 as a seaman recruit young Charles' skill with the pen and word led to early assignment as a ship's log writer. Assigned to the U.S. Asiatic Squadron at Subic Bay, PI, Fowler's bright mind and attention to detail attracted his superiors' attention leading to his participation in many interesting exercises and activities of the day. Fowler chronicles life in the Orient through a collection of eighty letters to his sister, along with over 200 photos. Fowler provides first hand looks at life 'tween' decks in an articulate and engaging style rarely found among enlisted men.

"Get Tough" Sentencing Initiatives

Researcher: Professor John A. Fitzgerald

In recent years there has been a pronounced legislative policy at both the federal and state levels to "get tough" in the area of prison sentencing. These policies have included "three strikes," mandatory sentencing guidelines, limiting of death row appeals, chain gangs and withdrawal of such inmate privileges as weight rooms, television, opportunities for higher education, etc. This research examines the origins of these policies, their nature, and weighs their success. Conclusion: these policies have been unsuccessful in curbing recidivism. In some cases, such as "three strikes," they have even been counterproductive.

Moral Reasoning-Personality Type-and Midshipmen Demographic Characteristics

Researcher: Associate Professor Eloise F. Malone

The Defining Issues Test (DIT) data were computerized. The data were then merged and analyzed with two other data sets: the American Council on Education's Student Information Form and the Myers-Briggs Personality Type Inventory. This research resulted in two papers: "Gender and Moral Reasoning; Empirical Study of the Relationship between Gender, attitudinal/behavioral Indicators and

Moral Reasoning. A cross sectional analysis of Midshipman at USNA," and "Leadership and Myers-Briggs Type Indicator." The first paper examined performance on the DIT with the Myers-Briggs Personality Type with the influence of gender on moral reasoning. The second paper stressed the relation between Myers-Briggs data midshipmen background, and moral reasoning.

Making a Difference: Citizen Courage in a Cynical Age

Researcher: Professor Stephen Frantzich

Despite widespread cynicism, individual citizens still make a difference in the American political process. The main purpose of this project is to develop a set of 15-20 profiles of non-elected individuals who have used various means to change public policy. Their stories will not only help counter public cynicism but also explore the strategic vehicles available to motivated citizens. The profiles will include individuals such as Barbara Brimmer and Valerie Schoen (the two women whose 1972 letter stimulated the admission of women into the military academies), Candy Lightner (the founder of MADD), and Gregory Watson (the student who reacted to a "C" on a paper about the proposed 27th Amendment by organizing a nationwide movement that secured its passage). The individual profiles will be placed in the larger context of citizen activism in a democracy. Initial research has begun and ten profiles are in preparation. The project has resulted in one conference paper and considerable interest from publishers.

The Structure of International Events- Testing a Theoretic Model of World Political Behavior

Researcher: Professor Rodney G. Tomlinson

This research is ongoing and focuses primarily on maintaining the World Events/Interaction Survey data files and testing the behavioral model with the new data. During the summer of 1995 and then Christmas, 1995, additional data (through November 1995) were collected. The year 1965 was added, giving WEIS a full run from 1965 through 1995. This project has been augmented by a co-research project with Professor Jack Vincent of the University of Idaho. This cooperative undertaking began in September 1995 and will continue for about eighteen months. In this effort the entire WEIS event collection will be cast into a set of matrices depicting annual dyadic interaction. The matrices values will come from adaptation of the Vincent and Goldstein scales. Professor Tomlinson will develop the matrices and conceptual rationale for the scaling. Professor Vincent will develop typologies of behavior by factor analysis of the matrices developed by Tomlinson. The project is about twenty-five percent complete.

Research Course Projects

The Humanitarian Soldier

Researcher: Midshipman 1/C Shawn Moyer
Advisor: Associate Professor Stephen Wrage

A study of the new roles demanded of American soldiers as they have engaged in humanitarian interventions in Somalia, Bosnia, Bangladesh and Northern Iraq. The researcher interviewed participants, read widely the accounts of the interventions, reviewed training manuals for the various services and discussed possible new forms of training and indoctrination that would make U.S. soldiers more effective in these missions without eroding their preparedness for more traditional ones.

A Second Act for U.S. Defense Reform: The Case For a Sequel to Goldwater- Nichols

Researcher: Midshipman 1/C Jeremy Thompson
Advisor: Instructor Douglas M. Brattebo

On October 1, 1986, Public Law 99-433, known as the Goldwater-Nichols Department of Defense Reorganization Act of 1986, was signed into law. Following on the heels of the tenth anniversary of the passing of Goldwater-Nichols (G-N) it is apparent that G-N has not accomplished its original mission--to abridge problems of parochialism, appropriation, dual hatting, duplicity, and decision-making within the National Military Command Structure (NMCS) and to relieve the stress those problems create for civil-military relationships within the NMCS. The reason that Goldwater-Nichols did not provide long-lasting and meaningful reform for the NMCS was that there was an extreme mismatch between G-N and the legislation sought by the Reformers. Somewhere in the reorganization process, the intention of exacting effective reform was lost and, therefore, a dilemma exists in the civil-military relationships between departments within the NMCS.

This study explores changes to be made in the future that potentially could alleviate this dilemma. The study claims that G-N was watered down and that the NMCS and its characteristic problems reflect the watered down legislation. The study also includes a critical analysis of the effects of the national security environment and U.S. military strategy upon civil-military theory and departmental organization. In support of the proposed hypothesis that change is needed to alleviate the dilemma within the NMCS, the study establishes that the currently dominant model of civil-military relations (the equilibrium model) is coordinated with today's international security environment and that the model should be applied to the inter-departmental organization within the NMCS. What appears to be the most fitting arrangement for the NMCS is a variant of the proposal made by General Meyer at the beginning of the 1982 reorganization effort. Defense reform legislation that creates a form of the National Military Advisory Council system within the NMCS, therefore, is recommended to alleviate the dilemma.

U.S. Nuclear Strategy in the Twenty-First Century

Researcher: Midshipman 1/C Christopher Mandernach
Advisor: Professor Gale A. Mattox

With the fall of the Berlin Wall, the United States has found itself plying turbulent waters in global security policy. Conflict planning has shifted from broad, global planning to smaller, regional-type contingencies, while actors beyond the former-USSR, including China, Iran , Iraq, and Korea have proven to be active threats to the policy goals of the United States. The stable, positive control of the Soviet arsenal can no longer be guaranteed, and the proliferation of nuclear material and nuclear technology is a harsh reality. The time has come for America to adjust its nuclear policies to reflect the new challenges to American nuclear security. American strategy should seek four basic goals: to increase the stability of the global environment; to decrease the risk of nuclear conflict; to decrease nuclear force levels to a minimum level while ensuring stability and decreased risk; and to minimize the cost to the American taxpayer. To achieve these goals, the United States should implement a four-tiered strategy, seeking to devalue the nuclear weapon in military strategy, to deter against potential attack, to provided conventional counter force attacks and to promote active defense.

Male Midshipmen Attitudes Towards Women in the Navy

Researchers: Midshipman 1/C Julie K. Gill
Midshipman 1/C Daniel P. Bozung
Advisor: Professor Rodney G. Tomlinson

Nineteen ninety-six marked the twentieth anniversary of the admission of women to the U.S. Naval Academy. Midshipmen Gill and Bozung replicated portions of the 1976 survey of male midshipmen attitudes conducted by Dr. Kathleen Durning of the Naval Personnel Research and Development Center (NPRDC) to examine where and how much male attitudes have changed. It was found that male attitudes, have, in general moved towards more egalitarian viewpoints in the areas of principles and theory. It was found, however, that in those areas related to specific issues, i.e., physical standards and job tasks, that male attitudes have not markedly changed. Males who do not socialize with female midshipmen were found to have the least positive attitudes. Male attitudes generally tend toward the less positive as time passes at USNA. Due to their small numbers, females appear salient, and hence subject to stereotyping in male eyes due to behaviors of one or just a few females. Repeal of the combat exclusion laws does not appear to have altered male attitudes.

Publications

FRANTZICH, Stephen E., Professor, "Conflict in Congress: The Members and the Media," in "Civility in the House of Representatives", House, Committee on Rules, Washington, D.C.: U.S. Government Printing Office, 1997, pp. 7-12.

Prepared testimony outlining the sources of conflict in the House and presenting a variety of options for reducing unproductive conflict. The testimony supported an April 17 and May 1 set of hearings.

FRANTZICH, Stephen E., Professor, "Congress and the New Information Environment," in "Legislating in the 21st Century Congress," U.S. Congress, House, Committee on Rules, Washington, D.C.: U.S. Government Printing Office, pp. 23-32, 1996.

Prepared testimony outlining the challenges and opportunities of new technology for Congress. The testimony supported a May 24 hearing which pioneered the use of video conferencing and Internet communications to improve the congressional hearing process.

FRANTZICH, Stephen, Professor, and John Sullivan, *The C-SPAN Revolution*. Norman, OK: The University of Oklahoma Press, September, 1996.

Using the literature on technological innovation, organizational behavior, and political communications, this book outlines the history, operations, and implications of C-SPAN for the political system. Based on over 60 interviews, access to internal C-SPAN documents, and an assessment of polling and other empirical data, this study is the first comprehensive analysis of a niche market public affairs network such as C-SPAN. After its publication in September, it was the leading seller of the fall publication list.

FRANTZICH, Stephen E., Professor, ed. , *Tocqueville and Democracy*. 1997, Washington, D.C.: C-SPAN.

A comprehensive guide to using C-SPAN video to teach the principles of Tocqueville's *Democracy in America*. Based on a three day conference organized by the editor, this collection of essays and teaching hints will be available in hard copy an in an expanded form on the World Wide Web.

HARFF, Barbara, Professor, Book review of "Death by Government," by R.J. Rummel, in the *Journal of Interdisciplinary History*, Vol. XXVII, pp. 117-119, Summer 1996.

HARFF, Barbara, Professor, and Ted Robert Gurr, "Early Warning of Communal Conflicts and Humanitarian Crises," The United Nations University Press, Tokyo, Japan, pp. 1-90, 1996.

HARFF, Barbara, Professor, "How and Why the Global Community Should Respond to Humanitarian Crises," ed. Dennis Pirages in special issues, *Futures Research Quarterly*, vol 13(1), pp. 25-44, Spring 1997.

HARFF, Barbara, Professor, "Humanitarian Intervention at Issue," in International Intervention: New Norms in the post-Cold War Era? Ed. Peter Wallensteen, Uppsala University, Sweden, 1997.

HARFF, Barbara, Professor, Revised version of "Rescuing Endangered Peoples: Missed Opportunities," in Albert J. Jongman (ed.), *Contemporary Genocides: Causes, Cases, Consequences*, Leiden: PIOOM Publications, University of Leiden, Netherlands, 1996, pp. 117-130.

HARFF, Barbara, Professor, and Ted Robert Gurr, Substantially revised version of "Victims of the State: Genocide, Politicide and Group Repression since 1945," in Jongman (ed.), pp. 33-58, Leiden, Netherlands, 1996.

MALONE, Eloise F., Associate Professor, ed. *Readings in Government and Ethics*. New York: American Heritage, 1996.

The book of readings published by American Heritage combines topics of interest to American government regarding question of ethics. This recent edition is substantially different from earlier editions. It presents a series of scholarly articles related to the ethics of the presidency, the Congress and the Courts. Also covered are topics of interest to Naval Officers.

MALONE, Eloise F., Associate Professor, Cochran, C.L., Professor, and Paul Roush. "Leadership and the Myers-Briggs Type Indicator." *Proceedings*. Second International Research Conference, Center for the Applications of Psychological Type, Gainesville, Florida, 1997, pp. 255-269.

This paper presents findings from analysis of three empirical studies of midshipmen behaviors and attitudes (ACE study), temperament (MBTI profile) and moral reasoning (DIT scores). The study asked if temperament correlated with certain behaviors, attitudes and background characteristics and if these variables predicted moral reasoning ability. The authors used factors analysis and multiple regression to test the hypothesis. Study findings indicate that more intuitive respondents who share certain attitudes earn higher scores in moral reasoning.

MATTOX, Gale A., Professor, "Alternative European Architecture," in Clay Clemens (ed.) *The Western Alliance in Transition*, Cambridge University Press, 1997.

MATTOX, Gale A., Professor, "Domestic debate of NATO Enlargement," occasional paper to appear in French by University of Quebec in Montreal, Summer 1997.

MATTOX, Gale A., Professor, "Organization for Security and Cooperation in Europe," in Bruce Jentleson (ed.), *Encyclopedia of U.S. Foreign Relations*, Council on Foreign Relations, Oxford University Press, 1997: 322-3.

PURKITT, Helen E., Professor, *Annual Editions: World Politics 97/8*. Editor, Sluice Dock, CT: Dushkin Publishing Group, 1997.

This book is the eighteenth edition of an annual collection of articles about recent issues and trends in international affairs. The book is organized into nine sections covering major current issues in each regional subsystem of the world and key policy issue areas related to the global economy, arms proliferation, and other global issues. Each section begins with an introduction which reviews key trends for the novice reader. A new feature of this volume this year are Internet web sites for each section and a list of "top 12 sites for international relations research." This volume is used as a supplemental test in introductory courses in International Relations, U.S. foreign policy and national security issues.

PURKITT, Helen E., Professor, Book review of Scott D. Sagan and Kenneth N. Waltz's, "The Spread of Nuclear Wars," pgs 139-141 in *Naval War College Review*, Autumn, 1996.

RACHWALD, Arthur R. Professor, "Interpretation of Constitutional Developments in Central Europe," paper prepared for a Conference on Democratic Consolidation in Eastern Europe-Institutional Engineering, European University Institute, Florence, January 24-5, 1997.

RACHWALD, Arthur R., Professor, "National Security. NATO: Hopes and Frustrations," book chapter in Richard F. Staar, ed., *Transition to Democracy in Poland*, St. Martin Press, 1997.

RACHWALD, Arthur R., Professor, "Russian Navy," book chapter in Arthur R. Rachwald, ed., *Civil-Military Relations in Russia*. Forthcoming.

WRAGE, Stephen D., Associate Professor, "Exploding the Myth of the Authoritarian Advantage" Mershon International Studies Review (1997) 41, pp. 302-304.

WRAGE, Stephen D., Associate Professor, "Watering to Endanger," *The Atlantic Monthly*, vol 277, no. 6, pp. 41-42, June 1996.

WRAGE, Stephen D., Associate Professor, Article on "Warsaw Pact" in *Encyclopedia of U.S. Foreign Relations*, Oxford Univ. Press, vol 4, pp. 302-303, New York: 1997.

Presentations

COCHRAN, Charles L, Professor, Eloise Malone, Associate Professor, and Paul Roush, "Gender and Moral Reasoning: An Empirical Study of the Relationship Between Gender, Attitudinal/Behavior Indicators and Moral Reasoning. Cross-Sectional Analysis of Midshipmen at the U.S. Naval Academy." Delivered at the Leadership in a Gender Diverse Military Conference at the United States Coast Guard Academy. March 22, 1997.

COCHRAN, Charles L., Professor, Eloise Malone, Associate Professor, and Paul Roush, "Leadership and Myers-Briggs Type Indicator." Delivered at the Center for Applications of Psychological Type Leadership Conference. April 2, 1997.

CURTIS, Willie, Associate Professor, "The American Perspective on Peacekeeping," Lester B. Pearson Canadian International Peacekeeping Training Centre, Peacekeeping Management, Command and Staff Course (PMCSC-C99). May 1-2, 1997, Nova Scotia, Canada. October 14, 1996.

CURTIS, Willie, Associate Professor, "U.S. Foreign and National Security in the Post-Cold War Era," Dag Hammerskjold Journalist Fellows, sponsored by International Visitor Program of the U.S. Information Agency (USIA).

FRANTZICH, Stephen E., Professor, "Congress and Information Technology--Some Thoughts on the Impact of the Next Wave," Invited testimony before the Subcommittee on Rules and Organization of the House, May 24, 1996.

FRANTZICH, Stephen E., Professor, "Explaining the U.S. Elections," Canadian Broadcasting Corporation, "FACE OFF," Broadcast, October 18, 1996.

FRANTZICH, Stephen E., Professor, "Understanding American Politics," International Politics Seminar, George Washington University, November 20, 1997.

FRANTZICH, Stephen E., Professor, "Using C-SPAN in the Classroom," Seminar for College Faculty, sponsored by C-SPAN, January 11-12, 1997.

FRANTZICH, Stephen E., Professor, "Making a Difference: Citizen Activism in a Cynical Age," paper presented at the Annual Meeting of the Midwest Political Science Association, April 10, 1997.

FRANTZICH, Stephen E., Professor, "Conflict in Congress," CNN'S "WASHINGTON UNWRAPPED," April 17, 1997.

FRANTZICH, Stephen E., Professor, "Conflict in Congress: The Members and the Media," Invited testimony before the Subcommittee on Rules and Organization of the House, April 17 and May 1, 1997.

HARFF, Barbara, Professor, "Minorities at Greatest Risk of Humanitarian Emergencies," with Ted Robert Gurr, Project Meeting "The Political Economy of Humanitarian Emergencies," sponsored by WIDER (U.N. World Institute for Development Economics Research), Helsinki, Finland, 6-8 October 1996.

HARFF, Barbara, Professor, "Early Warning of Humanitarian Crises: Sequential Models and the Role of Accelerators," Workshop on Crisis Early Warning Systems, CIDCM, sponsored by the DOD Joint Warfare Analysis Center, University of Maryland, November 1996.

HARFF, Barbara, Professor, and John Davies, "Dynamic Data for Early Warning of Ethnopolitical Conflict," Workshop on Crisis Early Warning

Systems, CIDCM, sponsored by the DOD Joint Warfare Analysis Center, Univ. of Maryland, November 1996.

HARFF, Barbara, Professor, and Ted Robert Gurr, "The State Failure Project: Early Warning Research for U.S. Foreign Policy Planning," Workshop on Crisis Early Warning Systems, CIDCM, sponsored by the DOD Joint Warfare Analysis Center, University of Maryland, November 1996.

HARFF, Barbara, Professor, "Monitoring Crises Development and the Role of Accelerators," Swiss Foreign Ministry on a Pilot Early Warning Project, April 28, 1997.

HARFF, Barbara, Professor, "Responses and Non-Responses to Humanitarian Crises: Zaire, Burundi, Rwanda and Abkhazia," sponsored by International Alert and the UNESCO Conflict Early Warning Systems Program, funded by the Carnegie Corporation, London, England, June 22-23, 1997.

MALONE, Eloise F., Associate Professor, "Public Attitudes Toward the Military: A Comparative Study of American, Canadian and Quebec Perspectives," The American Council for Quebec Studies, Quebec City, Canada, October 17-19, 1996.

MALONE, Eloise F., Associate Professor, Cochran, Charles L., Professor, and Paul E. Roush, "Gender and Moral Reasoning: Empirical Study of the Relationship Between Gender, Attitudinal/Behavioral Indicators and Moral Reasoning, Cross Sectional Analysis of Midshipmen at the United States Naval Academy," Leadership in a Gender Diverse Military Conference, U.S. Coast Guard Academy, New London, CT, March 20-23, 1997.

MATTOX, Gale A., Professor, "Security Policy at the Crossroads," Workshop on Grants and Fellowships, 1996 Summer Symposium for Graduate Students in International Affairs, St. John's College, Annapolis, MD, June 15, 1996.

MATTOX, Gale A., Professor, Chair and discussant, "New Challenges to Security: Ethnicity and Identity," Security Policy at the Crossroads, 1996 Summer Symposium for Graduate Students in International Affairs, St. John's College, Annapolis, MD, June 16, 1996.

MATTOX, Gale A., Professor, Chair and discussant, "EU/US Relations after the Cold War," sponsored by American Friends of Wilton Park and WIIS. Army-Navy Club, Washington, D.C., October 29, 1996.

MATTOX, Gale A., Professor, Chair, organizer and discussant, "The Changed Map of Europe: Has Germany's Role Changed or Will It?" Annual Conference of International Security Studies Section, International Studies Association, Atlanta, GA, November 1, 1996.

MATTOX, Gale A., Professor, Chair and discussant, "Round Table on Regional and Conflict Resolution: Alliance Politics in the Post-Cold War Era," ISSS/ISA Annual Conference, Atlanta, GA, November 1, 1996.

MATTOX, Gale A., Professor, "Access by Women to Decision Making in Foreign and Security Policy Making," American Association of University Women, O&F Club, Annapolis, MD, November 14, 1996.

MATTOX, Gale A., Professor, Luncheon speaker, "NATO: New Challenges," Annapolis Civitans, Annapolis, MD, January 16, 1997.

PURKITT, Helen E., Professor, Invited participant, "Round Table Discussion on the Impact of Context on Decision-making," 20th Annual meeting of the International Society of Political Psychology, Vancouver, July 2, 1996.

PURKITT, Helen E., Professor, "A Problem Centered Approach for U.S. Foreign Policy," American Political Science Association Annual Conference, San Francisco, CA, August 31-September 2, 1996.

RACHWALD, Arthur R., Professor, "Interpretation of Constitutional Developments in Central Europe," Conference on Democratic Consolidation in Eastern Europe-Institutional Engineering, European University Institute, Florence, January 24-25, 1997.

RACHWALD, Arthur R., Professor, "Interpretation of Constitutional Developments in Central Europe," Round Table Discussion, Council of the Center for Constitutional Studies and Democratic Development, University of Bologna, School of Law, Bologna, March 10, 1997.

WRAGE, Stephen D., Associate Professor, "Singapore's Authoritarian Advantage," Annual Conference of the International Studies Association South, Roanoke, VA, October 1996.

DIVISION OF MATHEMATICS AND SCIENCE

Captain Tim Halliday, USN
Director

DEPARTMENT OF CHEMISTRY

Professor Boyd A. Waite
Chair

This past year was very successful in terms of external recognition of research accomplishments within the Chemistry Department. Associate Professor Mark L. Campbell was recognized with the Academy-wide 1997 Research Excellence Award for his work in developing the Department's laser laboratory and the resulting research results related to transition metal gas phase reaction kinetics. In addition, Prof. Campbell was awarded the prestigious Henry Dreyfus Teacher/Scholar Award (one of five nation-wide) for the coming year, which will provide funding for his own research and for the Department.

Assistant Professor Judith Harrison has also been recognized by having her work highlighted in a *Scientific American* feature article on friction at the atomic level. She continues to develop an international reputation in this emerging field, and has supported again a post-doctoral associate within the Department. Associate Professors Robert Ferrante and Jeffrey Fitzgerald were awarded the first Kinnear Fellowships at the Naval Academy in support of their work in cometary chemistry and porphyrin complex chemistry. Assistant Professor John Bodnar continued his work in development biology and the genome project under a grant for undergraduate institution faculty from the National Institutes of Health.

The Chemistry Department faculty and midshipmen chemistry majors are supported by a diverse array of state-of-the-art instrumentation and computational facilities. One Trident Scholar completed a significant kinetics study of transition metal gas phase reactions, and 10 different midshipmen participated in directed research courses. Several of the midshipmen attended national scientific meetings and presented results of their work during the year.

The Chemistry Department faculty have continued to pursue collaborative research efforts with Navy laboratories and other government and private institutions. This year faculty collaborated with projects at the Naval Research Laboratory, the Naval Surface Warfare Center, the National Aeronautics and Space Administration, and the Johns Hopkins University. Faculty members were supported by grants from the Air Force Office of Scientific Research, NASA, the Office of Naval Research, the Petroleum Research Fund, the National Institutes of Health, and the Research Corporation.

Other research interests of the faculty include: organic synthesis of species for methanol fuel cells, radio-isotope studies in connection with specialized medical scanning technology, hazardous material handling and cataloguing, detonation simulations, electrochemical studies of fused salts, development of analytical methods based on electrophoretic techniques, and synthesis and characterization of organometallic species, among others. The active involvement of both civilian and military faculty in research provides strength to the curriculum and helps prepare our chemistry graduates for the technical challenges awaiting them in the fleet.

Sponsored Research

Decrypting the Language of the Genome

Researcher: Assistant Professor John W. Bodnar,
SC496 Student (Midshipman 1/C Robert Liotta, USN), SC432 Class (24 students)
Sponsor: National Institutes of Health Academic Research Enhancement Award (AREA Grant)

Analysis of human DNA sequences has indicated that the noncoding DNA has characteristics of a language which might be involved in the regulation of how, when, and where the coding sequences are expressed as proteins, and as we begin to sequence the human genome we must also begin to decipher the language of the genome. Ultimately, therefore, the genome project is a cryptography problem. I suggest that the key to reading the language of the genome will be found in other disciplines such as linguistics or cryptography which use statistical methods that focus on related function to deduce related structure.

Cryptographic methods have already been applied to deduce a basic vocabulary of the genomic language. We will continue to use statistical methods to determine similarities in the language by which seven model viruses can reprogram the cell cycle, then define similarities in the programming languages of those viruses and their host cells.

Students in the Biochemistry course participate by analyzing the molecular steps in the regulation of a single viral or cellular regulatory gene using the biochemical literature, and independent research students analyze molecular "language" by which the individual genes interact into the genetic control network that regulates organismal growth, viral infection, and carcinogenesis.

Kinetics of Oxidation Reactions of Group 6 and Group 12 Atoms in the Gas Phase

Researcher: Associate Professor Mark L. Campbell
Sponsor: Research Corporation

This research has been concerned with the fundamental parameters which affect gas-phase transition metal chemistry. At present we have studied the Group 6 metals tungsten and molybdenum and will be studying the Group 12 metals in the near future. Our primary focus has been to determine the influence electron configuration has on the reactivity of the transition metal. Our other objective has been to carry out a thorough study of the reactions of N_2O with transition metals to determine if the resonance interaction model proposed by Fontijn and co-workers predicts accurate energy barriers for these reactions. The primary conclusion we have drawn from our work is that transition metals with s^1d^{n-1} configurations (where n is the number of valence electrons) tend to be much more reactive than transition metals with s^2d^{n-2} configurations. For example, the s^1d^5 Mo atom reacts near the gas kinetic collision rate with O_2 while the s^2d^4 W atom has a temperature dependent rate constant with an activation energy of approximately 13 kJ/mole. An excited state of W with a s^1d^5 configuration was also found to react near the gas kinetic collision rate.

Kinetics of Gas Phase Oxidation Reactions of Transition Metal Atoms with Oxygen Containing Oxidants

Researcher: Associate Professor Mark L. Campbell
Sponsor: Petroleum Research Fund

The objective of this research is to determine the rate constants for reactions of ground state and low-lying excited state transition metal atoms in the gas phase with oxygen-containing oxidants as a function of temperature and pressure. In particular, three projects are proposed: (1) reactions of transition metals with

N_2O, (2) reactions of ground state and low-lying excited states of niobium and tantalum with several oxidants, and (3) reactions of zirconium and hafnium with water. By obtaining Arrhenius parameters for these reactions, geometric factors and energy barrier effects will be determined. The experimentally measured rate constants and barriers will be analyzed to determine if a relationship exists between these values and the physical properties of the transition metals and reactants. Results for the reactions with N_2O will be compared to the calculated values from a theoretical model developed by Fontijn and co-workers. The reactions of niobium and tantalum will indicate the importance electronic effects have on the reaction rate. The reactions of zirconium and hafnium with water will yield a better understanding of chemical reactions which may occur during accidents in nuclear reactors. Completion of this research will greatly enhance our understanding of transition metal chemical reactions.

Reaction Kinetics of Sc, V, Cr, Co and Ni with N_2O

Researchers: Midshipman 1/C Erica Kolsch, USN
Faculty Advisor: Associate Professor Mark L. Campbell
Sponsor: Trident Scholar Program

The purpose of this experiment was to determine the gas phase reactivities of N_2O with the following first-row transition metal atoms: $Sc(a^2D_{3/2})$, $V(a^4F_{3/2})$, $Cr(a^7S_3)$, $Co(a^4F_{9/2})$ and $Ni(a^3D_3, a^3F4)$. Reactions were studied in the temperature range of 298 - 623 K. Sc, V, Cr, Co and Ni atoms were produced by photodissociation of $Sc(hfa)_3$, $Sc(TMHD)_3$, $V(CO)_6$, $V(CO)_4(C_5H_5)$, $V(C_5H_5)_2$, $Cr(CO)_6$, $Co(C_5H_5)(CO)_2$ and $Ni(C_5H_5)_2$, respectively. Pseudo first-order conditions were maintained ([Transition Metal]<<[N2O]), and atoms were detected using a laser-induced fluorescence technique. Reactions of the ground states with N_2O were temperature dependent. Reactions of Sc, V, Cr and Co with N_2O were found to be pressure independent, indicating a bimolecular abstraction mechanism. Removal rate constants for the excited a^5D_J and a^5S_2 states of Cr were found to be fast compared to reactions with the ground state. The rate constants for Sc, V, Cr and Co can be described in Arrhenius form ($k=Aexp(-E_a/RT)$) by $k=1.5x10^{-10}exp(-11.7$ kJ/mol/RT)cm^3s^{-1}, $k = 4.6x10^{-11}exp(-10.7$ kJ/mol/RT) cm^3s^{-1}, $k = 4.2x10^{-11}exp(-20.4$ kJ/mol/RT) cm^3s^{-1}, and $k = 2.0x10^{-10}exp(-49.1$ kJ/mol/RT) cm^3s^{-1}, respectively. The rate constants for Ni were found to be pressure dependent at low temperature suggesting a intermolecular reaction.

Temperature dependent study of $Ta(a^4F_{3/2})$ and $Sc(a^2D_{3/2})$ with several oxygen-containing oxidants

Researcher: Midshipman 1/C Kelli L. Hooper, USN
Faculty Advisor: Associate Professor Mark L. Campbell
Sponsor: Research Corporation/Petroleum Research Fund

The gas phase reactivity of $Ta(a^4F_{3/2})$ with O_2, N_2O, CO_2 and NO in the temperature range 296 - 548 K was determined. Tantalum atoms were produced by the photodissociation of $[Ta(C_5H_5)(CO)_4]$ and detected by laser-induced fluorescence. The disappearance rates in the presence of all the reactants are independent of total pressure indicating a bimolecular abstraction mechanism. The bimolecular rate constants are described in Arrhenius form by $k(O_2) = (1.7\pm0.2)x10^{-10}exp(-7.8\pm0.4$ kJ/mole/RT) cm^3s^{-1}, $k(N_2O) = (7.1\pm1.0)x10^{-11}exp(-13.6\pm0.6$ kJ/mole/RT) cm^3s^{-1}, $k(CO_2) = (1.0\pm0.1)x10^{-10}exp(-26.8\pm0.5$ kJ/mole/RT) cm^3s^{-1} and $k(NO) = (1.0\pm0.2)x10^{-10}exp(-1.6\pm0.8$ kJ/mole/RT) cm^3s^{-1} where the uncertainties are $\pm2\sigma$. The removal rates of the spin orbit excited states with O_2, N_2O, CO_2 and NO are spin-orbit state dependent and are generally faster than the ground state. The gas phase reactivity of $Sc(a^2D_{3/2})$ with O_2, CO_2, NO and SO_2 in the temperature range 298 - 523 K was also studied. The bimolecular rate constants are described in Arrhenius form by $k(O_2) = (1.7\pm0.4)x10^{-10}exp(-7.9\pm0.7$ kJ/mole/RT)cm^3s^{-1} and

$k(CO_2) = (7.3\pm1.3)x10^{-11}exp(-12.3\pm0.6$ kJ/mole/RT)cm^3s^{-1}. The rate constants with NO and SO_2 were temperature insensitive with room temperature rate constants of $1.5x10^{-11}$ and $2.0x10^{-10}$ cm^3s^{-1}, respectively. The disappearance rates for all the reactants are pressure independent indicating a bimolecular abstraction mechanism.

Deposition of Metals from Lewis Acid Solvent Systems

Researcher: Professor Graham T. Cheek
Sponsor: Naval Research Laboratory

Work carried out this fiscal year at Naval Research Laboratory (NRL) was directed toward the deposition of various metal/aluminum films from the $AlCl_3$: 1-ethyl-3-methylimidazolium chloride room-temperature molten salt system. The reduction of molybdenum, niobium, and tantalum chloride salts in acidic melts was studied by cyclic voltammetry at platinum electrodes, and bulk deposition techniques were used to prepare the metal films on platinum substrates. Elemental compositions of the films were determined by XPS.

Molybdenum reduction in the acidic melt was initially studied by addition of $MoCl_5$ to a basic (N = 0.48) melt, then making the solution acidic by addition of $AlCl_3$ (N = 0.67). In either melt, the solubility was rather low, and voltammetric peaks were low compared to reduction current for aluminum. Similar behavior was seen for solutions in which $MoCl_3$ was added to an acidic melt (N = 0.60). In this case, aluminum deposition was observed at -0.36 V (scan reversal at -0.50 V), with stripping peaks at +0.218 V (major) and +0.576 V (minor). (Potentials are reported with respect to the Al/0.60 melt reference electrode.) The appearance of additional stripping peaks other than that due to stripping of bulk aluminum indicates that some molydbenum was incorporated in the deposited film. Raising the temperature to 80°C increased the solubility of $MoCl_3$ sufficiently to cause the appearance of a process for molybdenum reduction at -0.42 V.

Studies on the niobium/aluminum system began by dissolving $NbCl_5$ in a basic melt (N = 0.48), producing a much more concentrated solution (>50 mM) than was the case for molybdenum. Reversible systems were observed at +0.37 V and −0.72 V; however, after several hours these systems were replaced by a single wave due to interaction with oxide in the melt. In the acidic melt (N=0.52), closely-spaced reduction processes were seen at +1.04 V and +0.86 V, representing the +5/+4 and +4/+3 reduction processes. Although no well-defined reduction to niobium metal was observed, the presence of niobium in the deposit, formed by scanning past the aluminum reduction process, was evident in the additional stripping peaks seen on the positive-going scan. Bulk deposits were formed on 2000 Å platinum films which had been vapor deposited on quartz crystal substrates. At high current densities (average 3 mA/cm^2), a very loosely adherent deposit was formed which was readily removed upon handling. XPS analysis showed that the deposit contained roughly equal amounts of niobium and aluminum.

Molecular Dynamics Study of the Effect of Varying Exothermicity on the Properties of Condensed-Phase Detonation

Researcher: Professor Mark L. Elert
Sponsor: Naval Research Laboratory, Code 6179

To investigate the role of exothermicity on the properties of a chemically sustained shock wave, a series of two-dimensional molecular dynamics simulations was carried out in which the exothermicity was systematically varied. The simulations were based on a model diatomic system which has been previously shown to produce reasonable values for shock wave properties. Sensitivity to initiation of detonation, shock wave velocity, and peak temperature and particle density in the reaction zone were all studied as a function of the amount of energy released in the reaction of the model energetic material.

Laboratory Studies of Ices Deposited on Amorphous Silicate Grains

Researcher: Associate Professor Robert F. Ferrante
Sponsors: NASA/Goddard Space Flight Center and the Kinnear Foundation

Recent work has indicated that the use of silicate grain analogs as a substrate for simple ices of astrophysical interest (H_2O, CH_3OH, etc.) may have an effect on the crystallization behavior of those ices in laboratory studies. The ices are observed to form in the crystalline phase, even during deposition at temperatures near 10 K; in contrast, similar studies performed in the absence of the silicate lead only to amorphous ices on low temperature deposition. Comets and other interstellar objects are believed to have formed by the accretion of silicate grains upon which volatile molecules have condensed as ices; the particles may have undergone various types of processing both before and after accretion. Laboratory studies of the type described above have been used to model such condensation processes, and their results employed in the interpretation of the thermal history of the natural systems. Such models have always assumed the formation of amorphous ice at low temperatures; the recent results suggest a re-evaluation of that assumption. The work performed here is designed to expand the range of observations and conditions affected by the presence of the silicate surface, and to explore in more detail the mechanistic implications of these and earlier results. The goal is to provide a better understanding of the significance of these observations towards interpretation of astrophysical data.

This work continues in an attempt to examine the generality of the effect, and to explore the cause. Work on other treatments of the silicate smokes (oxidation, reduction, re-use) has identified two very different types of behavior for the spectral absorbances of deposited ices. These suggest that the effect of porosity of the silicate is significant, and that it can be readily changed. In a few instances, we have been able to destroy the low temperature condensation effect by such treatments. Additional efforts in that area are continuing. The use of Raman spectroscopy for diagnostic purposes has been explored. Research indicates that it would NOT be advantageous as a crystallization indicator with deposited methanol, but could be quite useful with other volatile ice materials like CS_2 and SO_2, where intense transitions show significant changes on crystallization. That work is also still continuing. Another new avenue being explored is the application of quartz-crystal microbalance techniques. This has succeeded at room temperature, but remains to be incorporated into the low-temperature system, a fairly major undertaking When completed, it will permit quantification of coverage levels required for the onset of the low-temperature crystallization phenomenon by measuring mass changes, from the added ice, at the nano- to micro-gram level.

Molecular Dynamics Investigations of the Tribology of Diamond Surfaces and Films

Researcher: Dr. Steven J. Stuart (postdoctoral associate), Assistant Professor Judith A. Harrison, Dr. Martin D. Perry, Jr. (postdoctoral associate),
Sponsor: The Office of Naval Research

Friction and the related phenomenon of wear are two of the more costly problems facing industry today. Understanding and ultimately controlling friction and wear has long been recognized as being central to many areas of technology. For instance, combustion engines break down and cutting tools become dull usually because of friction induced wear. Despite the obvious importance of friction and the induced wear, much of the atomic-scale dynamics responsible for these phenomena remain elusive. If the atomic-scale origins of friction and wear were understood, this might ultimately lead to the design of materials with specific friction and wear properties.

Molecular dynamics (MD) simulations have been used to investigate the atomic-scale origins of friction and wear in hydrocarbon systems. Previously, the atomic-scale friction that resulted when two diamond (111) surfaces were placed in sliding contact was

examined. The friction and tribochemical reactions were examined as a function of load, sliding direction, and chemisorbed groups on the diamond surface. Using MD simulations has proven useful in examining atomic-scale friction and relating the results to experimental data. For example, tribochemical reactions and their atomic-scale mechanisms were cataloged. These reactions and their products were consistent with inferences drawn from macroscopic friction experiments on diamond. In addition, the frictional properties of diamond (100) were investigated and shown to be similar to the behavior on the diamond (111) surface in agreement with atomic force microscope data.

More recently, hydrocarbon (third-body) molecules were trapped between two diamond (111) surfaces in sliding contact. The molecules acted as a boundary-layer lubricant and markedly reduced the atomic-scale friction compared to the same system in the absence of these molecules. The friction reduction was also shown to depend on the identity of the trapped molecule. The atomic-scale origins of this behavior were identified.

Investigation of the Atomic-Scale Mechanical Properties of Hydrocarbon Materials and Ultra-Thin Films

Researcher: Assistant Professor Judith A. Harrison
Sponsor: The Office of Naval Research (via University of Kentucky)

Traditionally, mechanical properties such as elastic modulus and hardness have been extracted from experimental data that measure the penetration of a macroscopic indentor into a material as a function of load. The advent of nanotechnology and nanofabrication, and the concomitant production of nanometer-scale devices, has underscored the need for new techniques to measure the nanomechanical properties of small devices and ultra-thin films. Recently, the atomic force microscope has been used to investigate the mechanical properties of materials on the microscopic level.

With this in mind, molecular dynamics simulations have been employed to investigate the indentation of diamond covered by amorphous-carbon films. These simulations have been undertaken to investigate the elastic moduli of the films, the effect of the film thickness on the indentation, and to discover the atomic-scale mechanism of indentation. Where appropriate, simulations results will be compared to experimental atomic force microscope data.

Supramolecular Inclusion of Non-Linear Optical Chromophores by Amylose

Researcher: Assistant Professor William B. Heuer
Sponsor: Naval Research Laboratory (ONR)

This project is being pursued in collaboration with Dr. Oh-Kil Kim of the Naval Research Laboratory. Supramolecular inclusion complexes of cationic hemicyanine dyes with low molecular weight amylose can be cast into films exhibiting promising non-linear optical (NLO) properties, however the NLO response of these films is currently insufficient for practical device applications. The goal of this reasearch project is to improve the NLO properties of these films by increasing the number density of chromophores in the films and/or enhancing non-linear susceptibility of the chromophore in the films. Accordingly, oligomeric assemblies of oriented hemicyanine chromophores with optimal structures for amylose inclusion are being synthesized. Size exclusion of large counterions from supramolecular complexes of cationic hemicyanine dyes is being explored as a means of increasing the intrinsic dipole strength of the chromophore. These approaches should permit the preparation of materials with improved NLO properties, while at the same time providing insight into the fundamental intermolecular interactions responsible for formation of these novel supramolecular systems.

Preparation of Organic Radiotracers

Researcher: Assistant Professor Chris M. Kinter
Sponsor: Naval Academy Research Council (ONR)

The use of radiotracers for the study of biochemical processes in animals relies heavily on the isotopes C-14 and H-3. Only with the advent of the use of the short-lived, positron emitting isotopes (C-11, N-13, O-15, F-18) and the radioisotopes of iodine (I-123, I-125) have the means become available for extending these studies directly to human subjects. Two imaging modalities using the short-lived isotopes, Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT), provide the means for noninvasive measurement of neurotransmitter receptor densities and metabolic change in human subjects. In this research neuroreceptor ligands are designed, synthesized, fully characterized, and radiolabeled with either tritium, the positron-emitting isotopes (C-11, F-18), or the radioisotopes of iodine (I-123, I-125). This work is done in collaboration with researchers in the Division of Radiation Health Sciences at The Johns Hopkins University Medical Institute.

Current efforts have focused on the synthesis of labeled compounds for the study of the delta opioid receptor. Past research resulted in the preparation of [11C]methylnaltrindole ([11C]MeNTI), the first radioligand which selectively labels the delta opioid receptors in vivo in the human brain following systemic administration. The ligand [11C]MeNTI has proven to be useful in the study of the involvement of the opioid neurotransmitter system in seizure mechanisms. It is now clear that the opioid-receptor subtypes play distinct roles in seizure phenomena. Current efforts have focused on the preparation of fluorine-18 labeled analogs of naltrindole. These analogs should retain the same selectivity and potence as native naltrindole for the delta opioid receptor. Additional benefits should be realized with respect to the ease of the preparation of the labeled compounds and enhanced image quality due to the decay characteristics of F-18 relative to C-11.

This research program has been designed so that students may make significant contributions to the research effort. Within the project are opportunities for organic methodology development, target oriented synthesis, and the study of the incorporation of radioisotopes into pharmacologically important molecules. In so doing, additional experience will be gained by the student in all phases of synthetic organic chemistry, in addition to acquiring knowledge of radiochemical synthesis and the methods involved in drug development.

Depletion Kinetics of Niobium Atoms in the Gas Phase

Researcher: Assistant Professor Roy E. McClean
Sponsor: Naval Academy Research Council (OMN)

The gas phase depletion kinetics of the two lowest terms of niobium in the presence of O_2, SO_2, CO_2, N_2O, and NO were studied in order to determine the effect of niobium's electron configuration on its depletion kinetics. The a^6D_J ground term has a $4d^45s^1$ electron configuration, and the first excited term, a^4F_J, has a $4d^35s^2$ electron configuration. The niobium atoms were produced by the 248 nm laser photodissociation of $Nb(C_5H_5)(CO)_4$ and detected by laser-induced fluorescence. In these types of experiments where a transition metal precursor is photodissociated, there is always the possibility that collisional cascading and/or the unimolecular decay of an energized photofragment into the state of interest might be important. Therefore, in addition to conducting experiments in neat argon buffer, we investigated the niobium + oxidant reactions in the presence of nitrogen, sulfur hexafluoride, and methane. These gases were used in order to test photochemical and physical effects since these molecules are expected to be more efficient quenchers than argon. We found that Nb reacted with both nitrogen and sulfur hexafluoride. Thus, a mixture of argon and methane was used as the buffer. Niobium was found to be very reactive towards all of the oxidants at room temperature. The ground term of niobium, with its $4d^45s^1$ electron configuration, was more reactive than the first excited term. These results are interpreted in terms of the more attractive s^1 electron configuration.

Association Reactions of Iron and Ruthenium with Nitric Oxide

Researcher: Assistant Professor Roy E. McClean
Sponsor: Research Corporation

The association reactions of ground state iron and ground state ruthenium with nitric oxide in the gas phase were studied at room temperature over the total pressure range 5 - 700 Torr. Iron and ruthenium atoms were produced by the 248 nm laser photodissociation of ferrocene and rutheneocene, respectively. Detection of the formed transition metal atoms was by laser-induced fluorescence. Two buffer gases were used in this work: argon and nitrogen. Reaction rates were faster in nitrogen buffer for both reaction systems (Fe + NO and Ru + NO). Ruthenium was found to be more reactive towards nitric oxide than iron. This observation is interpreted in terms of the different electron configurations of the transition metal atoms. Ground state iron has a $[Ar]3d^64s^2$ configuration and ruthenium has a $[Kr]4d^75s^1$ configuration. The singly occupied s orbital of ruthenium might overlap favorably with the single electron of nitric oxide, thus forming a bond. Since ground state iron has a closed s-subshell, electronic repulsive effects are encountered in the reactive surface of Fe + NO.

The Distribution of Hydrogen Peroxide, Methyl Hydroperoxide and Formaldehyde and their Relationship to Tropospheric Oxidant Chemistry over the Equatorial South Pacific

Researchers: Assistant Professor Daniel W. O'Sullivan and Dr. Brian G. Heikes (URI)
Sponsor: National Aeronautics and Space Administration

Hydrogen peroxide and methylhydroperoxide, are important compounds in the chemical cycles of O_3 and SO_2 in the troposphere. Although oxidation of sulfur dioxide by O_3 and H_2O_2 is thermodynamically possible in the gas phase, the reactions are kinetically inhibited and do not occur to a substantial extent. However, hydroperoxides and O_3 are effective aqueous oxidants of dissolved SO_2 in atmospheric aqueous phases (cloud drops, rain, and fog). Hydrogen peroxide is believed to be the dominant oxidant for SO_2 in atmospheric aqueous phases with pH < 5. In addition H_2O_2 and CH_3OOH are intimately involved in the odd-hydrogen ($\bullet OH$, $HO_2\bullet$, and $CH_3OO\bullet$) and odd-oxygen chemistry of the atmosphere. H_2O_2, CH_3OOH and HNO_3 are the main reservoirs for these radicals in the troposphere. Their photolysis produces odd hydrogen species, of which hydroxyl radical is the most abundant. Hydroxyl radical is the most significant oxidant and cleansing agent of the troposphere. Removal of H_2O_2 and CH_3OOH by reaction with hydroxyl (OH) or by deposition are the principal removal pathways for these radicals. Either directly or through the above radicals, hydroperoxides are involved in the conversion of sulfur, nitrogen, and carbon compounds to their acidic forms in atmospheric water.

The gas phase kinetics of H_2O_2 and CH_3OOH formation and destruction have been studied and their atmospheric concentration appears to be in agreement with photochemical models when the effects of rapid transport or heterogeneous processes are negligible. The simpler alkyl-hydroperoxides are believed to be produced by the reaction of hydroperoxyl radical with alkyl-peroxyl radicals, and lost by photolysis and reaction with OH. Consequently in the free troposphere the concentration of H_2O_2 and CH_3OOH can be used as constraints on odd hydrogen chemistry. During this field project the measurements of H_2O_2 and CH_3OOH will be used to improve our understanding of S(IV) oxidation and O chemistry in the lower troposphere over the tropical Pacific.

Electrodeposition of Aluminum Alloys from Ambient-Temperature Molten Salts: Preparation and Characterization

Researchers: Major Paul C. Trulove, USAF
Professor Graham T. Cheek
Sponsor: Air Force Office of Scientific Research (AFOSR)

Aluminum alloys with enhanced resistance to chloride-induced pitting corrosion have been produced using solute elements such as Ti, Cr, Mn, Cu, Zr, Nb, Mo, Ta, and W. These "stainless" aluminum alloys are of interest both for use as bulk deposits and as coatings over existing structural aluminum alloys. Producing improved corrosion resistance in the aluminum alloys often requires solute concentrations (up to 50 atom percent, a/o) that are far in excess of the equilibrium solubility limit (ca. 1 a/o). Consequently, nonequilibrium methods such as sputter deposition, melt spinning, and ion implantation have been employed to prepare these metastable single-phase aluminum alloys. Unfortunately, these techniques are of limited commercial utility because of their high inherent cost and the difficulty associated with their application to large structures. Electrochemical deposition is an alternative method for producing nonequilibrium aluminum alloys that generally does not suffer from the cost and applicability disadvantages of the above methods.

Room-temperature molten salts provide some unique properties which make them ideal for studying the deposition of aluminum and aluminum alloys. Aluminum can be reversibly electrodeposited from acidic melt compositions. The molten salts readily solubilize both ionic and molecular species, they possess a wide electrochemical window, they have high intrinsic conductivities, and they are thermally stable over a very wide temperature range.

We have demonstrated the deposition of Al-Mn, Al-Co, Al-Ni, Al-Nb, and Al-Cr from the molten salts. Characterization of these deposits shows them to be non-equilibrium alloys with solute concentrations up to 80 a/o. Aqueous corrosion studies indicate significant improvement in the chloride pitting potential over unalloyed aluminum.

Computational Investigations of Conformational Effects Involving Aromatic Rings

Researcher: Assistant Professor Joseph J. Urban
Sponsor: Office of Naval Research

Aromatic rings are present in a variety of natural and synthetic materials ranging from proteins to polymeric resins. The local conformational ramifications of aromatics rings have traditionally been understood in terms of the steric repulsive requirements of aryl groups. However, many interesting attractive electronic interactions involving aromatic rings have been reported in the literature. These include aryl---gamma-heteroatom interactions, C-H---pi interactions between aryl groups and neighboring alkyl groups, and p-stacking interactions between adjacent aryl groups. Here, a systematic investigation of these interactions using high-level ab initio calculations is proposed. The purpose of this work is to elucidate the nature and magnitude of these interactions by examining the substituent effects computationally. Also, the ab initio data acquired in this work will be extremely useful in evaluating molecular mechanics force fields in their description of these subtle electronic effects. This is of great interest because classical potentials are crucial in modeling the properties of macromolecules through molecular mechanics and molecular dynamics techniques.

Research Course Projects

Construction of a Beam/Gas Chamber

Researchers: Midshipman 1/C Cory Gaconnet, USN and
Midshipman 1/C Jonathan Forsberg, USN
Faculty Advisor: Associate Professor Mark L. Campbell

The purpose of this project was to construct a chamber in which an atomic beam will be used to study single collision events. Significant progress was made in putting together the chamber. Various pieces were designed and constructed. Vacuum tests will be performed shortly.

Developing Methods in Capillary Electrophoresis for the Detection of Several Toxins in the Human Body

Researcher: Midshipman 2/C David P. Durkin, USN
Faculty Advisor: Assistant Professor Christine L. Copper

Hemoglobin is the protein found in blood that is responsible for the transport of oxygen and carbon dioxide throughout the body. It can also transport other dissolved gasses, such as carbon monoxide and cyanide, which are harmful, and sometimes fatal. Current methods for detecting concentrations of carbon monoxide in the human body involve lengthy derivatization procedures followed by spectroscopic measurements. These methods are time-consuming and technically difficult because of the many manipulations they require.

Capillary electrophoresis (CE) could be used to quantify this poisonous gas in hemoglobin. This technique does not require derivatization of the hemoglobin samples prior to analysis, thus reducing sample loss and analysis time. Also, CE separations require minute amounts of sample, which is advantageous, as oftentimes, there is little blood left in bodies of fire victims suspected of dying from overexposure to carbon monoxide gases.

It was shown that difficulties related to proteins adhering to the silica capillary columns can be overcome by altering the pH of the running buffer to a level at which the protein will be protonated (pH of 3.5). However, hemoglobin samples need be prepared in a solution having a pH closer to physiological pH (around 7) such as to avoid degradation. A retention time difference on the order of a minute (9 minute total run time) was observed between hemoglobin and carbon monoxide-saturated hemoglobin samples. However, optimum exposure time for the hemoglobin samples to carbon monoxide and methods to account for the presence of hemoglobin variants have yet to be determined.

Synthesis of a Soluble Perfluorinated Tetraaza-porphyrin

Researcher: Midshipman 1/C Christopher Holloway, USN
Faculty Advisor: Associate Professor Jeffrey Fitzgerald

Oxidative dimerization of 2,3,4,5,6-pentafluorophenylaceto- nitrile yielded a *cis/trans* mixture of 1,2-bis(pentafluorophenyl)-1,2-dicyanoethylene in fair yield. These could be separated by flash chromatography on silica gel. The *cis* isomer was easily converted to a soluble perfluorinated tetraazaporphyrin by Linstead's method of reductive cyclization around a Mg^{+2} ion template. This macrocycl spectroscopic properties which show the effect of the strongly withdrawing e shows several unusual chemical and fluoro substituents on the central metal binding cavity and suggest that its metal complexes may be useful oxygenation catalysts. The *trans* isomer of the macrocycle precursor could be isomerized to the synthetically useful *cis* isomer.

Synthesis of Fluoroethyl Naltrindole: A Ligand for the Study of the Delta Opioid Receptor

Researcher: Midshipman 1/C Eric A. Bowen, USN
Faculty Advisor: Assistant Professor Chris M. Kinter

Binding studies have shown there to be three opioid receptor types (mu, delta, and kappa). The delta receptor has been identified as playing a role in neuropsychiatric, neurodegenerative and seizure disorders, in the modulation of morphine tolerance and dependance, and the neurobiology of substance abuse. The ability to selectively label the delta receptor sites has the potential for positive impact upon the study of opioid receptor function in healthy subjects and in a number of patient populations. Carbon-11 labeled methylnaltrindole, an analog of the delta selective ligand naltrindole, has previously been prepared and has undergone evaluation as an imaging agent in normal subjects as well as seizure patients. As an extension to this research, work was begun on the synthesis of N1'-fluoroethyl naltrindole (FEtNTI) to take advantage of the decay characteristics of fluorine-18 relative to carbon-11. Several routes for the synthesis of FEtNTI were explored. Ultimately, the most efficient route required initial preparation of 1-phenylhydrazinopropionitrile. This substituted hydrazine was found to undergo Fisher-Indole cyclization with naltrexone hydrochloride in high yield to give the corresponding N1'-substituted naltrindole. A sequence of functional group manipulations led to the production of the required precursor for radiolabeling, albeit in low yield. Future work will focus on optimization of the reaction conditionsleading to the precursor compound and exploring the conditions necessary for production of radioactively labeled [F-18]FEtNTI.

Conformational Analysis of Acetylcholine and Related Compounds

Researcher: Midshipman 2/C Curtis W. Cronin, USN
Faculty Advisor: Assistant Professor Joseph J. Urban

Acetylcholine is a major neurotransmitter in both the central and peripheral nervous systems. The cholinergic nerve transmission system is of particular importance to the military because this system is the target of the organophosphorous G nerve agents. The mechanism of action of these agents is to block nerve transmission by inhibition of the enzyme acetylcholinesterase, an essential component of the nerve transmission process. Upon binding to its receptor acetylcholine undergoes a conformational change. The energy cost associated with this conformational change, however, is not known and is extremely difficult to estimate experimentally. In this work a combination of molecular modeling techniques are being employed to determine the difference in energy between the bound and unbound conformations of acetylcholine. Additional goals of this work include establishing the effects of substituents and the surrounding environment on the conformational preferences of acetylcholine and similar systems.

Independent Research

Investigations of Nitrile-based Chloroaluminate Systems For Organic Electrochemistry

Researcher: Professor Graham T. Cheek

Recent studies in chloroaluminate solvent systems have usually involved work with room-temperature molten salt systems, most commonly the aluminum chloride : 1-ethyl-3-methylimidazolium (EMIC) system. These systems provide a wide range of acidity between the acidic and basic melts, in which the acidic and basic species are $Al_2Cl_7^-$ and Cl^-, respectively, and are also applicable to studies of organic compounds.

Unfortunately, these systems require considerable preparation of the melt components, and a more convenient system is highly desirable. It is known that aluminum chloride dissolves in acetonitrile (AN) to form highly conductive solutions containing $Al(AN)_5Cl^{2+}$ and $AlCl_4^-$, presenting an opportunity for use of this solution as a chloroaluminate solvent system for organic compounds. The positive limit is similar to that seen in the $AlCl_3$: EMIC system and indicates that no easily oxidizable species are present. Very little cathodic current is evident even at potentials more negative than -1.80 V, whereas aluminum deposition occurs readily in the $AlCl_3$: EMIC system at the corresponding potential. As the potential is swept to more negative values, considerable filming of the electrode occurs, as seen by distortion of the voltammetric waves for ferrocene in the solution. It is possible that this film formation prevents aluminum deposition; however, this situation provides almost an additional volt in potential range, compared to the $AlCl_3$: EMIC system, before appreciable filming occurs.

Considering the profound differences in electrochemical behavior seen in acidic and basic melts, formation of the analogous basic regime has also been studied. Addition of chloride as tetraethylammonium chloride results in a solution containing chloride and $AlCl_4^-$ ions, and produces a cathodic limit at -3.2 V vs ferrocene and an anodic limit at +0.8 V (chloride oxidation).

As an example of the usefulness of this system in organic electrochemistry, the voltammetric behavior of benzophenone was investigated. Benzophenone undergoes reduction as a broad process at approximately -1.1 V in the acidic regime, with a shift to -2.05 V in the basic solvent system. This finding is in accord with the behavior observed for benzophenone in the $AlCl_3$: EMIC system and indicates that benzophenone is complexed in the acidic system by aluminum chloride. It is evident, then, that the $Al(AN)_5Cl^{2+}$ species can act as a Lewis acid toward carbonyl functions in the solution.

Synthetic Lubricants and High Performance Fluids

Researcher: Associate Professor Frank J. Gomba

Phosphazenes are ring or chain compounds consisting of alternating phosphorus-nitrogen atoms with two substituents attached to the phosphorus. Representative structures are shown below. In these structures, R can be a halogen, organo, or organometallic substituent; X is generally a halide or a metal halide counterion. The physical properties of phosphazenes vary considerably with molecular weight and choice of substituents (R).Many of the cyclic phosphazenes are either liquids or low melting point crystalline solids. As the molecular weight is increased, increasing either by the size of the substituent or the number of P-N repeating units, one can obtain oils or greases; ultimately elastomers and thermoplastics are formed. Phosphazenes are of interest in applications where fire resistance and thermal stability are important considerations. Due to the presence of phosphorus and nitrogen, phosphazenes are inherently fire resistant. Halogen containing substituents further enhance fire resistance. With the proper selection of substituents, thermally and hydrolytically stable ring and chain compounds, including fluids with low pour points and good thermal stability, have been prepared. These may be referred to as “polymers”, but, reservation of this term should be made for n > 100. The chapter discuses the preparation of phosphazenes, including early work, prior to 1960. In the sixties, the Navy supported the development of cyclophosphazenes as fire resistant, compression-ignition hydraulic fluids to meet the requirements of MIL-H-19457A. Renewed interest was started in the 1980s as alternate synthetic procedures were able to optimize fluid composition and modern characterization techniques became available that could more accurately analyze product composition. Of the many phosphazenes prepared, the most promising for the Navy was one synthesized by phase-transfer catalysis (PTC), bulk addition, and a mixture of alkyphenols (*m*- and *p*- methylphenol), phenol, and trifluoroethanol: $N_3P_3(OCH_2CF_3)_{3.5}(OC_6H_5)_{1.25}$ $(OC_6H_4\text{-}m\text{-}CH_3)_{0.87}(OC_6H_4\text{-}p\text{-}CH_3)_{0.38}$. A copper corrosion inhibitor (tolytriazole) was formulated into the fluid which proved to have better fire resistance, thermal and hydrolytic stability and paint compatibility than MIL-H-19457 phosphate ester; a more commonly used hydraulic fluid. In addition, the fluid showed low toxicity; unlikely to cause any health problems if used in shipboard hydraulic system applications. Only the cost caused the curtailment of the project ($144/gallon). Other applications of phosphazenes are included in this chapter involving not only phosphazenes which are fluids, but also those that are grease-like. Newer formulations and mixtures with

other constituents have found uses in electrical conduction applications, as well.

Metallocrown Ethers Based Upon Metal Bis-Dithiolene Complexes

Researcher: Assistant Professor William B. Heuer

Redox-active molecules incorporating metal-ion binding sites are of interest as sensors or for the controlled uptake/release of metal ions. Previously, we have described the synthesis and electrochemistry of metal-dithiolene complexes bearing peripherally-appended crown ether binding functionality, and have shown that the redox potentials of these anionic complexes can be influenced by the binding of alkali metal cations at the crown ether site. That work has now been extended through preparation of a new series of anionic metal bis-dithiolene complexes in which the chelating dithiolene ligands are linked by tetra- and penta(ethylene glycol) bridges. The resulting metallo-cyclophane structures incorporate coordinated sulfur atoms of the electroactive metal bis-dithiolene core directly into the metal ion binding site, which should significantly enhance the shifts in redox potential observed upon binding of alkali metal cations. The spectroscopic and electrochemical properties of these complexes are currently being investigated.

Synthesis and Characterization of Acidic Pillared Metal(IV) Phosphates

Researcher: Associate Professor Joseph F. Lomax

The project objectives are to synthesize and characterize a series of pillared metal phosphonates whose properties will be rationally adjusted by changes in the pillar length and functional groups attached to the pillar. This will involve three parts. First, organic diphosponates with functional groups (**1**) will be the synthesized. Next, pillared metal diphosphonates will be the made

$(HO)_2(P=O)\text{-}(CH_2)_n\text{-}CHX\text{-}(CH_2)_n\text{-}(P=O)(OH)_2$ (n = 1,2,3; X = -OH, $-SO_3^-$, etc.)

by reacting the diphosphonates and phosphoric acid with metal oxychlorides(**2**).

$$MOCl_2 + 2x\ H_3PO_4 + (1\text{-}x)\ \mathbf{1} \rightarrow M(PO_4)_{2x}[(PO_3)\text{-}(CH_2)_n\text{-}CHX\text{-}(CH_2)_n\text{-}(PO)_3]_{1-x} + 2\ HCl + H_2O$$

Finally, structural, thermal, electronic and chemical properties of these compounds will be measured. Properties to be investigated include: 1) the pillar arrangement that can be deduced from powder and crystal X-ray diffraction and computer molecular modeling, 2) the number and thermal stability of the layer/pillar bonds and the water resident between the pillars investigated by thermal gravimetric analysis interfaced with infrared spectroscopy or gas chromatography, 3) the mechanism and magnitude of ion (in particular proton) conductivity as determined by audio frequency impedance/admittance measurements using state of the art devices; 4) the intercalation and ion exchange behavior of these compounds.

Structural Studies of Organic Ionic Crystals

Researcher: Associate Professor Wayne Pearson

In conjunction with Dr. Joan Fuller of Covalent, Inc., several crystals of ionic organic solids have been investigated. While a number of these materials were not of sufficient quality to yield structures, success was obtained with one tetraborate salt. Publication is pending.

Photochemical Study of Cyano-Isocyanide-PhosphineComplexes

of Iron and Ruthenium

Researcher: Professor J. 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, $(\eta^5\text{-}C_5H_5)Fe(CO)(CN)(CNCH_3)$, in the presence of a slight excess of triphenylphosphine at room temperature gave the desired product $[(\eta^5\text{-}C_5H_5)Fe(CN)(CNCH_3(PPh_3)]$ with loss of one equivalent of carbon monoxide. Two additional products have been obtained, however: one is $(\eta^5\text{-}C_5H_5)Fe(CNCH_3)_2(CN)$ and the other one is $(\eta^5\text{-}C_5H_5)Fe(CN)(PPh_3)_2$. 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 conclusively identify 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 Prof. Rest. Work on the project is continuing with a shift in focus to the analogous ruthenium species. Manuscripts on the synthetic portions of the project as well as the spectroscopic matrix work are being prepared and final spectral data is being obtained for inclusion in the papers.

Pentaphenylcyclopentadienyl Derivatives of Molybdenum and Tungsten Carbonyls

Researcher: Professor J. E. Shade

Previous work by this collaborative team (including Professor Rheingold - University of Delaware and Professor Bitterwolf - University of Idaho) examined the synthesis and chemistry of substituted cyclopentadienyl metal compounds in which simple functional substituents were introduced at one or two of the carbons of the 5-membered cyclopentadienyl ring. The focus of this research was the chemistry of molybdenum and tungsten carbonyl compounds containing sterically encumbered pentaphenylcyclopentadienyl rings. Research by Tyler, et al., had demonstrated that $[(Ph_5C_5)Mo(CO)_3]_2$ formed an equilibrium with two $(Ph_5C_5)Mo(CO)_3$ radical species. $[(Ph_5C_5)M(CO)_3]_2$, where M = Mo or W, was prepared following the low-temperature anion oxidation route developed by Tyler. Photolysis of the metal-metal bonded dimers in the presence of a chlorocarbon gave $(Ph_5C_5)M(CO)_3Cl$ derivatives, as expected by radical reactions. Both the molybdenum and tungsten hexacarbonyl dimers demonstrated thermal and photochemical carbonyl loss to give tetracarbonyl, triply bonded derivatives. Reaction of the $(Ph_5C_5)M(CO)_3$ anions with R-Cl, where R = CH_3, CH_2Ph, and $CH_2\text{-}CH{=}CH_2$, yield the expected $(Ph_5C_5)M(CO)_3R$ derivatives. The use of allyl bromide, however, was found to yield the unexpected product of $(Ph_5C_5)M(CO)_3Br$. Photolysis of $(Ph_5C_5)M(CO)_3\text{-}CH_2\text{-}CH{=}CH_2$ gives the tri-hapto-allyl derivative in good yield. Reaction of the metal $(Ph_5C_5)M(CO)$ anions with HBF_4 gave the corresponding hydridic species. Although all the compounds synthesized in this study have been found

to be remarkably stable in air, there is no other obvious effect on the chemistry resulting from the protective umbrella of the Ph_5C_5 ligand.

Conformational Analysis of Biologically Active Compounds

Researcher: Assistant Professor Joseph J. Urban

This work has focused on solvent and substituent effects on the conformational preferences of phenethylamine compounds. Phenethylamines make up an important class a bioactive compounds. This molecular framework is present in amino acids, hormones, neurotransmitters and drug compounds. The research underway involves calculations with a rvariety of molecular modeling techniques. Experimental information about a molecule's conformational potential energy surface is only obtainable for simple systems. The use of computer modeling allows for the study of conformations in all regions of the potential energy surface for complex systems. In the current work, particular attention has been paid to the effect of solvent as well as ring-substituents on the conformational preferences.

The results thus far indicate that there is a strong preference for gauche (folded) conformations of phenethylamines. This preference exists in the gas phase for both the neutral and N-protonated systems. The substituent effects indicate that this interaction is largely electrostatic in nature and is akin to the intermolecular "pi-cation" interactions that are important in molecular recognition. When the effects of an aqueous medium are included in the calculations the folded and extended (anti) forms are similar in energy.

Charge Delocalization in Fluoromethyl Fluorophenols: Model Compounds for Fluorinated Tyrosines

Researchers: Assistant Professor Joseph J. Urban and Captain Robert L. von Tersch, USA

This work involves computational investigations of the degree of charge delocalization from a phenol oxygen atom to a fluoromethyl group located in the para position. The effect of ring fluorination on this charge delocalization is also being examined. The motivation for this work is that fluoromethyl phenols represent model compounds for the beta fluorinated derivatives of the amino acid tyrosine. These compounds are substrates for the enzyme tyrosine phenol-lyase (TPL). TPL catalyzes the cleavage of the phenol portion of tyrosine and has been used to stereoselectively synthesize fluorinated derivatives of tyrosine. The beta fluoro tyrosines have a short lifetime under the reaction conditions presumably due to the elimination of fluoride. The lifetime is extended when the ring is also fluorinated. In the current research ab initio calculations are being carried out to examine the effect of ring fluorination and aqueous solvation on the electronic charge distribution in these compounds.

Publications

BODNAR, John W., Assistant Professor, co-author, The Emergence of a Command Network. *Naval War College Review* (Autumn 1996), 93-107.

At every level the effectiveness of any organization is dependent on how well the individuals in the unit can cooperate in a rapidly changing environment dependent on the flow of information or commands among its individual parts. Therefore, the effectiveness of any organizational structure depends directly on the ability of the individuals composing the unit to communicate among themselves. We suggest that in the current Revolution in Military Affairs huge changes in organizational doctrine are emerging -

where the military's ability to communicate on a global scale has provided a exceptional opportunity to enhance organizational effectiveness. Organizational structures, though drawn as they were fifty years ago, actually operate very differently in the Information Age. Accordingly, organizational operation and doctrine which was effective in the past for very small units can now be effective for an entire joint military. The emerging national military organization, which we term a command network, has the strengths of both a network and a hierarchy. An unexpected result of using the command network in increasingly larger organizations is that the responsibilities of the individuals and leaders have changed dramatically. We suggest new guidelines for leadership and doctrine in a command network that go beyond TQL and leadership by negation.

BODNAR, John W., Assistant Professor, co-author, "A Chromatin Switch." *Journal of Theoretical Biology* 183 (1996), 1-7.

Cellular and molecular bioloigcal approaches that study eukaryotic gene regulation have led to separate models which describe strucutre and mechanism with differing precision. Using principles of combinatorial and cooperative interactions inherent in both models, we have extended concepts derived from a "genetic switch" for prokarytoes to a chromatin switch for eukaryotes composed of DNA, transactivators, nucleosomes, and the nuclear matrix. We present a consensus model for gene regulation that uses a simple Monte Carlo method for simulating condensation and extension of chromatin. Such a chromatin switch can be modulated by known biochemical and moleculaar modifications, and the transactivator binding sites or enhancers within the DNA domains can be organized into a hierarchy to control cell cycling and differentiation.

BODNAR, John W., Assistant Professor, co-author, Digital Simulation of Organismal Growth, U.S. Patent #5,621,671, 15 April 1997.

The growth and development of a biological organism reflected as a series of molecular and cellular processes by chromatin switching networks, form threshold mechanisms applied through simulation transcription rules to pattern formations of a digital approximation of regulator concentration gradient. Digital logic statements are derived from such pattern formations to simulate the growth and development of the organism.

CAMPBELL, Mark L., Associate Professor, "A Systematic Method for Determining Molecular Term Symbols for Diatomic Molecules Using Uncoupled States Orbital Diagrams," *Journal of Chemical Education*, 73 (1996), 749-751.

A systematic method for determining molecular term symbols for diatomic molecules using uncoupled states orbital diagrams is described. Using this method, molecular terms symbols for a particular molecular orbital electron configuration are determined from the possible combinations of quantum numbers of the individual electrons. Two examples are included to illustrate the method.

CAMPBELL, Mark L., Associate Professor, "Kinetic Study of the Reaction of Ru(a^5F_5) with N_2O and O_2 from 296 to 623 K," *Journal of the Chemical Society, Faraday Transactions*, 92 (1996), 4377-4384.

The gas phase reactivity of Ru(a^5F_5) with N_2O and O_2 in the temperature range 296 - 623 K is reported. Ruthenium atoms were produced by the photodissociation of ruthenocene and detected by laser-induced fluorescence. The reaction rate of the ground a^5F_5 state with N_2O is very slow and temperature dependent. The bimolecular rate constant exhibits marked non-Arrhenius behavior. The rate constants are described by the empirical relation $\ln(k) = (-54.4\pm0.2) + (3.95\pm0.04)\ln T$ or, alternatively, by the biexponential relation $k(T) = (1.3\pm0.3)\times10^{-12}\exp(-11.1\pm0.5 \text{ kJ/mole}/RT) + (1.9\pm1.9)\times10^{-10}\exp(-37.8\pm5.7 \text{ kJ/mole}/RT)$ cm^3s^{-1} where the uncertainties are $\pm\sigma$. The disappearance rates in the presence of N_2O are independent of buffer gas identity (Ar or N_2) and total pressure indicating a bimolecular abstraction mechanism. The reaction rate of the a^5F_5 state with O_2 is pressure dependent and decreases with increasing temperature indicating adduct formation. The limiting low pressure third-order, k_o, and limiting high-pressure second-order, k_∞, room temperature rate constants in argon buffer are $(5.2\pm0.7)\times10^{-29}$ cm^6s^{-1} and $(2.8\pm0.2)\times10^{-11}$ cm^3s^{-1}, respectively. In N_2, k_o and k_∞ are $(1.1\pm0.2)\times10^{-28}$ cm^6s^{-1} and $(6.3\pm0.3)\times10^{-11}$ cm^3s^{-1}, respectively. An upper limit of 498 kJ/mole is established for the bond energy of RuO(g) based on the lack of a bimolecular reaction for Ru(g) with O_2.

CAMPBELL, Mark L., Associate Professor, "Temperature Dependent Study of the Kinetics of Os(a^5D_4) with N_2O and O_2," *Journal of Physical Chemistry*, 100 (1996), 19430-19435.

The gas phase reactivity of Os(a^5D_4) with N_2O and O_2 in the temperature range 373 - 623 K is reported. Osmium atoms were produced by the photodissociation of osmocene and detected by laser-induced fluoescence. The reaction rate constants of the ground a^5D_4 state with N_2O and O_2 are temperature dependent. The bimolecular rate constants are described in Arrhenius form by $k(N_2O) = (5.8\pm1.4)x10^{-11}exp(-38.1\pm1.2$ kJ/mole/RT) cm^3s^{-1} and $k(O_2) = (2.7\pm0.4)x10^{-11}exp(-9.0\pm0.5$ kJ/mole/RT) cm^3s^{-1} where the uncertainties are $\pm2\sigma$. The disappearance rates in the presence for both reactants are independent of buffer gas identity (Ar or N_2) and total pressure indicating a bimolecular abstraction mechanism.

CAMPBELL, Mark L., Associate Professor, co-author, "Depletion Kinetics of Low-Lying States of Tungsten in the Presence of NO, N_2O, and SO_2," *International Journal of Chemical Kinetics*, 29 (1997), 367-375.

The gas-phase reactivities of W(a^5D_J, a^7S_3) with N_2O, SO_2 and NO in the temperature range of 295 - 573 K are reported. Tungsten atoms were produced by the photodissociation of $W(CO)_6$. The tungsten atoms were detected by a laser-induced fluorescence technique. The removal rate constants for the $6s^25d^4$ $a5D_J$ states were found to be J dependent for all of the reactants. Removal rate constants for the $6s^1d^5$ a^7S_3 state were found to be fast compared to the a^5D_J states and often approached the gas kinetic rate constant. The reaction rates for all the states were found to be pressure independent with respect to total pressure. Results are discussed in terms of the different electronic configurations of the states of tungsten.

CAMPBELL, Mark L., Associate Professor, co-author, "Depletion Kinetics of Niobium Atoms in the Gas Phase," *Journal of Physical Chemistry*, 101 (1997), 3348-3355.

The gas phase depletion kinetics of Nb(a^6D_J, a^4F_J) in the presence of O_2, SO_2, CO_2, N_2O and NO are reported. Niobium atoms were produced by the 248 nm photodissociation of $Nb(C_5H_5)(CO)_4$ and detected by laser-induced fluorescence. The ground term of Nb ($4d^45s^1$ a^6D_J) reacts at or above the collision rate with all of the aforementioned oxidants. The first excited term, Nb($4d^35s^2$ a^4F_J), is not as reactive with these oxidants. Results are interpreted in terms of long range attractions and valence interactions. Additionally, we report reaction rate constants for ground state Nb interacting with N_2, CH_4 and SF_6. Nb(a^6D_J) is unreactive towards CH_4. Nb(a^6D_J) + N_2 is pressure dependent at 297 K with $k_o = (2.6 \pm 0.3) \times 10^{-32}$ cm^6 s^{-1} and $k_\infty = (4.1 \pm 0.5) \times 10^{-13}$ cm^3 s^{-1}. Nb(a^6D_J) + SF_6 is temperature dependent with the rate constants given by $k(T) = (1.2 \pm 0.3) \times 10^{-10}$ exp[- (4.8 ± 0.2) kcal mol^{-1} / RT] cm^3 s^{-1}. Depletion of the a^4F_J term by N_2, SF_6 and CH_4 is J-dependent.

CAMPBELL, Mark L., Associate Professor, co-author, "Temperature Dependent Study of the Kinetics of Ta($a^4F_{3/2}$) with O_2, N_2O, CO_2 and NO," *Journal of the Chemical Society, Faraday Transactions*," 93 (1997), 2139-2146.

The gas phase reactivity of Ta($a^4F_{3/2}$) with O_2, N_2O,CO_2 and NO in the temperature range 296 - 548 K is reported. The room temperature removal rate constants for the spin-orbit excited states (a^4F_J, J=5/2,7/2,9/2) are reported for these oxidants and CH_4. Tantalum atoms were produced by the photodissociation of tetracarbonyl cyclopentadienyl tantalum(0) [$Ta(C_5H_5)(CO)_4$] and detected by laser-induced fluorescence. The reaction rate constants of the $a^4F_{3/2}$ ground state with O_2, N_2O, CO_2 and NO are temperature dependent. The disappearance rates in the presence of all the reactants are independent of total pressure indicating a bimolecular abstraction mechanism. The bimolecular rate constants are described in Arrhenius form by $k(O_2) = (1.7\pm0.2)x10^{-10}exp(-7.8\pm0.4$ kJ/mole/RT) cm^3s^{-1}, $k(N_2O) = (7.1\pm1.0)x10^{-11}exp(-13.6\pm0.6$ kJ/mole/RT) cm^3s^{-1}, $k(CO_2) = (1.0\pm0.1)x10^{-10}exp(-26.8\pm0.5$ kJ/mole/RT) cm^3s^{-1} and $k(NO) = (1.0\pm0.2)x10^{-10}exp(-1.6\pm0.8$ kJ/mole/RT) cm^3s^{-1} where the uncertainties are $\pm2\sigma$. The removal rates of the spin orbit excited states with O_2, N_2O, CO_2 and NO are spin-orbit state dependent and are generally faster than the ground state. The $a^4F_{3/2}$ ground state is unreactive with methane, although the spin orbit excited states are quenched by methane. The $a^4F_{5/2}$, $a^4F_{7/2}$ and $a^4F_{9/2}$ states have second-order room temperature removal rate constants in methane of $6.0x10^{-13}$, $9.5x10^{-13}$ and $2.3x10^{-11}$ cm^3s^{-1}, respectively.

CHEEK, Graham T., Professor, "Electrochemical Studies of Acyl Halide Reduction in a Room-Temperature Molten Salt," *Proceedings of the Electrochemical Society*, 96-7 (1996), 116-124.

The electrochemical reduction of benzoyl chloride has been studied in both the aluminum chloride : EMIC molten salt and the acetonitrile / $LiAlCl_4$ sovlent systems. In both systems, electrolysis at mercury cathodes results in the formation of low (<10%) yields

of benzaldehyde, similar to behavior seen in acetonitrile/tetraalkylammonium perchlorate systems. Filming behavior was evident at mercury in the molten salt system by observation of maxima in the voltammograms.

CHEEK, Graham T., Professor, co-author, "Redox Behavior of the Nickel Oxide Electrode System: Quartz Crystal Microbalance Studies," *Journal of Electroanalytical Chemistry*, 421 (1997), 173-177.

The electrochemical reactions occurring in the nickel oxide electrode system have been studied with the quartz crystal microbalance. Following cathodic deposition from nickel sulfate solutions, α-nickel hydroxide films were cycled in 1.0 M alkali metal hydroxide solutions. The oxidation process produced frequency decreases in these solutions, indicating a correponding increase in mass in the electrode layer. A return to the initial frequency value was observed upon subsequent reduction. These shifts increased with the size of the alkali metal cation, indicating that cations are being taken up into the electrode film during oxidation. A mechanism based upon a net 1.7 electron oxidation has been proposed, involving predominant oxidation of nickel from the +2 to the +4 state as indicated by recent EXAFS studies.

β-Nickel hydroxide films were prepared by contacting α-$Ni(OH)_2$ films with hot 8 M KOH solution. Cycling these films in 1.0 M alkali metal hydroxide solutions gave frequency changes which were positive for the lighter cations and negative for the heavier ones, in contrast to the results for the α-$Ni(OH)_2$ films. Cations are also apparently taken up during oxidation in this case; however, a significant amount of water is also expelled, producing the observed frequency response. XANES studies indicate that the mechanism in this case also involves some oxidation to the +4 state.

COPPER, Christine L., Assistant Professor, co-author, "Separations of Alkyl-Substituted Anthracenes Using Cyclodextrin Distribution Capillary Electrochromatography," *J. Micro. Sep.*, 8 (1996), 461.

Alkyl-substituted anthracenes were separated using a technique dubbed cyclodextrin distribution capillary electrochromatography (CDCE). Native β- or γ-cyclodextrins (CDs), in conjunction with carboxymethyl-β-cyclodextrin (CM-β-CD) or sulfated-β-cyclodextrin (Su-β-CD), were employed in running buffers to create a dual-CD-phase system. In this system, analytes are separated based upon their differential distribution between the neutral CDs (β-CD or γ-CD) moving with the bulk electroosmotic flow and electrophoretically mediated, charged CDS (CM-β-CD or Su-β-CD). Comparisons are drawn between CDCE and CD-modified micellar electrokinetic capillary chromatography. CDCE is shown to provide unique selectivity and good resolution of methyl- and ethyl-substituted anthracenes. Control of retention is possible through varying the concentrations and types of CDs employed. Laser-induced fluorescence provides detection limits in the low-to-subparts per billion range. Field strength and total CD concentration exert a substantial influence on the observed plate height. Analysis of CM-β-CD with capillary electrophoresis reveals information about composition (range of degree of substitution) of the derivatized CD phase. Molecular modeling is also employed to investigate that position of CM substitution has an effect on the shape of the CD.

ELERT, Mark L., Professor, co-author, "Molecular Dynamics Study of Reaction Zone Properties in Chemically Sustained Shock Waves," in *Shock Compression of Condensed Matter - 1995*, S. C. Schmidt and W. C. Tao, eds., American Institute of Physics Conference Proceedings 370 (1996), 183-186.

Molecular dynamics simulations using chemically reasonable potentials have recently proven able to generate a chemically sustained shock wave with properties that rapidly approach near steady conditions just behind the front. This study reports an investigation of this chemically sustained shock wave which demonstrates that it is stable with respect to severe disturbances only 4 nm behind the front. The implications of these results are briefly explored.

ELERT, Mark L., Professor, co-author, "Molecular Dynamics Study of Chemistry from Strong Shock Waves Interacting with Voids," in *Shock Compression of Condensed Matter - 1995*, S. C. Schmidt and W. C. Tao, eds., American Institute of Physics Conference Proceedings 370 (1996), 187-190.

Previous molecular dynamics simulations have shown that even nanometer-scale voids interacting with strong shock waves can produce significant local heating of the material. These earlier simulations, however, did not allow for the possibility of chemical reactions. The current report describes a molecular dynamics study of the initiation threshold in two energetic molecular solids described by many-body

potentials that do allow for shock-induced chemistry. It is found that the piston velocity required to initiate detonation in these model materials can be reduced by more than 20% by introducing a 15 nm thick gap of infinite length.

ELERT, Mark L., Professor, and KOUBEK, Edward, Professor, co-authors, "A Demonstration of Crystal-Field Effects in Octahedral Complexes," *Journal of Chemical Education* 73 (1996) 947.

The difference in optical and magnetic properties between high- and low-spin octahedral complex ions can be demonstrated by comparison of solid salts of two complex ions of Fe^{+2}. The strong CN^- ligand produces a diamagnetic complex, so the corresponding salt is not attracted to the poles of a magnet. The weaker H_2O ligand produces a paramagnetic complex; the attraction of its salt to a magnet can be demonstrated on an overhead projector. The colors of the solids are consistent with the relative positions of the two ligands in the spectrochemical series.

FERRANTE, Robert F., Associate Professor, co-author, "Infrared Spectra of Proton-Irradiated Ices Containing Methanol", *Planetary and Space Science*, 44 (1996), 927.

A set of experimental results on the spectral identification of new species synthesized in irradiated methanol (CH_3OH) and water/methanol ices is reported. Mass spectroscopy of volatile species released during slow warming gives supporting information on identifications. Formaldehyde (H_2CO) is the dominant volatile species identified in the irradiated ices; methane (CH_4), carbon monoxide (CO) and carbon dioxide (CO_2) are also formed. During warming, the ice evolves into a residual film near 200 K whose feature are similar to those of ethylene glycol, along with a C=O bonded group. Irradiation simulates expected cosmic ray processing of ices in comets stored in the Oort cloud region for 4.6 billion years. Results support the idea that a comet originally containing an H_2O+CH_3OH ice component has a decreasing

concentration of CH_3OH towards its outer, most heavily irradiated layers (if independent of all other sources and sinks). The ratios of CH_4/CO and CO/CO_2 ratios are calculated as a function of irradiation; after 22 eV/molecule, the CH_4/CO = 1.96 and CO/CO_2 = 1.45 in an H_2O+CH_3OH ice mixture. Infrared spectra of CH_3OH at T<20 K on amorphous silicate smokes shows a predominantly crystalline ice phase. Irradiation of this ice/silicate composite, compared with irradiated CH_3OH on aluminum surfaces, shows significantly less CO_2, and lower CO and CH_4 production on the silicate surface. The crystalline CH_3OH phase is also amorphized by the radiation. Implications for cometary-type ices are discussed.

FITZGERALD, Jeffrey P., Associate Professor, "Electronic Origin of Variable Denitrosylation Kinetics from Isostructural $\{FeNO\}^7$ Complexes: X-ray Crystal Structure of [Fe(OETAP)(NO)]," *Journal of the Chemical Society, Chemical Communications*, (1997), 91-92.

In contrast to the nitrosyl derivative of iron(II) octaethylporphyrin, [Fe(OETAP)(NO)], the isostructural octaethyltetra-azaporphyrin, [Fe(OETAP)(NO)], exhibits fast ligand-promoted nitric oxide dissociation in the presence of pyridine and N-methylimidazole. This result is significant because it clearly shows the effect of the macrocycle electronic structure on dissociation kinetics of NO, an important intercellular messenger.

HARRISON, Judith A., Assistant Professor, "Friction between Diamond Surfaces in the Presence of Small Third-Body Molecules", *Journal of Physical Chemistry B*, 101 (1997), 1364-1373.

Molecular dynamics simulations have been used to examine the friction between the hydrogen-terminated (111) faces of diamond with small hydrocarbon (third-body) molecules trapped between them. In general, the presence of the third-body molecules reduced the friction between the diamond surfaces with the most pronounced reduction at high loads. The size and shape of the third-body molecule, as well as the alignment of atoms on opposing diamond surfaces, were found to be paramount in determining the magnitude of the friction. These results were compared to results from previous simulations that examined the effects of chemically bound hydrocarbons on the friction between diamond surfaces and to available experimental data.

HARRISON, Judith A., Assistant Professor, "Molecular Dynamics Investigations of the Effects of Debris Molecules on the Friction and Wear of Diamond", *Thin Solid Films*, 290-291 (1996), 211-215.

The friction between two diamond surfaces placed in sliding contact has been investigated using molecular dynamics simulations. These simulations show that the

friction between two hydrogen-terminated diamond (111) surfaces is significantly reduced when methane molecules are placed between the diamond surfaces compared to the same two surfaces in the absence of the debris, or third-body, molecules. Macroscopic experiments that have examined the friction of diamond on diamond in the presence of debris show similar trends. The specific atomic-scale motions that lead to the reduced friction and to the deformation of the methane molecules are identified.

HARRISON, Judith A., Assistant Professor, "Simulated Engineering of Nanostructures", *Nanotechnology*, 7 (1996), 1-7.

Results are reported from two molecular dynamics simulations designed to yield insight into the engineering of nanometer-scale structures. The first is the initial stages of the indentation of a silicon substrate by an atomically sharp diamond tip. The second study demonstrates patterning of a diamond substrate using a group of ethynyl radicals attached to a diamond tip.

HARRISON, Judith A., Assistant Professor, "Molecular Dynamics Studies of the Frictional Properties of Hydrocarbon Materials", *Langmuir*, 12 (1996), 4552-4556.

This essay discusses the importance of friction and wear and the necessity to understand these processes on the atomic level. Because of the unique friction and wear properties of diamond, molecular dynamics simulations were used to examine its friction and wear properties. These simulations have complemented available experimental data obtained with an atomic force microscope and that obtained with instruments that yield macroscopic data. In addition, the limitations of molecular dynamics simulations and possible future directions for this type of research are discussed.

HARRISON, Judith A., Assistant Professor, "Molecular Dynamics Simulations of Atomic-Scale Adhesion, Deformation, Friction, and Modification of Diamond Surfaces", in Forces in Scanning Probe Methods, eds., H.-J. Guentherodt et al., The Netherlands: Kluwer Academic Publishers, (1995), pp. 175-181.

We highlight our work dealing with molecular dynamics simulations of atomic-scale adhesion, deformation, friction, and surface modification of hydrogen-terminated diamond (111) surfaces. The simulations employ a unique many-body bond-order potential that treats explicitly chemical hybridization in carbon-based systems.

HEUER, William B., Assistant Professor, and PEARSON, Wayne H., Associate Professor, co-authors, "Synthesis and Characterization of Nickel-Group Bis(dithiocroconate) Complexes and Dicyanomethylene-substituted Analogues" *J. Chem. Soc., Dalton Trans.*, (1996), 3507-3513.

Two series of nickel-group metal bis(dithiolene) complexes with ligands 4,5-disulfanylcyclopent-4-ene-1,2,3-trionate (L^1) and 2-dicyanomethylene-4,5-disulfanylcyclopent-4-ene-1,3-dionate (L^2) have been prepared and characterized: $[NBu^n_4]_2[M(L^i)_2]$ (M = Ni, Pd or Pt, I = 1 or 2. Oxidation of the dianion complexes yielded paramagnetic monoanions with ESR spectra indicative of a delocalized b_{3g} HOMO (highest occupied molecular orbital), like that previously found for comparable bis(dithiolene complexes). The intense low-energy visible absorptions and multiple, reversible reductions exhibited by the dianions likewise suggest that the LUMO (lowest unoccupied molecular orbital) is a ligand-based $a_u(p^*)$ orbital, rather than the $b_{1g}(d_{xy})$ orbital as commonly found for such complexes. The stabilization of the ligand-based LUMO in this case is attributed to the strongly electron-withdrawing character of the ligand substituents. Iodination of $[NBu^n_4]_2[Pd(L^2)_2]$ in CH_2Cl_2 solution yielded the novel iodine inclusion compound $[NBu^n_4]_2[Pd(L^2)_2]\cdot I_2$, which crystallizes in space group p1(bar) with Z = 1, a = 10.792(3), b = 13.995(5), c = 10.737(3), a = 105.48(1), b = 115.15(1) and g = 76.51(2)° at 25°C. The I_2 molecules are associated with the complex anions through short [3.1696(9)A] S···I contacts; however, the observed I-I distance [2.7354(4)A] indicates that the degree of charge transfer associated with this interaction is small.

KINTER, Chris M.,, Assistant Professor, co-author, "Imaging of Delta- and Mu-Opioid Receptors in Temporal Lobe Epilepsy by Positron Emission Tomography" *Annals of Neurology* 41 (3) (March 1997), 358-367.

The involvement of opioid neurotransmitter systems in seizure mechanisms is well documented. In previous positron emission tomography (PET) studies in patients with unilateral temporal lobe epilepsy, we have found evidence for differential regulation of the

opioid-receptor subtypes. The present study extends our previous observations to delta-opioid receptors by using the delta-receptor-selective antagonist [11C]methylnaltrindole ([11C]MeNTI). Paired measurements of delta- and mu-opioid receptor binding and metabolic activity were performed with PET using [11C]MeNTI and [11C]carfentanil ([11C]CFN) and [18F]fluorodeoxyglucose ([18F]FDG), respectively. Binding of [11C]MeNTI and [11C]CFN increased and [18F]FDG uptake decreased in the temporal cortex (TC) ipsilateral to the focus. Decreases in [18F]FDG uptake were more widespread regionally than were increases in opioid receptors. Increases in the delta- and mu-receptor binding showed different regional patterns. Increases in mu-receptor binding were confined to the middle aspect of the inferior TC, whereas binding of delta receptors increased in the mid-inferior TC and anterior aspect of the middle and superior TC. The increase in delta receptors suggests their anticonvulsant action, as previously shown for the delta-receptor subtype, whereas the different regional pattern of receptor alterations suggest the distinct roles of different opioid-receptor subtypes in seizure phenomena.

KINTER, Chris M., Assistant Professor, co-author, "Imaging of Delta Opioid Receptors in Human Brain by N1'-([C-11]methyl)naltrindole and PET", *Synapse 24* (September 1996), 19-28.

Recently, we have developed the positron emitting radiotracer N1'-([11C]methyl)naltrindole ([11C]MeNTI) and demonstrated its high selectivity for delta opioid receptors in the mouse brain. In the present study, we examined the selectivity of [11C]MeNTI for the delta opioid receptor in the human brain, using positron emission tomography (PET). The regional kinetics and distribution as well as the pharmacology confirmed the selectivity of [11C]MeNTI for delta opioid receptor in the human brain. First, the regional kinetics of [11C]MeNTI are in accordance with the density of the delta opioid receptor. Rapid washout in receptor-poor areas and prolonged retention in receptor-rich areas were observed. Second, the regional distribution of [11C]MeNTI correlated well (r = 0.91) with the in vitro distribution of delta opioid sites but

not with mu or kappa site densities (r < or = 0.008 or r < or = 0.014 respectively). [11C]MeNTI binding was highest in regions of the neocortex (insular, parietal, frontal, cingulate, and occipital),caudate nucleus, and putamen. Binding was intermediate in the amygdala and lowest in the cerebellum and thalamus. Third, studies using the competitive antagonist naltrexone demonstrated the inhibition of [11C]MeNTI binding. Naltrexone inhibition of [11C]MeNTI binding was most effective in delta receptor-rich regions, and its inhibitory potency correlated well (r = 0.88) with the regional distribution of delta opioid sites. [11C]MeNTI is the first radioligand which selectively labels delta opioid receptors in vivo in the human brain following systemic administration. The availability of [11C]MeNTI will enable a receptor specific analysis of the role of [11C]MeNTI receptors in normal and abnormal human brain.

KOUBEK, Edward, Professor, and HEUER, William B., Assistant Professor, co-authors, "An Investigation into the Absorption of Infared Light by Small Molecules: A General Chemistry Experiment" *J. Chem. Ed.*, 74 (1997), 313.

An introductory, two-part classroom/laboratory activity demonstrating the mechanism of absorption of infrared light by small molecules is described. A model for molecular vibration is introduced during pre-lab discussion, and a mechanism by which such vibrations may be excited by infrared radiation is postulated. Students then explore the physics of simple harmonic motion (SHM) on the laboratory scale through several quantitative experiments using a spring oscillator, which serves as a macroscopic model for a vibrating chemical bond. The infrared spectrum of $CHCl_3$ is recorded, and the results of the preceding laboratory investigation are used to predict the shift in the C-H stretching and bending frequencies upon deuteration. The validity of applying classical SHM equations to a molecular system is tested by recording the spectrum of $CDCl_3$ and comparing the observed frequency shifts with those predicted by the model. The observed correspondence between infrared absorption frequencies and the frequencies of molecular vibration provides convienient entry into discussion of .analytical applications of IR spectroscopy and the greenhouse effect. The successful application of a macroscopic physical model to a molecular system also enhances the ability of students to visualize chemical processes occurring on a microscopic level.

MCCLEAN, Roy E., Assistant Professor, co-author, "Depletion Kinetics of Low-Lying States of Tungsten in the Presence of NO, N_2O, and SO_2," *International Journal of Chemical Kinetics*, 29 (1997), 367-375.

The gas-phase reactivities of $W(a^5D_J, a^7S_3)$ with N_2O,

SO_2, and NO in the temperature range of 295 - 573 K are reported. Tungsten atoms were produced by the photodissociation of $W(CO)_6$. The tungsten atoms were detected by a laser-induced fluorescence technique. The removal rate constants for the $6s^25d^4$ a^5D_J states were found to be J dependent for all of the reactants. Removal rate constants for the $6s^15d^5$ a^7S_3 state were found to be fast compared to the a^5D_J states and often approached the gas kinetic rate constant. The reaction rates for all the states were found to be pressure independent with respect to total pressure. Results are discussed in terms of the different electronic configurations of the states of tungsten.

MCCLEAN, Roy E., Assistant Professor, co-author, "Depletion Kinetics of Niobium Atoms in the Gas Phase," *Journal of Physical Chemistry*, 101 (1997), 3348-3355.

The gas phase depletion kinetics of Nb(a^6D_J, a^4F_J) in the presence of O_2, SO_2, CO_2, N_2O, and NO are reported. Niobium atoms were produced by the 248 nm photodissociation of $Nb(C_5H_5)(CO)_4$, and detected by laser-induced fluorescence. The ground term of Nb ($4d^45s^1$ a^6D_J) reacts at or above the collision rate with all of the aforementioned oxidants. The first excited term, Nb($4d^35s^2$ a^4F_J), is not as reactive with these oxidants. Results are interpreted in terms of long range attractions and valence interactions. Additionally, we report reaction rate constants for ground state Nb interacting with N_2, CH_4, and SF_6. Nb(a^6D_J) is unreactive towards CH_4. Nb(a^6D_J) + N_2 is pressure dependent at 297 K with $k_o = (2.6 \pm 0.3) \times 10^{-32}$ cm^6 s^{-1} and $k_\infty = (4.1 \pm 0.5) \times 10^{-13}$ cm^3 s^{-1}. Nb(a^6D_J) + SF_6 is temperature dependent with the rate constants given by $k(T) = (1.2 \pm 0.3) \times 10^{-10} \exp[- (4.8 \pm 0.2)$ kcal mol^{-1} / RT] cm^3 s^{-1}. Depletion of the a^4F_J term by N_2, SF_6, and CH_4 is J-dependent.

O'SULLIVAN, D.W., Assistant Professor, The Distribution and Redox Chemistry of Iron Across and Oxic/Anoxic interface in the Pettaquamscutt Estuary. Estuarine and Coastal Shelf Science, 45,(1997), 769-788.

O'SULLIVAN, D.W., Assistant Professor, Continuous Determination of the Total Inorganic Carbon in Surface Seawater. Marine Chemistry, CO2 in the Oceans Special Issue, 1997.

PEARSON, Wayne .H., Assistant Professor and SHADE, Joyce E., Professor, co-authors, "Structures of Two Monomeric Ruthenium Complexes Containing Bidentate Bis(diphenylphosphino) Ligands", *ActaCrystallographica C,*, C52 (1996), 1106-1110.

Crystal structures for chloropentahaptocyclopentadienylbisdiphenylphosphino)methaneruthenium (compoundA) and chloropentahaptocyclopentadienylbis(diphenylphosphino)ethaneruthenium (compound B) are reported. Both molecules contain a central ring structure consisting of the Ru center attached to both phosphorus atoms which are linked by $-CH_2-$ (compound A) and $-C_2H_4-$ (compound B) groups. The P - Ru - P bond angle undergoes expansion from 72.07(2) degrees in Compound A to 83.48(2) degrees in Compound B. Bond distances around the Ru center are compared to reported values for similar compounds. Both structures include a chloroform solvent molecule in addition to the ruthenium complex. The chloroform was found to be disordered in the structure of Compound A.

TRULOVE, Paul C., Major, USAF co-author, "Electrochemistry of room-temperature chloroaluminate molten salts at graphitic and nongraphitic electrodes," *Journal of Applied Electrochemistry*, 26 (1996), 1147-1160.

The electrochemistry of unbuffered and buffered neutral AlCl3-EMIC-MCl (EMIC = 1-ethyl-3-methylimidazolium chloride and MCl = LiCl, NaCl or KCl) room-temperature molten salts was studied at graphitic and nongraphitic electrodes. In the case of the unbuffered 1:1 AlCl3:EMIC molten salt, the organic cation reductive intercalation at about -1.6 V and the AlCl4- anion oxidative intercalation at about +1.8V were evaluated at porous graphitic electrodes. It was determined that the instability of the organic cation in the graphite lattice limits the performance of a dual intercalation molten electrolyte (DIME) cell based on this electrolyte.

TRULOVE, Paul C., Major, USAF, co-author, "Gutmann Acceptor Properties of LiCl, NaCl, and KCl Buffered Ambient-Temperature Chloroaluminate Ionic Liquids," in *Proceedings of the Tenth International Symposium on Molten Salts*, Carlin, R. T.; Deki, S.; Matsunaga, M.; Newman, D. S.; Selman, J. R.; Stafford, G. R., Eds.; The Electrochemical Society: Pennington NJ, (1996); Vol. 96-7, 104-115.

Gutmann acceptor numbers have been determined using 31P NMR for AlCl3:EMIC melts, where EMIC is 1-ethyl-3-methylimidazolium chloride, as well as

LiCl, NaCl, and KCl neutral buffered melts. Functions have been determined that allow the prediction of the acceptor numbers for AlCl3:EMIC melts and LiCl, NaCl, and KCl neutral buffered melts. The binary melts observed acceptor numbers are due to an equilibrium between a triethylphosphine oxide-AlCl3 monoadduct and a triethylphosphine oxide-2AlCl3 diadduct. The neutral buffered melts observed acceptor numbers are linear with respect to initial mole ratio of AlCl3:EMIC prior to buffering. The lithium cation appears to be the most Lewis acidic alkali metal cation followed by the sodium and potassium cations.

TRULOVE, Paul C., Major, USAF, co-author, "EQCM Studies of Aluminum and Aluminum Alloys in Room Temperature Molten Salts," in *Proceedings of the Tenth International Symposium on Molten Salts*, Carlin, R. T.; Deki, S.; Matsunaga, M.; Newman, D. S.; Selman, J. R.; Stafford, G. R., Eds.; The Electrochemical Society: Pennington NJ, (1996); Vol. 96-7, 276-283.

Room-temperature molten salts composed of aluminum chloride (AlCl3) and 1-ethyl-3-methylimidazolium chloride (EMIC) are well suited to studying the electrodeposition of aluminum (Al) and as a codeposit with other metals (Al-Mx). We have employed an Electrochemical Quartz Crystal Microbalance (EQCM) to investigate, in-situ, the deposition and stripping behavior of Al and Al-Mx in acidic AlCl3-EMIC molten salts. The EQCM provides both mass and charge data during electrodeposition and stripping processes. This information can be used to determine codeposited metal composition and to model deposition and/or stripping processes.

TRULOVE, Paul C., Major, USAF, co-author, "Electrodeposition of Cobalt-Aluminum Alloys from Room Temperature Chloroaluminate Molten Salt," *Journal of the Electrochemical Society*, 143 (1996), 2747-2758.

The electrochemical reduction of cobalt (II) in the 1.5:1.0 AlCl3:EMIC (EMIC = 1-ethyl-3-methylimidazolium chloride) room temperature molten salt leads to cobalt metal at potentials positive of +0.4 V and CoAlx alloys when the deposition potential is negative of +0.4 V. The value of x in CoAlx gradually increases up to a value of 2 as the electrodeposition potential ($E_{deposition}$) decreases; however, plots of x vs. $E_{deposition}$ exhibit sloping plateaus and indicate preferential formation of alloys having integral compositions of CoAl1 and CoAl2. The formation of these alloys can be interpreted in terms of an underpotential deposition-based process or as a free energy of alloy formation. Evaluation of the chronoamperometric transient behavior during electrodeposition shows that pure Co deposition proceeds via 3D progressive nucleation with diffusion-controlled growth. However, as $E_{deposition}$ crosses from Co metal to the alloy-forming range, the nucleation process exhibits characteristics indicative of kinetic control.

TRULOVE, Paul C., Major, USAF, co-author, "Electron transfer kinetics of weakly bonded, labile metal-ligand complexes," *Journal of the Chemical Society, Faraday Transactions*, 92 (1996), 3969-3973.

The electron transfer kinetics for the weakly-bonded, labile Cu(I)-L (L = CO and ethene) complexes have been investigated with square-wave voltammetry (SWV) in the ionic liquid solvent AlCl3-EMIC (EMIC = 1-ethyl-3-methyl-1H-imidazolium chloride). The oxidation of Cu(I)-L to Cu(II) and free ligand proceeds through an asymmetric quasi-reversible electron transfer mechanism in which the heterogeneous rate constant (k^0) is decreased relative to the rate constant for uncomplexed Cu(I), and the anodic transfer coefficient (β) is much less than 0.5. The Cu(I)-L bond energies were determined using potentiometric methods and found to be 9.4 (+/-0.8) and 11.1 (+/-0.1) kcal/mol for the CO and ethene complexes, respectively.

TRULOVE, Paul C., Major, USAF, co-author, "Gutmann Acceptor Properties of LiCl, NaCl, and KCl Buffered Ambient-Temperature Chloroaluminate Ionic Liquids," *Inorganic Chemistry*, 36 (1997), 1227-1232.

Gutmann acceptor numbers have been determined using 31P nuclear magnetic resonance (NMR) for AlCl3:EMIC melts as well as LiCl, NaCl, and KCl neutral buffered melts. In AlCl3:EMIC melts, where EMIC is 1-ethyl-3-methylimidazolium chloride, the change in Gutmann acceptor number as a function of the AlCl3:EMIC melt ratio is attributed to an equilibrium between a monoadduct of triethylphosphine oxide-AlCl3 and a diadduct of triethylphosphine oxide-2AlCl3. Observed acceptor numbers for the neutral buffered melts appear linear with respect to the melt's initial mole ratio of AlCl3:EMIC prior to buffering. The lithium cation appears to be the most Lewis acidic alkali metal cation followed by the sodium and potassium cations. Possible reasons for the change in acceptor number as

a function of changing alkali metal cation concentration are presented.

URBAN, Joseph. J., Assistant Professor, co-editor, "Special Issue: Conformational Analysis", *Theochem*, 370 (October 1996), 97-255.

This Special Issue is dedicated to the topic of Conformational Analysis. A molecule's chemical, physical, and biological properties are influenced to a large extent by its conformational preferences. These conformational preferences are governed by a balance between the intramolecular attractive and repulsive forces and the effects of interactions with the surrounding environment. In order to accurately model interesting properties via calculation or computer simulation, careful attention must be paid to many factors associated in some way with conformational analysis. For example, adequate sampling of the conformational (or configurational)hypersurface, accurate representation of the energy differences between conformational states as well as the barriers between them, and appropriate models for the surrounding environment are all important concerns. This Special Issue attempts to highlight recent research in a wide range of fields related to conformational analysis. In no way does this represent a comprehensive review of the field, but rather it provides a sampling of a variety of techniques applied to a range of chemical systems.CAMPBELL, Mark L., Associate Professor, "Kinetic Study of W(a^5D_J, a^7S_3) with N_2O, NO and SO_2," 212th ACS National Meeting, Orlando, Florida, 26 August 1996.

Technical Reports

O'SULLIVAN, D.W., Assistant Professor, Carbon Dioxide System Measurements on Arabian Sea Waters, University of Miami Technical Report, No. RSMAS-97-005, March 1997.

Presentations

CAMPBELL, Mark L., Associate Professor, "Temperature-dependent Kinetics of Ru(a^5F_5) with with N_2O and O_2," 212th ACS National Meeting, Orlando, Florida, 27 August 1997.

CAMPBELL, Mark L., Associate Professor, "Kinetics Study of the Reaction of Ta($a^4F_{3/2}$) with O_2, CO_2, N_2O, NO and SO_2 from 298 to 573 K," 213th ACS National Meeting, San Francisco, California, 13 April 1997.

HOOPER, Kelli L., Midshipman 1/C, USN, and CAMPBELL, Mark L., Associate Professor, "Reaction Kinetics of Sc($a^2D_{3/2}$) with O_2, CO_2, NO and SO_2," 213th ACS National Meeting, San Francisco, California, 14 April 1997.

KOLSCH, Erica J., Midshipman 1/C, USN, and CAMPBELL, Mark L., Associate Professor, "Reaction Kinetics of Sc, V, Cr, Co and Ni with N_2O," 213th ACS National Meeting, San Francisco, California, 14 April 1997.

CHEEK, Graham T., Professor, "Nitrile-Based Chloroaluminate Systems," Robert Osteryoung Symposium, Raleigh, North Carolina, 24 January 1997.

CHEEK, Graham T., Professor, "Investigations of Nitrile-Based Chloroaluminate Systems for Organic Electrochemistry," 191st Meeting of the Electrochemical Society, Montreal, CA., 6 May 1997.

COPPER, Christine L., Assistant Professor, co-author, "Probing Cyclodextrin-PAH Associations with Electrospray Mass Spectrometry," American Society for Mass Spectrometry, Palm Springs, California, 5 June 1997.

ELERT, Mark L., Professor, "Effects of Crystalline Defects on the Initiation to Detonation Process in Model Energetic Materials," Gordon Research Conference on Energetic Materials, New Hampton School, New Hampshire, 16-21 June 1996.

ELERT, Mark L., Professor, "Investigation of Detonation Properties by Molecular Dynamics

Simulations," International Conference on Shock Waves in Condensed Matter, St. Petersburg, Russia, 2-6 September 1996.

FERRANTE, Robert F., Associate Professor, co-author, "Radiation Chemistry and Surface Interaction Studies in Cosmic Type Ices", 1996 International Symposium on the Physics and Chemistry of Ice, Hanover, New Hampshire, 26-30 August, 1996.

FERRANTE, Robert F., Associate Professor, co-author, "Spectroscopic Analysis of Soil-H_2O-CO_2 Ice Mixtures at Temperatures Ranging From 75 to160K,and Implications for Mars", 28th Annual Meeting of the Division of Planetary Sciences, American Astronomical Society, Tucson, Arizona, 23-26 October 1996.

FERRANTE, Robert F., Associate Professor, author, "Low Temperature Spectroscopy for Crystallization Diagnostics", 213th National Meeting of the American Chemical Society, San Francisco, California, 13-16 April 1997.

FITZGERALD, Jeffrey P., Associate Professor, "Recent Advances in Tetraazaporphyrin Chemistry," 213th National Meeting of the American Chemical Society, San Francisco, California, 12-16 April 1997.

HARRISON, Judith A., Assistant Professor, "The Effects of Third-Molecules on the Tribology of Diamond", 213th American Chemical Society National Meeting, San Francisco, California, 13-17 April 1997.

HARRISON, Judith A., Assistant Professor, "Molecular Dynamics Investigations of the Tribology of Surfaces", University of California at Berkeley, Berkeley, California, 16 April 1997.

HARRISON, Judith A., Assistant Professor, "Molecular Dynamics Modeling of Tribochemistry", Northeastern University, Boston, Massachusetts, 5 December 1996.

HARRISON, Judith A., Assistant Professor, "Thin Film Characterization via Indentation", Fall Meeting of the Materials Research Society, Boston, Massachusetts, 2-6 December 1996.

HARRISON, Judith A., Assistant Professor, "Molecular Dynamics Investigations of the Tribology of Diamond Surfaces", Stevens Institute of Technology, Hoboken, New Jersey, 6 November 1996.

MCCLEAN, Roy, E., Assistant Professor, "Depletion Kinetics of Niobium Atoms in the Gas Phase," presented at the American Chemical Society 213th National Meeting, San Francisco, California, 13-16 April 1997.

O'SULLIVAN, Daniel W., Assistant Professor, "Observations of Hydrogen Peroxide and Methylhydroperoxide from the NASA P3B in the lower troposphere of the Equatorial Pacific", NASA GTE PEMT data workshop, Hampton, Virginia, 8 April 1997.

O'SULLIVAN, Daniel W., Assistant Professor, Coauthor, "Temporal variation of the seasurface CO_2/carbonate properties in the Arabian Sea", International Joint Global Ocean Flux Modelling Symposium, Oban, Scotland, May 1997.

TRULOVE, Paul C., Major, USAF, "Application of the Electrochemical Quartz Crystal Microbalance to Electrodeposition of Aluminum Alloys from Ambient-Temperature Chloroaluminate Molten Salts," Gordon Research Conference on Electrodeposition, New London, New Hampshire, 11-16 August 1996.

TRULOVE, Paul C., Major, USAF, co-author, "Aluminum Alloy Electrodeposition (Co-Al and Mn-Al) from Room-Temperature Ionic Liquids," Gordon Research Conference on Electrodeposition, New London, New Hampshire, 11-16 August 1996.

TRULOVE, Paul C., Major, USAF, co-author, "Electrodeposition of Aluminum and Chromium from Acidic Room-Temperature Molten Salts," Gordon Research Conference on Electrodeposition, New London, New Hampshire, 11-16 August 1996.

TRULOVE, Paul C., Major, USAF, co-author, "Nucleation and Growth Phenomena for Aluminum and Chromium Electrodeposition," Gordon Research Conference on Electrodeposition, New London, New Hampshire, 11-16 August 1996.

TRULOVE, Paul C., Major, USAF, co-author, "Microelectrode Evaluation of Aluminum and Aluminum Alloy Electrodeposition in Ionic Liquids," Frontiers in Electrochemistry Symposium, 212th Meeting of the American Chemical Society, Orlando, Florida, 25-29 August 1996.

TRULOVE, Paul C., Major, USAF, co-author, "Electrodeposition of Chromium from an Ambient-Temperature Molten Salt," 190th Meeting of the Electrochemical Society, San Antonio, Texas, 6-11 October 1996.

TRULOVE, Paul C., Major, USAF, "Investigation of Electrodeposition in Ambient-Temperature Chloroaluminate Molten Salts using the Electrochemical Quartz Crystal Microbalance," Third International Symposium on In-Situ Characterization of Electrodeposition Processes, 191st Meeting of the Electrochemical Society, Montreal, Canada., 4-9 May 1997.

TRULOVE, Paul C., Major, USAF, "Electrodeposition of Chromium from Acidic Ambient-Temperature Chloroaluminate Molten Salts," 191st Meeting of the Electrochemical Society, Montreal, CA, 4-9 May 1997.

URBAN, Joseph J., Assistant Professor, "Electrostatic Potentials as Teaching Tools in Undergraduate Organic Chemistry" 213th National Meeting of the American Chemical Society, San Francisco, CA., 13 April 1997.

URBAN, Joseph J., Assistant Professor, and VON TERSCH, Robert, L., Captain USA "A Computational Study of the Fluoro Substituent Effects on Fluoromethylphenoxides" 213th National Meeting of the American Chemical Society, San Francisco, California, 15 April 1997.

DEPARTMENT OF COMPUTER SCIENCE

Commander Joseph G. Kovalchik, USN
Chair

During the 1995-1996 academic year, the computer Science Department continued to conduct important research including that which solidly involved Midshipmen. Student research continued to prosper. A total of six independent research courses were conducted. Midshipman Kevin Graves completed a Trident Scholar Project under the Principal Advisor, Dr. Patrick Harrison. Midshipman Eason obtained approval for a Trident Scholar Project for the Academic Year 1997-1998 under the guidance of Dr. Kay Schulze. The department encouraged its faculty to seek summer support through outside funding. Last summer the Naval Research Laboratory funded two faculty members. Defense Mapping Agency, Defense Information Systems Agency, and National Science Foundation funded other members of the department. The Computer Science Department had a productive year. Overall, there were eleven publications and six presentations.

Sponsored Projects

Advances in Case-Based Reasoning Program of Research

Researcher: Professor Patrick R. Harrison
Sponsor: Office of Naval Research

Case-based reasoning (CBR) tools are now commonly used to assist in developing decision aids for help-desk, diagnosis, and other applications. However, for application to large-scale, real-time planning, strategic and tactical situation assessment and other complex domains critical to the Navy, current CBR technology needs to be extended in a variety of ways. In particular, progress is needed in verification and validation, indexing of case memories, reasoning about case similarity, case adaptation and the integration of varieties of case representation. On-going 6.1 research addressing these issues has been growing rapidly, and the ONR basic research program in Intelligent Systems has a long-term commitment to supporting such research. This research program is providing the larger scope 6.2 effort that is needed to evaluate and transition the 6.1 results.

CRB systems rarely can solve complex problems in a stand-alone mode. Rather, they must be integrated with and embedded in other tools. Therefore, CBR practitioners must have access to tools that address practical issues in the course of building their applications, such as the ability to identify and consider the merits of alternative forms of case representation and reasoning; in particular, Navy needs for cost-effective system development would benefit from innovative CBR tools offering prototyping and simulation support. This program includes building, demonstrating and eventually disseminating such next-generation tools.

This program currently has two grants. One under the ONR base program and a new start for transitioning new technologies into the NRL-Remind CBR tool.

A Fast Algorithm for Performning Pairwise Energy Calculations in a Many Particle System

Associate Professor Andrew T. Phillips
Researcher: 1/C Michael S. Hingst

The purpose of this research project is to implement a fast algorithm for performing pairwise calculations between n particles in three-dimensional space. The standard algorithm for this type of problem runs in O(n^2)time. However, if an "approximate calculation" is suitable, then an algorithm exists to perform this operation in O(nlogn) time. This algorithm can be adjusted through the use of a user specified parameter "lambda." By adjusting this value the algorithm can be made to run faster albeit with less accuracy. The original pseudo-code algorithm written by Andrew W. Appel ("An Efficient Program for Many-Body Simulation") contains several recursive functions, one of which called itself in three separate places depending upon a particular condition. To enable faster RISC-based execution, it is necessary to remove this recursion. By clever use of the data structures already in place this task can be accomplished without the need to implement a stack. In addition, many conditional tests can be removed, to maximize the efficiency of the algorithm, through the use of bit-wise calculations and memory overlays. The algorithm was tested with several data sets. As expected, the size of the data set and the parameter lambda determine the speed and accuracy of the output. Testing shows that about 300 points are required in order to get the new efficient algorithm to run points are required in order to get the new efficient algorithm to run faster than the original n^2 algorithm with an associated error of only 2%. For the testing, a simple Newton's Law of gravitation calculation is performed between each of the points. Since the new algorithm works by reducing the number of these calculations, it has been observed that the complexity of this energy calculation adds a third dimension to the analysis. If this energy calculation is nontrival, a much more significant amount of time can be saved by the more efficient algorithm.

Insight

Researcher: Professor Patrick R. Harrison
Sponsor: Office of Research and Development, CIA

This research focuses on the development and implementation of advanced machine learning and case-based reasoning capabilities in a windows NT based, CBR tool for evaluating economic indicators. The project has focused on advanced tree pruning algorithms, multi-variate decision trees and case retrieval precision. A commercial quality tool developed using OLE2 interface standards under windows NT will be delivered next year.

Cooperative Research and Development Agreement With Cognitive Systems, Inc.

Researcher: Professor Patrick R. Harrison
Sponsor: NCRADA-NRL-95-066

This is a cooperative research and development agreement for the development of advanced commercial Case-based reasoning (CBR) tools. These tools will be made available to Navy, DOD and commercial customers. The current CBR tool called Remind-NRL is being developed under Windows NT using MS standards for interface design and standard version control and testing tool suites. The tool is a full 32 application that will be available as both a standalone and as a dynamic link library for embedded applications. The tool can be used to develop a variety of applications that require knowledge management, organization and delivery. It includes machine learning components for induction.

Computational Solutions for Protein Structure Prediction

Researcher: Associate Professor Andrew T. Phillips
Sponsor: National Science Foundation

This research project, currently in its third year, involves the study of solution methods for the protein structure prediction problem. The protein structure prediction, or protein folding problem, attempts to predict the native, or folded, state of a protein in three-dimensional space, given its primary sequence of amino acids. One common approach for a solution is to treat each complex amino acid as a single sphere, or "united atom," and to model each peptide linkage between residues by a virtual bond between spheres. Computational efforts being examined rely on two major assumptions: (1) for any specific molecular conformation, a corresponding potential energy function can be computed, and (2) the three-dimensional, folded state corresponds to the global minimum of this energy function. The optimization method being used to minimize the potential energy involves collecting a large number of conformers, each attained by finding a local minimum of the potential energy function from a random starting point. The information from these conformers is then used to form a convex quadratic global underestimating function for the potential energy of the known conformers. The minimum of this under-estimator is used to predict the global minimum for the function, allowing a localized conformer search to be performed based on the predicted minimum. The new set of conformers generated by the localized search can serve as the basis for another quadratic underestimation. After several repetitions, the global minimum can be found with reasonable assurance. The conformer which lies at the global minimum represents the three-dimensional folded state of the molecule.

An Analysis of Human Dialogue in the CIC

Researcher: Associate Professor Kay G. Schulze
Sponsor: Naval Research Laboratory

Verbal communication is a crucial aspect of the Command and Control environment and can frequently be so heavy as to overwhelm the entire CIC process. We began this research to identify verbal communication that could possibly be eliminated or transferred to the computer interface in order to reduce the verbal communication traffic. The current research will conclude a long range investigation with a study that will compare human-to-human, human-to-computer, computer-to-human, and computer-to-computer communications. The study, using software developed explicitly for the study, will determine if there is any significant impact on performance of each of the four types of communication. The outcome of this study will determine the feasibility of transferring or eliminating certain specific verbal communication.

Human and Computer Dialogue in the CIC

Researcher: Associate Professor Kay G. Schulze
Sponsor: Naval Research Lab/SPAWAR

Verbal communication is a crucial aspect of the Command and Control environment and can frequently be so heavy as to overwhelm the entire CIC process. We began this research to identify verbal communication that could possibly be eliminated or transferred to the computer interface in order to reduce the verbal communication traffic. This traffic can be viewed as a dialogue between the user and the computer. The current research continues this long range investigation and consists of implementing a networked, software package that compares human-to-human, human-to-computer, computer-to-human, and computer-to-computer communications.

ANDES: A Tutoring System for Classical Physics

Researcher: Associate Professor Kay G. Schulze
Sponsor: Office of Naval Research

Classical physics is a prerequisite for virtually all university-level study of science and technology, yet is notoriously difficult for students to learn. We will build a tutoring system, named ANDES, that will help students learn physics. ANDES will be based on the latest research in Cognitive Science, as well as, input from a team of physics instructors with years of experience in instructional reform. When completed, ANDES will be used at the U.S. Naval Academy to enhance their introductory physics class, which is taken by approximately 1200 students a year.

Independent Research

Bidirectional Motion Planning for Mobile Robots

Researcher: CDR J. G. Kovalchik, USN

The problem addressed is how to provide a motion plan between two configurations (position, orientation and curvature) for a mobile robot when backing up is not necessary. Such situations are encountered in the terminal parking phase of motion, when the robot must stop at a specified configuration. Proposed is a new method of motion planning in an obstacle free space using a steering function in conjunction with a bidirectional approach. This method provides a motion plan which allows the mobile robot to travel from an initial configuration to a final configuration, even when the initial and final configuration curvatures are not zero.

Research Course Projects

Continuous Localization and Navigation of Mobile Robots

Researcher: Midshipman 1/C Kevin Graves
Faculty Advisor: Professor Patrick R. Harrison

The purpose of this research project was to advance understanding and performance of robot navigation. The project used the Nomad 200 robot environment for this purpose. The robot estimates its position (Odometry) using information from its wheel encoders. Errors occur as a result of friction and wheel slippage. Evidence grid representation uses the robot's odometry to generate the robot's maps. Continuous localization builds a series of local evidence grids which reduces the odometry errors introduced to the maps. The potential field method uses evidence grids to devise the robot's most efficient path from one point to another. Each point in space is assigned a "potential" value which represents the cost of traveling through that position. The robot navigates through the least-cost path to the desired position. This research focused on the computational efficiency of the navigational approach, the robustness of the method as a function of environmental clutter and the robustness of the method in environments with other moving objects. Midshipman Graves developed and tested new algorithms which addressed issues with respect to these two problems.

The Development of a Physics Knowledge Base

Researcher: Midshipman 2/C Damon Eason

Faculty Advisor: Associate Professor Kay G. Schulze

This research project will begin the development of a knowledge base for energy physics problems. Before this can be done, it will be necessary to conduct a literature review of recent developments in the intelligent tutoring field, learn the basics of the LISP programming language, and become proficient in the CLIPS rule based language. The knowledge base will solve typical energy problems encountered in a college level physics course by generating the equations necessary to solve the problem. The knowledge base and the equations generated by it will be integrated into the ANDES Research Project.

Publications

HARRISON, Patrick, Professor, co-author, "Expert Systems and Uncertainty", In Liebowitz, J.CRC Handbook on Expert Systems, CRC Press, In press, 1997.

Artificial Intelligence has struggled to find ways to effectively use probabilistic reasoning to aid in solving problems where knowledge is incomplete, error-prone or approximate. It has invented logics to deal with the problem symbolically. It has invented concepts to skirt the issue of conditional independence, prior probabilites and the difficulties of conditional probabilities and casual inferences. A summary of the development of these ideas could be stated as, "we would use Bayesian models if only we could satisfy all the assumptions and were omniscience". This chapter focuses on the dominate themes that have occupied most of the literature on uncertainty and expert systems. These include the Bayesian approach, the certainty factor approach, the Dempster-Shafer approach and the more advanced Bayesian belief networks approach. Fuzzy reasoning is not discussed because it addresses the problem of vagueness rather than uncertainty. It is not a method for uncertain reasoning and is problematic in that it is inconsistent with the first-order predicate calculus.

Kovalchik, Joseph G., Assistant Professor, co-author, "Expert Systems and Uncertainty", In Liebowitz, J. CRC Handbook on Expert Systmes, CRC Press, In Press. 1997

Artificial Intelligence has struggled to find ways to effectively use probabilistic reasoning to aid in solving problems where knowledge is incomplete, error-prone or approximate. It has invented logics to deal with the problem symbolically. It has invented concepts to skirt the issue of conditional independence, prior probabilities and the difficulties of conditional probabilities and casual inferences. A summary of the development of these ideas could be stated as, "we would use Bayesian models if only we could satisfy all the assumptions and were omniscience". This chapter focuses on the dominate themes that have occupied most of the literature on uncertainty and expert systems. Those include the Bayesian approach, the certainty factor approach, the Dempster-Shafer approach and the more advanced Bayesian belief networks approach. Fuzzy reasoning is not discussed because it addresses the problem of vagueness rather than uncertainty. It is not a method for uncertain reasoning and is problematic in that it is inconsistent with the first-order predicate calculus.

PHILLIPS, Andrew T., Associate Professor, co-author, "Molecular Structure Prediction by Global Optimization," *Developments in Global Optimization, 217-234, I.M. Bomze et al. (Eds), Dordrecht Germany, 1997.*

The CGU (convex global underestimator) global optimization method is used to predict the minimum energy structures, i.e. folded states, of small protein sequences. Computational results obtained from the CGU method applied to actual protein sequences using a detailed polypeptide model and a differentiable form of the Sun/Thomas/Dill potential energy function are presented. This potential function accounts for steric repulsion, hydrophobic attraction, and phi/psi pair restrictions imposed by the so called Ramachandran maps. Furthermore, it is easily augmented to accommodate additional known data such as the existence of disulfide bridges and any other a priori distance data. The Ramachandran data is modeled by a continuous penalty term in the potential function, thereby permitting the use of continuous minimization techniques.

PHILLIPS, Andrew T., Associate Professor, co-author, "Protein Structure Prediction and Potential Energy

Landscape Analysis Using Continuous Global Minimization." *Proceedings of the First Annual International Conference on Computational Molecular Biology*, 109-117, Santa Fe, NM, 1997.

The purpose of this paper was to show how one could apply efficient continuous minimization techniques to the energy minimization problem by using an accurate continuous approximation to the discrete information provided for known protein structures. In addition, we show how the results of one particular computational method for protein structure prediction (the CGU algorithm), which is based on this continuous minimization technique, can be used both to accurately determine the global minimum of potential energy function and also to offer a quantitative analysis of *all* of the local (and global) minima on the energy landscape.

PHILLIPS, Andrew T., Associate Professor, co-author, "CGU: An Algorithm for Molecular Structure Prediction" *IMA Volumes in Mathematics and its Applications: Large Scale Optimization with Applications, Part III: Molecular Structure and Optimization, L.T. Beigler et al. (Eds,), vol 94, pp. 1-22, New York, 1997.*

A global optimization method is presented for predicting the minimum energy structure of small protein-like molecules. This method begins by collecting a large number of molecular conformations, each obtained by finding a local minimum of a potential energy function from a random starting point. The information from these conformers is then used to form a convex quadratic global underestimating function for the potential energy of all known conformers. This underestimator is an L approximation to all known local minima, and is obtained by a linear programing formulation and solution. The minimum of this underestimator is used to predict the global minimum for the function, allowing a localized conformer search to be performed based on the predicted minimum. The new set of conformers generated by the localized search serves as the basis for another quadratic underestimation step in an iterative algorithm. This algorithm has been used to predict the minimum energy structures of heteropolymers with as many as 48 residues, and can be applied to a variety of molecular models. The results obtained also showed the dependence of the native conformation on the sequence of hydrophobic and polar residues.

SCHULZE, Kay G., Associate Professor, co-author, "Teaching Social and Ethical Issues in CS1 and CS2," *SIGCSE Bulletin*, 28(1) (March 1997), 6-9.

The discussion of whether ethical and social issues of computing should be explored in undergraduate computer science education has resulted in most academic institutions and educators agreeing that they are important topics that must be included. Further support has been provided by Curricula '91, the CSAC/CSAB accreditation and ImpactCS. Many books and papers have discussed what topics should be covered and what techniques can be used either in a dedicated course or in modules across the curriculum. However, explicit detailed examples that have worked successfully, particularly in lower level computer science courses, are still rare. This paper discussed several examples that have been successfully used in CS1 and CS2 at a medium-sized university.

Presentations

PHILLIPS, Andrew T., Associate Professor, "Protein Structure and Energy Landscape Dependence on Sequence Using a Continuous Energy Function." Department of Pharmaceutical Chemistry Colloquium Series, University of California at San Francisco, San Francisco, CA (May 22, 1997).

PHILLIPS, Andrew T., Associate Professor, "Protein Structure and Energy Landscape Dependence on Sequence Using a Continuous Energy Function." San Diego Supercomputer Center, San Diego, Ca (February 20, 1997).

PHILLIPS, Andrew T., Associate Professor, "Protein Structure and Energy Landscape Dependence on Sequence Using a Continuous energy Function." The Scripps Research Institute, Department of Molecular Biology Seminar, San Diego, CA (February 17, 1997).

PHILLIPS, Andrew T., Associate Professor, "Protein Structure Prediction and Potential Energy Landscape Analysis Using Continuous Global Minimization."

RECOMB97, Sante Fe, MN (January 20, 1997).

PHILLIPS, Andrew T., Associate Professor, "Protein Structure Prediction Using Continuous Global Minimization." INFORMS, Atlanta, GA (October 8, 1996).

SCHULZE, Kay G., Associate Professor, "Teaching Ethical and Social Issues in Computing," The Consortium for Computing in Small Colleges, Northeastern Conference, Boston, MA 25-26 April 1997.

DEPARTMENT OF MATHEMATICS

Professor Michael W. Chamberlain
Chair

Mathematics provides a logical framework and a language indispensable to understanding the technical world in which we live. The following description summarizes the many contributions to this field of study made during the past academic year by the faculty and midshipmen of the Mathematics Department of the U.S. Naval Academy. The results cited reveal the great scope, diversity, and applicability of mathematics and offer glimpses of its intellectual beauty and appeal.

Several midshipmen conducted research projects either as Honors Mathematics Majors or in specially created projects under the guidance of faculty members. Several faculty spent many hours serving as mentors and readers for capstone projects required of all majors.

Professor Peter Andre guided midshipman William Getchius in his Honors Research Project: "Spatially Distributed Prisoner's Dilemma". Professor Carol Crawford continued to lead many midshipmen in their discovery of the applicability of discrete mathematics. Professor W. David Joyner helped midshipmen James McShea, Michael Fourte, and Ann Luers in individualized mathematical investigations as well as Luers' Honors Research Project: "Dodecahedral Faces of M_{12} and the Pyraminx Project". Professor Charles Mylander directed Midshipman Janette Hay's development of a Markov chain model to predict how promotion and retirement policy decisions affect the distribution of naval enlisted personnel. Professor Geoffrey Price supervised Midshipman Glenn Truitt's Honors Research Project: "Symmetries of Nullity Sequences of Toeplitz Matrices". Professor Thomas Sanders worked with Midshipman Mark Tripiano on helping the USMC predict enlisted personnel requirements for HMLA after the UH-1 Huey is replaced by the H-60 Blackhawk. Midshipman Michael Wheeler worked on "Factors Affecting Promotion Rates" for the USMC under Professor John Turner and Major J. Michael Shehan as well as on "Factors Affecting Promotion in the Marine Corps" with the guidance of Professor John Turner. Professor Peter Turner led eight midshipmen in various investigations concerning massively parallel computers applied to linear algebra and to artificial intelligence.

Once again, the USNA Mathematics Department produced a wide range of scholarly work that appeared as technical reports or as publications in refereed journals throughout the world. Nearly thirty articles appeared as applications of mathematics or as pure mathematical research. Topics include: fingerprint identification, mathematical physics and cosmology, parallel computer applications, algorithms for computers, and basic research in areas such as algebra, differential equations, combinatorics, matrices, and number theory.

In addition to over a dozen independent research projects, another two dozen research projects were sponsored by a variety of sources, such as:

Arizona State University
The Johns Hopkins University/Applied Physics Lab
Office of Naval Research
Naval Air Warfare Center
Naval Surface Warfare Center
Naval Academy Research Council
National Science Foundation
National Security Agency

During the past year, members of the USNA Mathematics Department presented the results of their work on over fifty 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 expand their intellectual horizons and stay vital in their disciplines. They contribute to the discovery of new mathematics. And they develop new materials and ideas that they can share with midshipmen students in their mathematics courses and research projects.

Sponsored Research

Shallow Ocean Acoustics

Researcher: Professor James L. Buchanan
Sponsor: National Science Foundation, Faculty Recognition Grant

When considering sound transmission in a shallow ocean, the acoustic properties of the seabed below must be taken into account. The seabed has been modeled variously as a completely rigid slab, dense fluid, or an elastic slab. A more realistic model needs to allow for the poroelastic nature of the sediment. In the Biot-Stoll sediment model the seabed is taken to consist of a viscoelastic frame with an interstitial pore fluid. For the last four years the researcher has been investigating sound transmission in the ocean over a poroelastic seabed. Recent work has included computing acoustic pressure in the near field over a one layer seabed using a modal solution combined with integrals along certain branch cuts, computing pressure in the far field over a two layer seabed using a model solution, and computing pressure in the far field using a numerical technique called parabolic approximation.

A related problem that is currently being investigated is the inverse problem of determining the nature of the seabed from the measured values of pressure in the far field. The investigator has developed a fairly successful algorithm based on the Nelder-Mead simplex method for determining the five parameters of an elastic seabed. Further investigation will reveal whether a similar approach can successfully find the more numerous (eleven) parameters of a poroelastic seabed.

Connected Beam Structures, Dynamical Systems, and Wave Localization Effects

Researcher: Professor James M. D'Archangelo
Sponsor: Naval Surface Warfare Center, Annapolis and Office of Naval Research

A two-dimensional connected beam structure is modeled as a network of connected dynamic systems, each characterized by a propagation wavenumber, loss factor, and length. An analytic formal procedure has been developed to calculate the response of the network to an out-of-plane harmonic drive as a function of frequency.

Computer code (using a version of FORTRAN-90 on a Massively Parallel Computer) has been written and tested, implementing the above mentioned formal analytic procedure for large systems. The next step is to generalize the formal analysis and computational programs to include three dimensional systems and other than out of plane harmonic drives.

Also, structures with discrete periodic variations in impedance may exhibit pass and stop bands and the related wave localization and delocalization phenomena in their frequency response. Localization, similar to Anderson localization in atomic systems, occurs in the pass band frequency range when the periodicity is perturbed and waves are thereby inhibited from propagating. Conversely, delocalization occurs in the same systems in the stop band regions where perturbing the strict periodicity allow for relatively more propagation. Localization and delocalization are demonstrated in several systems: specifically, a beaded string, membranes and plates with periodic stiffeners attached, and a "jungle gym," i.e., a connected beam structure. We have demonstrated that these effects depend on the interactions between discontinuities and are studying the implications to passive and active vibration control.

Closed-loop Degaussing Using Both Naval Vessels and Scale

Researcher: Associate Professor Gary O. Fowler
Sponsor: Naval Surface Warfare Center, Annapolis

Naval vessels containing ferrous material emit detectable magnetic signals. Naval Surface Warfare Center administers a project that studies and measures this phenomenon. Data is collected from naval vessels under a variety of conditions and from scale models under similar conditions. A goal of the project is to connect these data in a manner that will allow measurements from the scale model to predict measurements on the naval vessel. This analysis is both statistical and mathematical in nature. It includes both the design of the experiments and the analysis of the data.

Aspects of the Theory of Free Groups

Researcher: Professor Anthony M. Gaglione
Sponsor: Naval Academy Research Council

Combinatorial (or Infinite) Group Theory refers to the theory of group presentations, that is, of groups specified by a set of generators and corresponding defining relations. The theory has its origins in topology and complex analysis and in particular in the theory of the fundamental groups of combinatorial cell complexes. Because of its nature and its origins, combinatorial group theory comes into contact with and uses many different areas of mathematics. Clearly algebra and topology as mentioned above are very significant for the combinatorial group theorist. But also hyperbolic geometry comes into play via the study of Cayley graphs, pure mathematical logic through the study of various decision problems, and last, but not least, computer science through the study of rewriting systems (certain kinds of algorithms). Central to all of these studies is the concept of a free group. This centrality is due to the fact that a free group is the most basic construction of infinite group theory and also that free groups serve as primary motivating examples for both properties and proofs in all the other areas mentioned. The purpose of this project would be to try to bring to bear all these different points of view and focus primarily on the group theoretical properties closely tied to the Tarski conjecture. This conjecture has to do with the relations of combinatorial group theory to pure logic and the logical underpinnings of the whole theory.

Moving Space-Time Mixed Finite Element Methods

Researcher: Associate Professor Sonia M. F. Garcia and Rafel Santos
Sponsor: Office of Naval Research/U.S. Naval Academy
and Universidade do Algarve, Portugal

The authors are defining and analyzing mixed finite element methods for solving time dependent partial differential equations. Our methods are based on a previous paper "Analysis of Some Moving Space-Time Finite Element Methods," by Todd Dupont and Rafael Santos where one method allows for adding and deleting knots in a continuous fashion and the other allows for discontinuous changes in the mesh. They believe the combination of mixed finite element methods with the moving techniques will bring surprising results for parabolic equations models.

Finite Element Method with Moving Grid for a System of Equations Modeling Shear Band Formation

Researcher: Associate Professor Sonia M. F. Garcia
Sponsor: Office of Naval Research/U.S. Naval Academy

The idea here is to take different meshes and subspaces for different time levels. The author believes a good approximation to the solution using this type of technique would be that the finite element solution at the current time is projected on the next (time) finite element space and then it should adopt the Crank-Nicolson scheme to evaluate the next finite element approximation.

Mixed Finite Element Method with Moving Grid for a System of Equations Modeling Shear Band Formation

Researcher: Associate Professor Sonia M. F. Garcia
Sponsor: Office of Naval Research/U.S. Naval Academy

The author believes the treatment of the thermo-elasticity problems with mixed methods could bring pleasant surprises on the rates of convergence compared with traditional numerical methods. She believes the convergence of the mixed method continuous time scheme for parabolic system is going to be reduced to a question of convergence of the associated elliptic problem.

Stability of Spacetimes with Mild Singularities or Cauchy Horizons

Researcher: Associate Professor Deborah A. Konkowski
Sponsor: National Science Foundation

The researcher is studying mild singularities and Cauchy horizons in spacetime models. Mild singularities include quasiregular and nonscalar curvature singularities. In the former, particle paths may end with no accompanying catastrophes, while in the latter, some particles moving near the singularity will feel infinite tidal forces, but not all do. In most cases the spacetime models examined satisfy Einstein's equations.

In particular, the researcher is using a conjecture she and T. M. Helliwell first published in 1985 to predict whether various mild singularities and Cauchy horizons are stable. Thus far the conjecture has held true for the quasiregular singularities in Taub-NUT-type cosmologies and in Khan-Penrose spacetime when fields are added. When applied to the quasiregular singularity in Bell-Szekeres spacetime and the nonscalar curvature singularity and Cauchy horizon in a type-V LRS spacetime, a prediction was possible but no exact solutions were available for comparison. A study of the Cauchy horizons in Reissner-Nordstrom spacetime using the conjecture correctly predicted the effects of null dust when compared with exact solutions. The Cauchy horizons in the Kerr spacetime were predicted to be generally unstable to the addition of null dust but no exact solutions were known for comparison.

Last year the Cauchy horizons in anti-deSitter spacetime were shown to be unstable to the addition of null dust. For the first time the conjecture failed -- it predicted correctly the occurrence of a singularity but not the type. Therefore this year we have studied the instability more thoroughly using scalar fields and we have altered the conjecture to account for the discrepance. A paper was recently published on scalar field behavior in anti-deSitter spacetime and the new conjecture. Further studies using the new, improved conjecture are underway.

Work was also done this year to understand the nature and stability of the Geroch and Tod spacetimes which have complete geodesics but an incomplete pathof bounded acceleration. The singularities were found to be quasiregular but stable to the addition of fields. In addition, we studied the stability of Cauchy

horizons in single plane wave spacetimes and a paper is being prepared for submission to Physical Review D.

Fraction-free Algorithms for Linear and Polynomial Equations

Researchers: Professors George C. Nakos, Peter R. Turner and Robert M. Williams
Sponsors: Naval Academy Research Council and Naval Air Warfare Center

This report extends the ideas behind Bareiss' fraction-free Gauss elimination algorithm in a number of directions. First, in the realm of linear algebra, algorithms are presented for fraction-free LU "factorization" of a matrix and for fraction-free algorithms for both forward and back substitution. These algorithms are valid not just for integer computation but also for any matrix system where the entries are taken from a unique factorization domain such as a polynomial ring. The second part of the paper applies a fraction-free formulation to resultant algorithms for solving systems of polynomial equations. In particular, the use of fraction-free polynomial arithmetic and triangularization algorithms in computing the Dixon resultant of a polynomial system is discussed in detail.

Military Application Projects for Calculus I, II and III

Researchers: Professor Howard L. Penn and Associate Professor T. S. Michael
Sponsor: Curriculum Development Committee

In this project the researchers developed a series of projects for Calculus I, II and III. Professor Michael wrote the projects for Calculus III while Professor Penn wrote the projects for Calculus I and II. These projects
involved applications of Calculus that should be of interest to midshipmen. They used the software, Maple, which was issued to the midshipmen.The projects are available on the courses web pages maintained by the USNA Mathematics Department.

Shifts on Operator Algebras

Researcher: Professor Geoffrey L. Price
Sponsor: National Security Agency/USNA

One of the key problems in the theory of von Neumann algebras is to study and to classify the position of subfactors of a prescribed index in the hyperfinite II_1 factor R. In many ways this problem resembles the analysis of subgroups in group theory: in fact, the group-theoretic notions of index, normality, and conjugacy all have analogues in the theory of subfactors. Over the past few years Price has worked jointly with Professor R. T. Powers to study a family of subfactors in R on which one can define a sort of non-commutative version of the Bernoulli shift of index 2. These shifts are called binary shifts. For each binary shift there is a corresponding bitstream of 0's and 1's which defines the shift. The structure of the shift is reflected in certain properties possessed by the bitstream. For example, the relative commutant of the range $\sigma^k(R)$ of the kth power σ^k of the shift σ is non-trivial for some k, if and only if, the bitstream is eventually periodic. In independent work over the past two years, Price has shown that all binary shifts of commutant index 2 are cocycle conjugate. Subsequently to obtaining this result, Price has successfully addressed the cocycle conjugacy problem for binary shifts of higher relative commutant indices.

Cruise Missile/TACAIR Effectiveness Assessment Software

Researcher: Professor Thomas J. Sanders
Sponsor: The John Hopkins University/Applied Physics Laboratory

This project involved the continued development of a cruise missile and tactical air (TACAIR) effectiveness assessment system that is being done by the Strike and Anti-Surface Warfare Group of the Naval Warfare Analysis Department of the John Hopkins University Applied Physics Laboratory (APL). The purpose of this system is to aid an analyst in scenario development, scenario analysis, survivability analysis, mission planning, and equipment performance prediction. During the summer of 1996, this investigator added options and improved the DTED map program (DTMA). This program was written in C++ and MacApp, and may be used by an analyst to display and manipulate Digital Terrain Elevation Data (DTED) files.

The DTED files are data files generated by the Defense Mapping Agency and are used in aspects of cruise missile mission planning. In particular, they are used by an analyst to assist in scenario analysis to investigate such things as radar site location and masking, and cruise missile flight paths. The DTED map program developed allows for computer generated color displays of the (large) data files quickly, and allows the analyst to use the computer to determine radar site locations and masking, and to plan cruise missile flight paths.

Electromagnetic Signature Reduction

Researchers: Professor John C. Turner and P. Izat
Sponsor: Naval Surface Warfare Center, Annapolis

The work on this project this past year has consisted mainly of writing up past results and preparing for a major sea trial in the fall of 1997. The preparations for the coming trial include reviewing the design of experiments and developing analysis methodologies. Also, software design is required for the onboard, real time, data collection system.

C3 Applications of RNS Arithmetic and Linear Algebra

Researcher: Professor Peter R. Turner
Sponsor: Naval Air Warfare Center-Air Defense, Warminster, PA
and Office of Naval Research (NARC)

The problem of beamforming is that of tuning an array of antennas so as to maximize the reception in the direction of a desired signal while minimizing the signal strength in the direction of a jammer signal. Over the last several years, this work has focused on the use of the Residue Number System to solve the adaptive beamforming problem using Gaussian elimination. During this last year further progress has been made and the scope of the project broadened. First, the potential for use of Gauss elimination in an integer computing environment has been significantly enhanced by developing an improved fraction-free integer Gauss elimination algorithm. This algorithm has the further benefit of eliminating all unnecessary common factors in matrix elements without the need for any additional computational effort to find these factors. The modified algorithm is also applicable in the situation where the matrix elements (coefficients) are taken from a more general ring such as a ring of real polynomials.

Within many C^3 problems it is necessary (or at least desirable) to be able to identify the rank of a matrix which is highly rank deficient - but is contaminated by noise. This problem is of particular importance in radar processing. Late in the summer of 1995 a new approach was developed for this problem based on least squares approximation of rows of a matrix by other rows of the matrix. This is essentially a modification of the Gramm-Schmidt orthogonalization process performed in an iterative

manner. This approach appeared from early testing to have great potential as a much cheaper (and therefore quicker) algorithm than the standard SVD-based approach.

Solution of Linear and Polynomial Systems

Researcher: Professor Peter R. Turner and George Nakos
Sponsor: Naval Air Warfare Center-Air Defense, Warminster, PA
Office of Naval Research (NARC)

From the previous work for NAWC, the potential for use of Gauss elimination in an integer computing environment is significantly enhanced by an improved fraction-free integer Gauss elimination algorithm. This algorithm has the further benefit of eliminating all unnecessary common factors in matrix elements without the need for any additional computational effort to find these factors. The modified algorithm is also applicable in the situation where the matrix elements (coefficients) are taken from a more general ring such as a ring of real polynomials.

Also within the realm of RNS arithmetic a new algorithm for exact integer division within the RNS system has been developed. This could be combined with the fraction-free algorithm since the divisions required there are known to be exact. This may have the effect of making the RNS-based approach more practical. The complexity analysis of this algorithm has not yet been fully explored.

These two developments combine to make a more practical method for solving integer linear systems with the fast parallel arithmetic of RNS. This has resulted in a paper to be presented to the 13th Symposium on Computer Arithmetic this summer.

The developments in fraction-free algorithms, and their extensions to a fraction-free LU algorithm make it possible to combine these ideas within a computer algebra setting with the earlier work of Nakos on using Dixon resultants for the solution of polynomial systems. These are important within the realms of threat analysis, robot control and object recognition.

This is the subject of continuing research to be sponsored again by NAWC-AD, Patuxent River this year.

Implementation and Applications of Level-index Arithmetic

Researcher: Professor Peter R. Turner
Sponsor: Naval Academy Research Council

This project continues the development of possible schemes for the eventual hardware implementation of SLI arithmetic and the analysis of the algorithms used. We also are gaining more computational experience and evidence of the potential practical value of the system using software implementations of the symmetric level-index, SLI arithmetic system. This was a continuation of previous work on the level-index system.

The principal recent objectives have been to investigate further the implementation and application of LI and SLI arithmetic and the comparison of these with other proposed new computer arithmetics. The primary goal was to begin the implementation of this system on the Math Dept MasPar MP-1 system to investigate the advantages to be derived from a massively parallel implementation. This aspect of the work was enhanced during the summer of 1995 by the visit of Nicolas Schabanel, a graduate student from the Ecole Normale Superieure, Lyon, France who spent his summer internship working here at USNA. His work on implementing SLI arithmetic on the MasPar is summarized in his Technical Report. 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 areas of activity here have been and are concerned with 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.

Frequency of Overflow and Underflow Failure in Scientific Computing

Researcher: Professor Peter R. Turner and Alan Feldstein (Arizona State University)
Sponsor: Arizona State University

This work is the continuation of earlier work in which the authors considered this question from the viewpoint of arithmetic overflow resulting from addition and subtraction on the basis of the logarithmic distribution of numbers. The assumption of the logarithmic distribution combined with a further assumption that the distribution of numbers should be smooth and independent of the arithmetic base leads to the claim that the exponents of floating-point numbers should be uniformly distributed. It was on this basis that alarming frequencies of overflow and underflow were obtained. The further observation was made there that these results were unrealistically pessimistic for scientific computing.

This departure from realism was explained by stating that the distribution of exponents is not uniform in practical scientific applications because of the choice of units and the scaling of the problem. It is the purpose of this work to examine the distribution of exponents in an attempt to obtain a more realistic model for the occurrence of overflow and underflow failure. Initially, this is applied only to a random process taking no account of the special nature of any particular process.

The basic models used to develop the results are described beginning with a discrete hardware designs for their implementation. The log model which is directly comparable to the floating-point situation. This is followed by a continuous model which can be thought of as modeling the situation which would be encountered in using a logarithmic arithmetic. Such arithmetic systems have been proposed as alternatives to floating-point and extensive work has been carried out in obtaining arithmic number systems are essentially equivalent to level 1 of the level-index and symmetric level-index systems.

It is shown here that the continuous model mirrors very closely the behavior of the discrete model, a fact which makes it suitable for the analysis of the floating-point situation. This analysis shows that, as the number of multiplicative operations increases, the exponent distribution becomes a spline function of increasing degree which mimics more and more closely a normal distribution function. This remains true until exponent spill begins to take over. This is followed up by the presentation of computational evidence on the frequency of exponent spill as a result of an extended sequence of multiplications and divisions. One striking aspect is the marked difference between balanced and unbalanced initial ranges of exponents. In the case of even very slight unbalance - which may simply be the result of good scaling applied within an unbalanced floating-point system - the frequency of exponent spill grows alarmingly. Account is taken here of whether the exponent spill is reported before or after the normalization of the result.

Polynomial Functions over Z/(m)

Researcher: Professor William P. Wardlaw
Sponsor: Naval Academy Research Council

Any polynomial F(X) with coefficients chosen from **Z/(m)** uniquely determines a polynomial function F:**Z/(m)**→ **Z/(m)** evaluated by substituting elements of **Z/(m)** into F. The researcher denotes the ring of all polynomial functions over **Z/(m)** by **P (Z/(m))**. The purpose of this project is to determine the structure and the cardinality of **P (Z/(m))**. The researcher has run Maple programs to evaluate the cardinality of **P (Z/(m))** for a number of values of m,
but has so far not been able to determine a pattern for the cardinality for general m. He is now looking into the generalization to the ring **P(R)** of polynomial functions over an arbitrary commutative ring **R** in the hope that the abstract algebraic properties of this ring will give some insight into the original problem.

Independent Research

Applications of Graph Theory to Automated Fingerprint Identification

Researcher: Professor Carol Crawford

This ongoing investigation matches the theories and algorithms of graph theory to the design of neural networks for an important computer vision problem. In particular, this research is applied to the design of fully automated programs for fingerprint identification. Graph representations utilizing a new class of proximity graphs, called "Sphere-of-Influence Graphs," provide a robust representation of fingerprint minutiae maps. These graph representations are then incorporated into the design of graph matching neural networks. This research has received previous funding from The Federal Bureau of Investigation and The Office of Naval Research. Various papers have been published and presentations given, including a paper at Oxford University.

Generating Functions for Metrics on Singular Kahler Varieties (Formerly titled: Modified Saper Metrics and Singular Algebraic Varieties)

Researcher: Associate Professor Caroline G. Grant

This project is a continuation of research funded by the NARC, in joint work with Prof. P. Milman of the University of Toronto. During the year 16 June 1996 - 15 June 1997, the authors have obtained several additional results which go beyond the original objective of the project and which will be included in the paper in preparation. These results are applied to construct a complete Kahler metric of modified Saper type with a particularly simple local description. However, these results may have many other interesting consequences in the theory of singular spaces.

A generalized Chow's Theorem for ideals was proved using the Direct Image Theorem. The author proved that a tower of blow-ups of a compact complex manifold along smooth centers is equivalent to a single blow-up of the manifold along a product of ideals corresponding to the individual blow-ups and gave a formula for these ideals. In spite of the fact that blow-ups are a fundamental tool in resolution of singularities, this result does not seem to have been known except in the case in which the centers are isolated points.

Explicit local formulas were found for Chern forms of the exceptional line bundles of blow-ups over the inverse image of neighborhoods of points in the base.

A Primer for Apprentice Mathematicians

Researcher: Professor Charles C. Hanna

The primer will be a set of notes for an introductory course for mathematics majors such as our SM291, "Fundamentals of Mathematics."

The objective of the text is to ease the transition from engineering-oriented mathematics, emphasizing techniques for solving particular problems, to mathematicians' mathematics, emphasizing discovery and proofs of mathematical truths. The text begins with an introduction to basic mathematical concepts—sets,
logic, numbers, functions, sequences, and vectors. There follows an extensive discussion of how to understand and construct proofs of simple statements. Finally, the readers are invited to apply these techniques in a deeper discussion of the basic ideas. Additional chapters will consider equivalence relations

(applied to modular arithmetic and construction of number systems), vector spaces, sequences and their limits, and an introduction to real analysis.

Deriving Vardiman's Sedimentation Equations

Researcher: Professor Robert A. Herrmann

The Vardiman sedimentation equation for ocean floor sediment is obtained from empirical evidence and data matching. In this research, a derivation from first principles of this equation is obtained by considering a homogeneous mixing problem with reflaxation time incorporated for the period of discontinuous mixing. The differential equation obtained has as unique solution which is the Vardiman sedimentation equation.

Multiple Harmonic Series and Euler Sums

Research: Associate Professor Michael E. Hoffman

The author and his colleague C. Moen have studied the multiple harmonic series

$$\zeta(i_1,i_2,\ldots,i_k)=\sum_{n_1>n_2>\cdots>n_k\geq 1}\frac{1}{n_1^{i_1}n_2^{i_2}\cdots n_k^{i_k}}$$

since 1988, primarily in an effort to resolve two conjectures (called the duality and sum conjectures) about them. In recent years these sums have arisen in knot theory in connection with the invariant introduced by Kontsevich. The duality conjecture can be proved easily from this point of view, and recently the sum conjecture has been proven in full generality by Granville and Zagier. The focus of investigation has now shifted to more general questions about these sums. For example, if we define the weight of $\zeta(i_1,\ldots,i_k)$ to be $i_1+\cdots+i_k$, then how many sums of weight n are irreducible(i.e., not expressible in terms of sums of lower weight)? The set of multiple harmonic series also has a natural algebraic structure, and it makes sense to ask what the ideal of relations between such sums looks like. Finally, the class of multiple harmonic series can be generalized to include "Euler sums" of the form

$$\zeta(i_1,i_2,\ldots,i_k;\varepsilon_1,\varepsilon_2,\ldots,\varepsilon_k)=\sum_{n_1>n_2>\cdots>n_k\geq 1}\frac{\varepsilon_1^{n_1}\varepsilon_2^{n_2}\cdots\varepsilon_k^{n_k}}{n_1^{i_1}n_2^{i_2}\cdots n_k^{i_k}}$$

where the ε_j are roots of unity. Again the set of these sums has an algebraic structure, and the problem of analyzing the ideal of relations looks quite challenging.

The author introduced a "harmonic algebra" to formalize the multiplicative structure on the set of multiple harmonic series. This harmonic algebra turns out to be isomorphic to the algebra of quasi-symmetric functions, which had been studied from other points of view. He was also able to describe some of the known sets of relations in more algebraic terms. Recently he has generalized some of his algebraic results to the class of Euler sums.

Crystal, Version 2.5

Researcher: Associate Professor W. David Joyner and Roland Martin

Crystal, a Maple package which helps decompose the restriction of an irreducible finite dimensional representation and the tensor product of two irreducible finite dimensional representations of a simple Lie algebra into irreducible constituents using crystal graphs. Basically this amounts to implementing a theorem of Kashiwara: the irreducible constituents of such a tensor product are in a natural 1-1 correspondence with the connected components of the crystal graph of the tensor product.

The crystal package contains programs to : 1) compute the crystal graph of an irreducible; 2) representation, associated to a fundamental weight; 3) compute the crystal graph of the tensor product of Two irreducible representations; 4) display the crystal graph of the tensor product obtained above; 5) display the crystal graph of the restriction of an irreducible component of a tensor product representation to a simple subalgebra; 6) computing all the weights occurring in a given irreducible representation.

Multiplicity One for Sl(2)

Researcher: Associate Professor W. David Joyner

Further work on revising a work on comparing the automorphic forms of SL(2) with those of its two-fold metaplectic cover based on discussions with Jeff Adams and Jason Schultz.

Invariant Distributions on P-adic Groups

Researcher: Associate Professor W. David Joyner

Revising work on invariant distributions of p-adic reductive groups.

Symmetry and the Existence of Multiple Eigenvalues for Laplacians

Researcher: Associate Professor Robert Lockhart

Generically a Laplace operator on a compact manifold has only simple eigenvalues. This is also true for elliptic boundary value problems for Laplacians on compact manifolds with boundaries. In research done several years ago, however, the researcher showed that if the manifold has a symmetry of order three or more, then there are infinitely many multiple eigenvalues. Furthermore, if the manifold is in fact homogenous, then all but the first eigenvalue is multiple. During the past year the researcher has been investigating the extent to which some symmetry is necessary for the existence of multiple eigenvalues. Put simply, does the existence of infinitely many multiple eigenvalues imply the existence of a symmetry?

The Time Evolution of Space Curves

Researcher: Associate Professor Thomas J. Mahar

This work dealt with a nonlinear system of singular-hyperbolic partial differential equations involving time and three spatial variables. Analytical methods were used to derive a priori estimates on the derivatives of the solutions and these led to a conservation property (length of an arbitrary sub-curve for one parameter and measure of arbitrary measurable sets for three parameters). A class of traveling solutions was constructed, as well as a class of rotating solutions. Mid-point discretizations of the system were studied and shown to have the same conservation propereties as the continuous problem, as well as the same classes of explicit solutions. Numerical computations were performed on the MasPar computer and dealt with examples of the explicitly known solutions, the behavior of a curve with a knot, the behavior of geodesics on a surface and numerical instabilities when explicit discretizations were used.

Special Values and Congruence Properties of Multiple Series

Researchers: Associate Professors Courtney S. Moen and Michael E. Hoffman

The authors have jointly been studying these topics for several years. Their paper entitled, "Sums of Triple Harmonic Series," appeared in the Journal of Number Theory. Another paper on these topics, also written with Michael E. Hoffman, is virtually complete and will soon be submitted.

Discrete Math

Researcher: Associate Professor Courtney S. Moen

A major conjecture in graph theory is the tree-packing conjecture. The author is studying various generalizations of the conjecture, both in the context of graph theory and in other situations. He has also been studying various related problems concerning packings of rectangles and squares. He has written one paper on this subject entitled, "Dissecting with near sequares," and is currently writing another.

Number Theory and Representation Theory

Researcher: Associate Professor Courtney S. Moen

The author is studying various number-theoretical problems which involve automorphic forms, representation theory and algebraic geometry.

Elimination with the Dixon Resultant

Researchers: Professor George Nakos and Robert Williams

Most of this work was done last year. Rewriting had to be done due to the submission to a new journal (the Mathematica Journal where the manuscript was submitted ceased to exist.)

From last year's introduction: "The Dixon resultant can be used to eliminated a number of unknowns from a system of polynomial equations in one step. To the Mathematica user our code complements and greatly enhances the command ***Eliminate***. Our program also improves the command ***Resultant***, which implements the Sylvester resultant. This is up to constant factor(s) a special case of the Dixon resultant. There are two advantages in using Dixon's resultant of Sylvester's: 1) The end matrix has

smaller size; hence, it is often easier to row reduce it or compute its determinant. 2) A whole block of variables can be eliminated in one calculation, instead of the successive eliminations. Finally, as a bi-product - which may also be of general interest - the researchers found a symbolic Gauss elimination that complements Mathematica's ***RowReduce***. This Gauss elimination is done without scaling so that no extra factors are imposed on the pivots."

SM230 Textbook

Researchers: Professor John C. Turner and Associate Professor Gary O. Fowler

The authors have written a textbook for SM230. This book will be published by Wiley Custom Publishing for use next year. The innovative ideas for this book include: using the table form of Venn diagrams to eliminate the formulas for conditional probability and Bayes' Theorem; programs for calculators that compute cdf's for 4 basic distributions and eliminate the need for paper tables; presenting the negative binomial as a special version of the binomial; similarly presenting the exponential and Erland distributions as "negative Poisson" distributions; presenting sums of discrete random variables as convolutions, along with a spreadsheet to illustrate the Central Limit Theorem; functions of continuous random variables, with an application to simulation.

Computational Algorithms in Algebraic Number Theory

Researcher: Associate Professor JoAnn S. Turisco

This project is a continuation of the researcher's previous work. She is writing Mathematica programs which determine prime numbers and compute the class numbers of certain algebraic number fields. The researcher is also working on Mathematica programs which will compute numerical invariants associated to quadratic mappings.

Research Course Projects

Spatially Distributed Prisoner's Dilemma

Researcher: Midshipman 1/C William Getchius
Adviser: Professor Peter P. Andre

Each cell in a circular array of cells is initially assigned a 0 or 1. At time n+1, a given cell is assigned a 0 or 1 determined by a transition rule which uses the cell's own condition and the condition of its two neighbors at time n. At each time step, each cell makes an error in following the transition rule with a given probability.

The study examined the probability of landing in each possible configuration after a long time. The study looked for states and orbits of states that have high probability if the transition probability is allowed to move toward zero.

The study can be extended to a two-dimensional toroidal array of cells with each cell possessing four or eight nearest neighbors.

Applications of Discrete Structures

Researchers: Midshipmen 1/C : Anzalotti, Barber, Booth, Brunson, Cunningham, Drexler, Effimba, Gettys, Haas, Hay, Joseforsahky, Levantovich, Pritchett, Puga, Robinson, Wheeler, Zimmerman, and Midshipman 2/C Francis
Adviser: Professor Carol Crawford

This projects course was created at student request as a flow up course to the SM342 Discrete Mathematics Course. Students in this Reading/Projects course spent half of the course attending in class lectures by outside speakers as well as those by Professor Crawford. Presentations gave special emphasis to applications of graph theory and discrete mathematics to other areas of mathematics as well as computer vision, pattern recognition and operations analysis. The second half of the semester was devoted to 2-person team projects culminating in oral presentations and 12-20 page papers.

The projects investigated included: Neighborhood Graphs and The Henon Attractor; Applications of Graph Theoretic Tournaments; The Chinese Postman Problem; Classification and Fingerprint Identification; Applications of Sphere-of-Influence Graphs; PERT and CPM Path Algorithms and Applications; Project Planning and Organization Using Graph Theory; Latent Fingerprint Analysis; Graph Representations of Groups; and The Application of Graph Theory to Mass Transit Problems.

Homology Group of Square 1

Researcher: Midshipman 1/C James McShea
Adviser: Associate Professor W. David Joyner

We study the group theoretic properties of the collection G of all "words" in the basic moves of the square 1 puzzle which preserve the cube shape. This collection G forms a group which, motivated by a paper of Wilson, we call the homology group of the square 1 puzzle.

Odd King Tours

Researcher: Midshipman Michael Fourte
Adviser: Associate Professor W. David Joyner

We plan to answer (in the negative) a question raised in a paper by C. Bailey and M. Kidwell on whether or not a complete odd king tour exists.

Dodecahedral Faces of M_{12}

Researcher: Midshipman Ann Luers
Adviser: Associate Professor W. David Joyner

The researchers explored twelve different ways M_{12} appears in mathematics, hence the pun the "dodecahedral faces" in the title. Specifically, this paper relates M_{12} to the Mongean Shuffle, the Steiner Hexad, Golay Codes, the Hadamard Matrix of order 12, 5-transitivity, presentations, Crossing the Rubicon, the MOG and the Minimog, the Kitten, Mathematical Blackjack, Sporadic Groups, and the Stabilizer in M_{24} of a dodecad.

The Pyraminx Group

Researcher: Midshipman 1/C Ann Luers
Adviser: Associate Professor W. David Joyner

We explored the pyraminx puzzle (a "Rubik tetrahedron") using group theory. We proved an isomorphism between the pyraminx group and a semi-direct product of an alternating group with a Cartesian product of cyclic groups.

Modeling the Navy's Enlisted Personnel Distribution by Paygrade and Length of Service

Researcher: Midshipman 1/C Janette Lan Hay
Adviser: Professor W. Charles Mylander
Sponsor: Commander Michael Mara, Bureau of Naval Personnel

CDR Mara believes the forecasting accuracy of the distribution of Navy enlisted personnel can be improved, especially during periods of restructing. Currently, the Bureau of Naval Personnel is using a statistically based forecasting model. Errors resulting from a purely statistical approach during a period of restructuring have caused significant budgeting problems, both cost over-runs and shortfalls. Midshipman Hay explored the use of a Markov chain model to improve the forecasts. She laid out the difficulties in building a Markov chain model of the personnel structure of the Navy's enlisted force and explored alternatives for dealing with the difficulties.

More work must be done to define the model. Handles must be included to deal with the factors subject to the control of Pentagon decision makers and the model must use values that can only be estimated statistically. A Markov chain model still seems appropriate.

Symmetries of Nullity Sequences of Toeplitz Matrices

Researcher: Midshipman 1/C Glenn Truitt
Adviser: Professor Geoffrey L. Price

In his studies on shifts on operator algebras, Price has shown that there are useful connections to be made between equivalence classes of certain shifts and Toeplitz matrices which are used to define these shifts. Given a sequence $d_1,d_2,...$ of elements of a finite field, the corresponding Toeplitz matrix T_n is the n x n skew-symmetric matrix of the form T_n =

$$\begin{matrix} 0 & d_1 & d_2 & \cdots & d_{n-1} \\ -d_1 & 0 & d_1 & \cdots & d_{n-2} \\ -d_2 & -d_1 & 0 & \cdots & d_{n-3} \\ & & \vdots & & \\ -d_{n-1} & -d_{n-2} & -d_{n-3} & \cdots & 0 \end{matrix}$$

In work carried out in the summer of 1996 Price noticed that if the sequence is finitely nonzero, and if k is the highest index for which d_k is non-zero, then maximum nullity of T_n is k. He also showed that there are infinitely many n for which the nullity of T_n assumes the value k. With the help of a computer program Price and Midshipman Truitt observed that if $\text{null}(T_n) = k$, then $\text{null}(T_{n-r}) = \text{null}(T_{n+r})$ for all positive integers $r < n$. Using some results proved by Price and others about the impulse response sequence corresponding to shift register sequences, Midshipman Truitt obtained a proof of the observation about the nullities of T_{n-r} and T_{n+r}. Truitt's proof used linear algebra techniques as well as some ideas from the mathematics of cryptology.

Maintenance Personnel Requirements for a Marine Corps Helicopter Light Attack Squadron

Researcher: Midshipman 1/C Mark D. Tripiano
Adviser: Professor Thomas J. Sanders
Sponsor: Resources, Plans and Studies, HQ,USMC

The Marine Corps is currently considering replacing the UH-1 Huey helicopter with a variant of the SH-60 Seahawk. The purpose of this study was to predict the number of enlisted Marines that would be needed for maintenance in the squadron once the change is made.

Data was obtained from Naval Aviation Maintenance Office (NAMO), Patuxent River, MD. The data for the corrent configuration of AH-1 Cobras and UH-1 Hueys was from HMLA 367. The data for the SH-60 Seahawk was from Helicopter Anti-submarine Squadron 3. The number of flight hours for the period Jan-Sep 96 was 2096 for the Cobras and 1225 for the Hueys. The unit level maintenance hours for that period were 32,272 hours for the Cobra and 18,580 hours for the Huey. This gives a total of 50,852 maintenance hours for the squadron. The number of flight hours for calendar year 1996 for the Seahawk was 2040, and the unit level maintenance resulted in 31,245 hours. The assumptions were made that the ratio of maintenance hours to flight hours (MH/FH) would, over a long period of time, remain the same for the Seahawk, and that the Seahawks in the HMLA squadron would fly the same number of hours as the Huey. This gives a predicted number of unit level maintenance hours of 45,624 for a 9 month period when the Seahawk replaces the Huey. This is a reduction of about 10% over the observed number of maintenance hours. The prediction is then made that the enlisted maintenance personnel can be reduced by 10% without reducing the readiness of the squadron. For a squadron with 18 Cobras and 9 Hueys, the current Table of Manpower Requirements lists 68 enlisted maintenance billets at the unit level. A reduction of 10% would mean a loss of 7 billets and a total of 61 billets remaining.

A discrete-event simulation using ProModel software was also constructed as a model of the helicopter maintenance. The model exhibited chaotic-like behavior and no reliable estimate was obtained from the model.

Factors Affecting Promotion Rates

Researcher: Midshipman 1/C Michael Wheeler
Adviser: Major J. Michael Shehan, USMC and Professor John C. Turner
Sponsor: Headquarters, Marine Corps, Manpower Analysis Section

The focus of the research was to identify factors affecting promotion from Captain to Major and Major to Lieutenant Colonel in the Marine Corps. Data provided by Headquarters, Marine Corps was analyzed to identify significant factors which increase the probability of promotion to the 0-4 and 0-5 level. Further, a predictive model was developed utilizing classical regression techniques.

Factors Affecting Promotion in the Marine Corps

Researcher: Midshipman 1/C Michael Wheeler
Adviser: Professor John C. Turner

This SA412 project examined factors that influence promotion in the Marine Corps. These factors include education, performance in TBS, attendance at various schools, source of commission, sex, population group, etc. Promotion to Major turned out to be much more interesting than promotion to Lieutenant Colonel.

Neural Networks

Reseacher: Midshipman 1/C Haynie
Adviser: Professor John C. Turner

This capstone project investigated neural networks and how they relate to standard statistical methods.

Use of Massively Parallel Computers in Linear Algebra and Artificial Intelligence

Researcher: Midshipmen from SM485Q Spring 1997
Adviser: Professor Peter R. Turner

The final stage of this course was devoted to team projects. These were on three different topics in two quite distinct areas.

One was devoted to the issue of finding the most efficient matrix multiplication algorithm for matrices smaller than the processor array. Midshipman Halman and Dunivan came up with a good idea for spreading the work across the processors by making copies of the matrices onto different parts of the array - with one of the factors permuted differently in each copy. The result is that all component multiplications for the complete product of two 16x16 matrices can be performed simultaneously on a 64x64 processor array.

Two teams (Midshipman Martin and Lyne, and Midshipman Mitchell and Hingst) each attacked the problem of solving large systems of linear equations on a 64x64 processor array. (Here large means 128x128 or larger.) Their solutions were essentially similar using a block Gauss elimination algorithm together with Gauss-Jordan inversion of the pivot matrices. This algorithm allows for a natural breakdown of the data and makes good use of the basic building blocks of parallel linear algebra.

The final team, Midshipman Moore and Kritschgau, decided to attack a problem in artificial intelligence. Specifically they used the MasPar machine to try to teach a neural net to learn to recognize fractals. They worked with many different views of the Mandelbrot set, some of which were artificially scrambled using random transformations of the pixels. They then came up with a quantitative scheme for assessing whether a particular image was a fractal by studying the variability of the pixels on the boundary. The decision process depended on a parameter whose value had to be learned from known cases. By the end of this semester their scheme was reporting around 90% success on the trial set of problems.

Publications

CRAWFORD, Carol G., Professor, "Applications of Graph Theory to the Design of Neural Networks for Automated Fingerprint Identification", Mathematics of Neural Networks: Models, Algorithms and Applications, Boston: Kluwer Academic Publishers, 1997, 156-160.

This paper was first presented at The First International Conference on Mathematics and Applications of Neural Networks, Oxford University, July 1995**.** The paper presents applications of graph theory and neural networks to automated fingerprint identification. In particular, the paper presents relaxation networks for graph matching and deterministic annealing to design a matching program for matrix representations of fingerprint minutiae maps. Research for this program received funding from The Federal Bureau of Investigation and The Office of Naval Research**.**

GAGLIONE, Anthony M., Professor, coauthor, "The Commutative Transitive Kernel," Algebra Colloquium, accepted for publication on 27 Nov. 1996.

A group G is *commutative transitive* provided the relation of commutativity is transitive on the non-identity elements of G. A subgroup T(G) is constructed and the main theorem asserts that (1) T(G) is a characteristic subgroup of G contained in the commutator subgroup of G . (2) G/T(G) is commutative transitive. (3) G is commutative transitive if and only if T(G)=1. More generally, if N is a normal subgroup in G then T(G,N) is constructed as the union of an increasing chain of normal subgroups $N=T_0(G,N)\subseteq T_1(G,N)\subseteq\cdots$. T(G) is defined as T(G,1).

GAGLIONE, Anthony M., Professor, coauthor, "Formal Power series Representations of Free Exponential Groups,'" Communications in Algebra, 25(2), (February 1997), 631-648.

A classical result of Magnus asserts that a free group F has a faithful representation in the group of units of a ring of non-commuting formal power series with integral coefficients. We generalize this result to the category of A-groups, where A is an associative ring or an Abelian group. We say that a free A-group F^A has a faithful Magnus representation if there is a ring B containing A as an additive subgroup (or a subring) such that F^A is faithfully represented (exactly as in Magnus' classical result in the case A = Z) in the group of units of the ring of formal power series in non-commuting indeterminates over B. The three principal results are: (I) If A is a torsion free Abelian group and F^A is a free A-group of Lyndon's type, then F^A has a faithful Magnus representation; (II) If A is an ω -residually Z ring, then F^A has a faithful Magnus representation; (III) for every nontrivial torsion-free Abelian group A, F^A has a faithful Magnus representation in B[[Y]] for a suitable ring B if and only if F^Q has a faithful Magnus representation in Q[[Y]].

HERRMANN, Robert A., Professor, "A Hypercontinuous Hypersmooth Schwarzschild Line Element Transformation," International Journal of Mathematics and Mathematical Science., 20(1) (1997), 201-204.

In this paper, a new derivation for one of the basic black hole line elements is given since the basic derivation is flawed mathematically. This derivation postulates a transformation procedure that utilizes a transformation function that is modeled by an ideal nonstandard physical world transformation process that yields a connection between an exterior Schwarzschild line element and a distinctly different interior line element. The transformation is an ideal transformation in that in the natural world the transformation is conceived of as occurring at an unknown moment in the evolution of a gravitationally collapsing spherical body with radius greater than but near to the Schwarzschild radius. An ideal transformation models this transformation in a manner independent of the object's standard radius. It yields predicted behavior based upon a Newtonian gravitational field prior to the transformation, predicted behavior after the transformation for a field internal to the Schwarzschild surface and predicted behavior with respect to field alteration processes taking place during the transformation period.

HOFFMAN, Michael E., Associate Professor, and Courtney Moen, Associate Professor, "Sums of Triple Harmonic Series," Journal of Number Theory 60 (1996), 329-331.

For positive integers a, b, c, with a $\geq$2, let A(a,b,c) denote the triple harmonic series

$$\sum_{i>j>k\geq 1} \frac{1}{i^a j^b k^c} .$$

The authors show that the sum of the A(a,b,c) with a + b + c = n is

$$\zeta(n) = \sum_{i\geq 1} \frac{1}{i^n} .$$

A similar identity for double harmonic series goes back to Euler.

JOYNER, W. David, Associate Professor, and Roland Martin, "Decomposing Lie Algebra Representations Using Crystal Graphs," The Symbolic and Algebraic Computation Newsletter, No. 2, June 1997, pg. 2.

The researchers use the theory of crystal graphs to give a simple graph-theoretical algorithm for determining

the branching rule for decomposing a representation of a simple Lie Algebra when restricted to a simple subalgebra. They also describe a computer package for determining such decompositions graphically.

JOYNER, W. David, Associate Professor, and Roland Martin, "Using Crystal Graphs To Decompose Lie Algebra Representations", SIGSAM Bull, vol 31, December 1997.

JOYNER, W. David, Associate Professor, and Roland Martin, "A Constructive Algorithm For Determining Branching Rules Of Lie Group Representations", accepted Maple Tech, 1997.

KONKOWSKI, Deborah A., Associate Professor, (Co-author), "Improved Cauchy horizon stability conjecture", Phys. Rev. D15,7898-7901 (1996).

An improved stability conjecture for Cauchy horizons is presented. The conjecture predicts the stability of Cauchy horizons based upon the behavior of test fields, and in the case of instability it also predicts the nature of the singularity produced. The results for Cauchy horizons in Reissner-Nordstrom, Kerr, Reissner-Nordstrom-de Sitter, Kerr-de Sitter, anti-De Sitter, and a type V LRS spacetime are reviewed. The improved conjecture agrees with the stability and singularity types in all cases for which an exact back reaction solution has been found.

MARUSZEWSKI, Richard F., Associate Professor, "Spreadsheets in a Differential Equations Course," AMATC Review, Volume 18, #1, pp 40-44, Fall 1996.

MARUSZEWSKI, Richard F., Associate Professor, "A Note on Benford's Law," with J. Huddle, MACE Journal, Volume 31, #1, pp 66-69, Winter 1997.

MCCOY, Peter A., Professor, "A Classical Theorem on the Singularities of Legendre Series in C^3 and Associated System of Hyperbolic Partial Differential Equations," SIAM J. Math Analysis, vol. 28, issue 3, May 1997.

A classical theorem of Z. Nehari relates the singularities of Legendre series expansions with those of Taylor's series. The generalization of Nehari's theorem is known for Legendre series in two complex variables. In this paper, function theoretic methods develop the analogous relationships between the singularities of series expanded as triple products of Legendre series and those of the associated Taylor's series. The singularities of these generalized Legendre series are determined by certain elliptic curves. Moreover, these series satisfy a system of hyperbolic partial differential equations in three complex variables that are connected to S. Bochner's study of Poisson processes in two real variables.

MEYERSON, Mark D., "The x^x Spindle," Mathematics Magazine, June 1996, pp. 198-206.

MEYERSON, Mark D., Professor, One problem solution published by American Mathematical Monthly (10328), November 1996.

PRICE, Geoffrey L., Professor, co-author, "On the Ranks of Skew-Centrosymmetric Matrices over Finite Fields," Linear Algebra and Application, 248 (1996) 317-325.

This work is an extension of an honors project by (then) Midshipman Kristen W. Culler under the supervision of Professor Price. If F is a finite field, and if $d_1,d_2,...$ is a sequence of elements of F, then for each positive integer n one can form the n by n skew-symmetric matrix T_n of the form

$$\begin{matrix} 0 & d_1 & d_2 & \dots & d_{n-1} \\ -d_1 & 0 & d_1 & \dots & d_{n-2} \\ -d_2 & -d_1 & 0 & \dots & d_{n-3} \\ & & \vdots & & \\ -d_{n-1} & -d_{n-2} & -d_{n-3} & \dots & 0 \end{matrix}$$

Let ν_n be the nullity of this matrix. Then the authors showed that the sequence $\{\nu_n\}$ of nullities is the concatenation of infinitely many strings of the form 1,2,...,m-1,m,m-1,...,1,0. Using this result the authors were able to compute the number of n by n matrices of skew centrosymmetric form of a prescribed rank.

PRICE, Geoffrey L., Professor, co-author, "Endomorphisms of B(H)," Proceedings of Symposia in Pure Mathematics, 59 (1996) 93-138.

In this paper the authors study unital shifts on the algebra of bounded operators on an infinite-dimensional Hilbert space H. The authors show that each unital shift σ on B(H), with Jones subfactor index $[B(H): \sigma(B(H))] = n^2$, $n = \infty,2,3,...$ is implemented by a representation of the Cuntz algebra O_n. Using this result the corresponding conjugacy classes of shifts are identified. The authors also use a construction due to von Neumann to show that there exist shifts on B(H)

which have no invariant normal states.

SHEHAN, J. Michael, Major, USMC, "Benchmarking for Better Mathematics at a Service Academy," Mathematica Militaris, Vol. 6, issue 3, Fall 1997.

Benchmarking is a process that involves seeing which procedures enhanced the success rate at other institutions and then applying those procedures at one's own organization. Responses to a questionnaire given to Math Department faculty members at the Naval Academy regarding benchmarking are explored. The author argues that while this approach to organizational improvement has merit, service academies must exercise considerable care when selecting for implementation things which have worked for civilian colleges and universities.

TURNER, Peter R., Professor and Alan Feldstein,(ASU), "Overflow and Underflow in Multiplication and Division," Applied Numerical Mathematics, 21 (1996) 221-239.

The logarithmic distribution combined with a further assumption that the distribution of numbers should be smooth and independent of the arithmetic base leads to alarming frequencies of overflow and underflow. It is the purpose of this work to examine the distribution of exponents in an attempt to obtain a more realistic model for the occurrence of overflow and underflow failure. The basic models used to develop the results are described beginning with a discrete model which is directly comparable to the floating-point situation. This is followed by a continuous model which can be thought of as modeling the situation which would be encountered in using a logarithmic arithmetic. It is shown here that the continuous model mirrors very closely the behavior of the discrete model. This analysis shows that, as the number of multiplicative operations increases, the exponent distribution becomes a spline function of increasing degree which mimics more and more closely a normal distribution function. This remains true until exponent spill begins to take over.

TURNER, Peter R., Professor, Daniel W. Lozier, (NIST) and Michael A. Anuta (Cray Research), "The MasPar MP-1 as a Computer Arithmetic Laboratory," NIST J Research 101 (1996) 165-174.

This paper describes the use of a massively parallel SIMD computer architecture for the simulation of various forms of computer arithmetic. The particular system used is a DEC/MasPar MP-1 with 4096 processors in a square array. This architecture has many advantages for such simulations due largely to the simplicity of the individual processors. Arithmetic operations can be spread across the processor array to simulate hardware. Alternatively they may be performed on individual processors to allow simulation of a massively parallel implementation of the arithmetic. Compromises between these extremes permits speed-area trade-offs to be examined. The paper includes a description of the architecture and its feature. It then summarizes some of the arithmetic systems which have been, or are to be, implemented. The implementation of the level-index and symmetric level-index, SLI, systems is described in some detail. An extensive bibliography is included.

TURNER, Peter R., "Fraction-Free RNS Algorithms for solving Linear Systems ARITH13," 13th IEEE Symposium on Computer Arithmetic, IEEE Computer Society, Washington DC, (1997) 218-224.

This paper is concerned with overcoming the arithmetic problems which arise in the solution of linear systems with integer coefficients. Specifically, solving such systems using (integer) Gauss elimination or its variants usually results in severe growth in the dynamic range of the integers that must be represented. To alleviate this problem, a Residue Number System (RNS) can be utilized so that large integers can be represented by a vector of residues which require only short wordlengths. RNS arithmetic, however, cannot easily handle any divisions that are needed in the solution process. This paper presents fraction-
free algorithms for the solution of integer systems. This does involve divisions --- but only divisions where the result is known to be an exact integer. The other principal contribution of this paper is the presentation of an RNS division algorithm for exact integer division which does not require any conversion to standard binary form. It uses entirely modular arithmetic, perhaps including a step equivalent to RNS base extension.

TURNER, Peter R., Professor and LOZIER, Daniel W (NIST), "Error-bounding in Level-Index Computer Arithmetic," Numerical Methods and Error Bounds (G. Alefeld & J. Herzberger, eds) Akademie Verlag, Berlin, 1996, pp 138-145.

The main purpose of this paper is to compare the new SLI arithmetic with the old (floating-point) with

particular reference to interval arithmetic and other error-bounding techniques. This yields advantages such as immunity to considerations of underflow and overflow, a unified error analysis and a natural means for increasing precision within any algorithm. The secondary purpose is to describe the Computer Arithmetic Laboratory which is being developed on a MasPar MP-1 system. The MasPar built-in arithmetic is built up from 4-bit operations and the new arithmetic systems will be similarly constructed. The MasPar setting is ideal for demonstrating and comparing different computer arithmetics.

TURNER, Peter R., and D. W. Lozier, "Parallel Algorithms for Basic Linear Algebra in SLI Arithmetic," Proceedings of Computational and Applied Mathematics, Leuven, Belgium, July (1996) ID2.

This paper reports on a continuing project to develop, implement and apply parallel algorithms for the SLI arithmetic system. In this paper the arithmetic algorithms for SLI are reexamined with a view to SIMD and possible eventual hardware implementation. The algorithms are extended to parallel SLI BLAs such as scalar products and saxpys. The parallel computational complexity of these algorithms is seen to be similar to a single scalar SLI arithmetic operation.

TURNER, Peter R., Professor and M. A. Anuta, D. W. Lozier, N. Schabanel, "Basic Linear Algebra in SLI Arithmetic," EuroPar96 Parallel Processing, LNCS 1124, Springer, 1996, pp 193-202.

Symmetric level-index arithmetic was introduced to overcome recognized limitations of the floating-point system. The original recursive algorithms for SLI operations could be parallelized to some extent and a SIMD implementation of these algorithms is described. The main purpose of the paper is to present parallel SLI algorithms for arithmetic and basic linear algebra operations.

TURNER, Peter R., Professor and D. W. Lozier, "Parallel BLAs in SLI Arithmetic," (Extended Abstract) Proceedings of 33rd Annual Meeting of Soc of Engineering Science, Tempe, AZ, October 1996 ID2.

This paper reports on a continuing project to develop, implement and apply parallel algorithms for the SLI

arithmetic system. Algorithms for SLI are developed for a SIMD parallel computer. Vector code is also being developed using MATLAB. The standard arithmetic algorithms are extended to parallel SLI BLAs such as scalar products and saxpys. The application of these to solving linear systems using Gauss elimination and Gauss-Jordan reduction is discussed.

WARDLAW, William P., Professor (with G. M. Benkart and M. D. Meyerson), Problem 600, The

College Mathematics Journal, vol. 28 no.2 (March 1997) 146.

Let R be a commutative ring with unit element 1. Prove or disprove: If a, b $\in$ R are multiples of one another, then they are unit multiples of one another; that is, there is an invertible element u $\in$ R such that a = ub.

WARDLAW, William P., Professor, Problem 601, The College Mathematics Journal, vol. 28 no. 3 (May 1997) 231.

Prove that if the sum of finitely many consecutive terms from the harmonic sequence is written as a fraction in lowest terms, then the numerator is odd.

WITHERS, W. Douglas, Associate Professor, "A Rapid Entropy-Coding Algorithm," Dr. Dobb's Journal, 264 (April 1997), 38-43.

The researcher describes a new entropy-coding algorithm which he calls the ELS-coder. The ELS-coder is extremely simple to implement, and yet combines rapid execution with near-optimum compression performance. It is competitive in both speed and compression with the Q-coder and QM-coder.

Technical Reports

MARUSZEWSKI, Richard F., Associate Professor, "Scoring via Galois equations," DOD Technical

Report, October 1996.

TURNER, Peter R., Professor, "Gauss elimination: Workhorse of Linear Algebra," Tech Rep NAWCADPAX-96-194-TR, 1996.

This report brings together many different aspects of Gauss elimination. The basic GE algorithm is a fundamental tool of linear algebra for solving systems, computing determinants and determining rank. All of these are discussed in various contexts. These include different arithmetic or algebraic settings such as integer arithmetic or polynomial rings as well as conventional real (floating-point) arithmetic. Both accuracy and complexity are considered. The impact of parallelism is also discussed. Finally, GE is considered in the context of noisy matrices.

TURNER, Peter R., Professor, "A simplified Fraction-Free Integer Gauss Elimination Algorithm," Tech Rep NAWCADPAX-96-196-TR, 1996

This report presents a new version of Gauss elimination for integer arithmetic. This new algorithm allows fraction-free integer computation without requiring any calls to a greatest common divisor routine. It does however keep the growth in the integer dynamic range to a minimum. The algorithm is based on a careful comparison of the divisionless integer GE and the normal algorithm using divisions in a real arithmetic setting. From this analysis, we identify common factors which are necessarily present throughout the active part of the matrix. These can then be removed by exact integer division. A further consequence of this analysis is that the diagonal entries of the final triangular factor are precisely the determinants of the principal minors of the original matrix. In a parallel processing environment, the additional cost of these integer divisions is minimal since, at each stage, the whole active array is being divided by the same integer.

TURNER, Peter R., Professor, "Low Rank Determination using Least Squares," Tech Rep NAWCADPAX-96-195-TR, 1996.

This report discusses a technique for determining the rank of a matrix of special type. The matrix is assumed to be composed of a matrix of very low rank relative to its size, a "noise" component. The objective is to determine the rank of the underlying matrix. The idea behind this algorithm is to approximate each row of the matrix (in a least squares sense) by linear combinations of "significant rows" in an iterative

manner until the effective rank is revealed.

TURNER, Peter R., Professor, with George Nakos and Robert M. Williams (NAWCADPAX), "Fraction-Free Algorithms for Linear and Polynomial Equations," Tech Rep NAWCADPAX, 1997.

This report extends the ideas behind Bareiss' fraction-free Gauss elimination algorithm in a number of directions. First, in the realm of linear algebra, algorithms are presented for fraction-free LU "factorization" of a matrix and for fraction-free forward and backward substitution. These algorithms are valid not just for integer computation, but also for any matrix system where the entries are taken from a unique factorization domain such as a polynomial ring. The second part of the paper applies a fraction-free formulation to resultant algorithms for solving polynomial systems. In particular, the use of fraction-free polynomial arithmetic and triangularization algorithms in computing the Dixon resultant of a polynomial system is discussed in detail.

Presentations

BAILEY, Craig K., "Teaching Calculus with the TI-92," MD-DC-VA section meeting of the MAA, Williamsburg, VA, 18-19 April 1997.

BUCHANAN, James L., Professor, R. P. GILBERT, and Z. LIN, "Determination of Seabed Parameters from Far Field Acoustic Data," World Congress for Nonlinear Analysis, Athens, Greece, 11 July 1996.

BUCHANAN, James L., Professor, R. P. GILBERT, and Z. LIN, "Determination of Seabed Parameters from Far Field Acoustic Data," AMS Sectional Meeting, Chattanooga, TN, 11 October 1996.

BUCHANAN, James L., Professor, "Direct and Inverse Problems for a Poroelastic Seabed," Conference on Generalized Analytic Functions, Graz, Austria, 8 January 1997.

BUCHANAN, James L., Professor, and R. P. GILBERT, "Transmission Loss over a Two-layer Seabed," ISAAC Conf., Newark, DE, 5 June 1997.

CRAWFORD, Carol G., Professor, Panel Member, "National Science Foundation Grants Review for Undergraduate Course and Curriculum Development Program", Washington, DC, 22-25 July, 1996.

CRAWFORD, Carol G., Professor, Team Member, "Middle States Evaluation of East Stroudsburg State University", Report of Team Evaluation to East Stroudsburg, Pennsylvania, 6-10 April 1997.

CRAWFORD, Carol G., Professor, Conference Chair, "Maryland-DC-Virginia Regional Meeting Introductory Remarks", Hood College, Frederick, Maryland, 1-2 November 1996.

CRAWFORD, Carol G., Professor, Conference Chair, "Maryland-DC-Virginia Regional Meeting Introductory Remarks", The College of William and Mary, Williamsburg, VA, 18-19 April 1997.

GAGLIONE, Anthony M., Professor, "Logic and the first-order theory of the non-Abelian free groups," AMS meeting Special Session, Ryder College, Lawrenceville, NJ, 4 October 1996.

GAGLIONE, Anthony M., Professor, "Surface Groups and Logic," McGill Univ., Montreal, Canada, Conference on Geometric Group Theory, 19 October 1996.

GAGLIONE, Anthony M. Professor, "Residual Properties of Groups and Rings," Zassenhaus Group Theory Conference, Univ. of S. FL, Sarasota, FL, 10 January 1997.

GAGLIONE, Anthony M. Professor, "Surface Groups and Logic," NY Group Theory Seminar, 14 February 1997.

GAGLIONE, Anthony M. Professor, "Solving Equations in Groups," Fairfield Mathematics Seminar, Fairfield Univ., Fairfield, CT, 11 April 1997

GRANT, Caroline G., Associate Professor, "Kahler Metrics for Singular Algebraic Varieties," The Fields Institute for Research in Mathematical Sciences, Toronto, Canada, 26 February 1997.

GRANT, Caroline G., Associate Professor, "Generating Functions for Kahler Metrics on Singular Algebraic Varieties," Algebraic Geometry Seminar, University of Toronto, Toronto, Canada, 19 March 1997.

GRANT, Caroline G., Associate Professor,"Chow's Theorem in Algebraic Geometry," U. S. Naval Academy, Annapolis, Maryland, 9 April 1997.

HOFFMAN, Michael E., Associate Professor, "Recent Progress on Multiple Harmonic Series," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, MD, 2 October 1996.

KAPLAN, Harold M., Professor, "A neglected virtue of the Cox-Stuart tests for trend," Mid-Atlantic Probability and Statistics Day, Department of Mathematics and Statistics, University of Maryland Baltimore County, 20 October 1990.

KONKOWSKI, Deborah A., Associate Professor, "Stability Tests for Mild Singularities and Cauchy Horizons", Texas Symposium on Relativistic Astrophysics, Chicago, Illinois, December 1990.

KONKOWSKI, Deborah A., Associate Professor, "The Stability of Plane-Wave Cauchy Horizons," London Relativity Seminar, Queen Mary and Westfield College, University of London, London, England, March 1990.

KONKOWSKI, Deborah A., Associate Professor, "The Stability of Plane-Wave Cauchy Horizons," Relativity Seminar, University of Southampton, Southampton, England, March 1990.

KONKOWSKI, Deborah A., Associate Professor, "The Stability of Cauchy Horizons in Plane Wave Spacetimes," Spring APS Meeting, Washington, D.C., April 1990.

LOCKHART, Robert B., Associate Professor, "Symmetry and Multiple Eigenvalues for Laplacians," Special Session on Partial Differential Equations at the Eastern Regional Meeting of the AMS, College Park, MD, 12 April 1990.

MARUSZEWSKI, Richard F., Associate Professor, "Introduction to the Mathematics Department Computer Systems," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, MD, Fall 1990.

MARUSZEWSKI, Richard F., Associate Professor, "Uploading/Downloading," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, MD, Fall 1990.

MARUSZEWSKI, Richard F., Associate Professor, "Using Spreadsheets In and Out of Class," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, MD, Fall 1990.

MCCOY, Peter A., Professor, "Sampling Theorems for Initial-boundary Value Problems in Several Variables," SIAM Annual Meeting, Kansas City, MO, 24 July 1990.

MCCOY, Peter A., Professor, "Wavelet Sampling Associated with Fractional Partial Differential Operators, Solution of Boundary Value Problems via Sampling Theory," American Mathematical Society Annual Meeting #103, San Diego, CA, 8 January 1990.

MCCOY, Peter A., Professor, "Solution of Boundary Value Problems via Sampling Theory," Special Session on Harmonic Analysis and Applications, American Mathematical Society Meeting #920, College Park, MD, 12 April 1990.

MCCOY, Peter A., Professor, "United States Naval Academy: History and Function," Introduction to the Conference on "High Performance Micro Wave Technology," NATO Conference held at the U.S. Naval Academy, 20-29 May 1990. NRL Condensed Matter Division sponsor.

MICHAEL, T.S., Associate Professor, "Rigidity and

Rank: Report from Annapolis," Wisconsin Centennial Conference, May 1997.

NAKOS, George, Professor, Presented a Poster titled, "Fraction-Free Algorithms for Linear and Polynomial Equations," ECCAD 98, Boston, MA.

PENN, Howard L., Professor, "A Comparison of Grades in Follow on Courses for Students who took Reformed Calculus vs Students who Took Traditional Calculus," Arizona State Conference on Calculus Reform, invited talk, Scottsdale, AZ, June 1996.

PENN, Howard L., Professor, "A Comparison of Grades in Follow on Courses for Students who took Reformed Calculus vs Students who took Traditional Calculus," 5th Annual Conference on the Teaching of Mathematics, invited talk, Baltimore, MD, June 1996.

PENN, Howard L., Professor, "Military Application Projects for Calculus," Mathematical Association of America Summer National Meeting, Seattle, WA, August 1996.

PENN, Howard L., Professor, "A Comparison of Grades in Follow on Courses for Students who took Reformed Calculus vs Students who took Traditional Calculus," MAA Sectional Meeting, Fredericksburg, MD, November 1996.

PRICE, Geoffrey L., Professor, "Shifts on the Hyperfinite II_1 Factor," University of Heidelberg, Heidelberg, Germany, 23 January 1997.

PRICE, Geoffrey L., Professor, "Toeplitz Matrices over Finite Fields," MAA Regional Meeting, College of William and Mary, Williamsburg, VA, 19 April 1997.

PRICE, Geoffrey L., Professor, "Toeplitz Matrices and Shift Equivalence," National Security Agency, Fort George G. Meade, MD, 14 May 1997.

TURNER, John C., Professor, "Electromagnetic Signature Reduction," Mathematics Majors open house, U.S. Naval Academy, Annapolis, MD, March 1997.

TURNER, John C., Professor, "Using Calculators in SM230," Service Academies Student Mathematics Conference, U.S. Air Force Academy, Colorado Springs, CO, 18 April 1997.

TURNER, Peter R., Professor and D. W. Lozier, "Parallel Algorithms for Basic Linear Algebra in SLI Arithmetic," Computational and Applied Mathematics, Leuven, Belgium, July 1996.

TURNER, Peter R., Professor and M. A. Anuta, D. W. Lozier, N. Schabanel, "Basic Linear Algebra in SLI Arithmetic," EuroPar 96, Lyon, France, August 1996.

TURNER, Peter R., Professor and M. A. Anuta, D. W. Lozier, "Parallel Solution of Linear Systems using SLI Arithmetic," SIAM National Meeting, Kansas City, MO, July 1996.

TURNER, Peter R., Professor, "A Simplified Fraction-Free Integer Gauss Elimination Algorithm," SIAM National Meeting, Kansas City, MO, July 1996.

TURNER, Peter R., Professor, and M. A. Anuta, D. W. Lozier, "Parallel BLAs in SLI Arithmetic," Society of Engineering Science National Meeting, Tempe, AZ, October 1996.

TURNER, Peter R., Professor and G. Nakos, R. M. Williams, "Fraction-Free Algorithms for Linear and Polynomial Equations," ECCAD, East Coast Computer Algebra Days, Boston, MA, May 1997.

TURNER, Peter R., Professor, "Fraction-Free Algorithms for Solving Linear Systems," ARITH13, Asilomar, CA, July 1997.

TURNER, Peter R., Professor, "Fraction-Free Algorithms for Solving Linear and Polynomial Systems," SIAM National Meeting, Stanford, CA, July 1997.

WARDLAW, William P., Professor, "Principal Ideals and Associates in Commutative Rings," fall meeting of the Maryland-District of Columbia-Virginia Section of the Mathematical Association of America at Hood College in Frederick, MD, 2 November 1996.

WARDLAW, William P., Professor, "Linear Independence in Sets and Sequences," spring meeting of the Maryland-District of Columbia-Virginia Section of the Mathematical Association of America at the College of William and Mary, Williamsburg, VA, 19 April 1997.

WITHERS, W. Douglas, Associate Professor, "The ELS-coder and Augmented ELS-coder," AT&T Research Labs, Holmdel, NJ, 5 March 1997.

WITHERS, W. Douglas, Associate Professor, "The ELS-coder: a Rapid Entropy-Coder with Applications to Image Compression," ImageTech '97, Atlanta, GA, 12 April 1997.

DEPARTMENT OF OCEANOGRAPHY

Captain Dennis J. Whitford, USN
Associate Professor
Chair

Academic Year 1996-1997 was particularly productive in terms of U.S. Naval Academy meteorology and oceanography (METOC) research. With only four tenure track faculty and two externally-funded research faculty, the quantity and quality of the department's research, as well as its focus on midshipmen involvement, continued to be noteworthy.

The department's efforts commenced in July 1996 with a focus on pedagogical research. The department held it's third Maury Project summer workshop, hosting twenty-six science teachers from across the country. Enhancing the scientific foundations and teaching methodology for K-12 teachers in the area of physical oceanography continued as the project's primary focus.

In the area of traditional scientific research, the department had a significant contribution with its precedent-setting at-sea participation in the Chesapeake Bay Outflow Plume Experiment (COPE I) in September 1996. This was the Naval Academy's first participation in a DoN Accelerated Research Initiative (ARI). Using YP686, a specially configured YP for oceanographic research, honors midshipmen and faculty made multiple transects of the mouth of the Chesapeake Bay in conjunction with satellite and aircraft overflights, as well as offshore sampling by oceanographic vessels of other universities and government laboratories. This type of state-of-the-art research is normally accomplished only by leading research laboratories and graduate schools of our nation, and rarely by an undergraduate institution such as the Naval Academy. The results of the ARI should benefit warfighters in the littoral environment.

Eleven midshipmen were directly involved in METOC research through their enrollment in the department's Independent Research courses. Their research projects were cooperative efforts by the midshipmen and their research advisors. The projects introduced the midshipmen to the excitement and responsibility of data collection and analysis, as well as exposing the midshipmen to independent scientific thought and evaluation. At the end of each semester, these midshipmen presented their results to the department's faculty in a formal presentation. As a result of these efforts, several midshipmen went on to deliver oral and poster presentations at technical conferences.

The department was fortunate to have another Trident Scholar this year. His research was entitled "Dynamics of Destratification in the Severn River." This project had co-advisors from both the Mathematics and Oceanography Departments and served as an excellent example of cross-disciplinary research.

In June 1997, nineteen midshipmen participated in the ninth Oceanographic YP Summer Cruise aboard YP686. This cruise exposed midshipmen to at-sea METOC data acquisition and analysis, in addition to traditional seamanship and navigation training. More than fifty-seven oceanographic stations were executed, resulting in an extensive collection of biological, chemical, geological, and physical oceanographic samples and data, as well as meteorological observations. These data were then processed and analyzed using state-of-the-art equipment and techniques. Results from the cruise were debriefed at a formal presentation given to a senior military member of the Oceanographer of the Navy's (OPNAV N096) staff, faculty, and midshipmen guests.

Our externally-funded research faculty continued their strong research efforts with multiple scientific articles submitted for publication.

Sponsored Research

Is There a Pattern to Clear-Sky Polarization?

Researcher: Adjunct Assistant Professor Raymond L. Lee, Jr
Sponsor: National Science Foundation

This project will use twilight's optical structure to evaluate the verisimilitude of atmospheric scattering models. However, unlike other researchers, the researchers propose to do testing with a remote sensing system that combines: a) multiple spectral channels with broad bandwidths, and b) very high spatial and temporal resolutions.

Photography and digital imaging also allow ready analysis of: a) spectra from large portions (or all) of the twilight sky at once, b) the temporal evolution of twilight spectra at very high resolutions, and c) the spatial details of twilight polarization.

The researchers plan to use digital analysis of color slides, occasionally corroborated by spectroradiometry, to explore the photometric, and colorimetric structure of twilight. With a variety of data inversion techniques, the researchers will then assess how well various atmospheric scattering models account for twilight as seen by the naked-eye observer (included here observers equipped with simple linear polarizers).

With Professor Lee's assistance, Midshipman 2/C Foret performed a sequence of 4-image polarization photographs on 12 March 1997; subsequent image analysis was the basis for Foret's Capstone paper. Commendable, Foret made the following original (and accurate) observation: "At the horizon, the polarization drops off as the atmospheric pathlength thickens." This is an excellent example of a midshipman bringing classroom learning to bear on original research.

Mapping Mesoscale and Submesoscale Wind Fields Using Synthetic Aperture Radar

Researcher: Adjunct Assistant Professor Todd D. Sikora
Sponsor: Office of Naval Research

Our goal in this research effort is to utilize the multiscale information in SAR imagery to diagnose a quantitive description of the marine atmospheric boundary layer, including the depth, stability, wind speed, wind direction, and sea-surface stress on the mesoscale and submesoscale. Because of its potential for yielding both boundary layer depth and the surface wind field at high horizontal resolution, this application of SAR data would represent a significant and innovative advance over most scatterometer algorithms that yield only coarse-resolution wind fields. Moreover, because conventional scatterometry cannot resolve the turbulence structures in the marine atmospheric boundary layer, it cannot be used to diagnose the surface layer stability and cannot yield wind speed estimates corrected for this important effect.

The Maury Project - Exploring the Physical Foundations of Oceanography

Researcher: Associate Professor David R. Smith
Sponsor: National Science Foundation; Commander, Naval Meteorology and Oceanography Command; Office of Naval Research; National Ocean Services; and National Environmental, Satellite, Data and Information Services

The Maury Project is a teacher enhancement program on the physical foundations in oceanography for pre-college educators. Each year, approximately twenty-five teachers are brought to the United States Naval Academy to attend a summer workshop where they learn about fundamental concepts in physical

oceanography. This includes a combination of lectures, hands-on laboratory exercises, field experiences, and tours of oceanic facilities. Upon completion of the summer workshop, these teachers return to their respective states where they conduct peer-training sessions for other teachers using materials developed by project staff. In addition, the project produces a publication in conjunctions with the National Marine Educators Association which is distributed nationally to pre-college educators.

Research Course Projects

Sea Surface Temperature and the 1995 Hurricane Season

Researcher: Midshipman Jamie L. Valdivia
Adviser: Adjunct Assistant Professor Alan E. Strong

Many different factors such as sea surface temperature (SST), sea level pressure, upper level winds, and humidity, play important roles in the formation and development of tropical cyclones. Although hurricane generation depends on a combination of all of these, this study focuses on the role played by SST in hurricane development. In order for a powerful hurricane to develop from a weak tropical wave, tremendous amounts of energy are required. Emanuel (1986) suggests that the steady-state hurricane is comparable to a simple Carnot engine: air flowing inward along the boundary layer acquires heat from warm surface waters, and as it rises, releases this heat energy at lower temperature in the upper atmosphere. Consequently, hurricanes usually develop only over waters with SST exceeding 26°C.

Global Warming: A Study in a Hotly Debated Phenomenon

Researcher: Midshipman 2/C Kenji Gjovig, USN
Adviser: Adjunct Assistant Professor Alan E. Strong

The debate on global warming has become a very political and heated one. As our understanding of complex oceanic and atmospheric processes has improved, scientists have been able to develop computer models designed to predict the climate response to various forcing mechanisms, including increases in carbon dioxide and sulfate aerosols. Attempts are underway to ensure that these models represent the true behavior of our environment and to compare these predictions with actual observations to determine the correlation. Dr. Benjamin Santer developed a model prediction demonstrating asymmetric warming between the two hemispheres. Dr. Patrick Michaels argues that Santer's predictions are diverging from observations. A thorough analysis of each scientist's arguments leads to the conclusion that global warming carries with it an anthropogenic signal superimposed upon natural climate variability although the magnitude of the temperature increase is not statistically significant.

An Intercomparison of Algorithms for use in Determining Sea Ice Conditions

Researcher: Midshipman 1/C Abigail Goss, USN
Adviser: Adjunct Assistant Professor Alan E. Strong

The National Ice Center (NIC) is currently reevaluating the performance of the Navy Calibration/Validation (Cal/Val) algorithm which is used at the Fleet Numerical and Oceanography Center (FNOC). The algorithm is used to support NIC activities on the west coast of the US, and has had some difficulty in accurately determining sea ice concentrations in the past.

This paper examines the results of a case study comparing two Special Sensor Microwave/Imager

(SSM/I) images to Optical Line Scanner (OLS) images. One SSM/I image was produced using the Cal/Val algorithm, while the other was produced using the NASA Team algorithm. The observed region is located in the Ross sea. The results concluded in the case study were found to be similar to results found in separate case studies for each algorithm. both of the past case studies were conducted during the years 1987-1988.

The Team algorithm was shown to have some difficulty in accurately predicting the location of ice edge. This is due mainly to the fact that the ice edge is largely composed of new and young ice, which the Team algorithm has difficulty detecting. The Cal/Val algorithm was shown to have difficulty in accurately predicting mid concentration levels for sea ice, ranging from 30-90% concentrations. In most cases, the Cal/Val algorithm severely underestimated these areas.

The Team algorithm was found to be superior to the Cal/Val algorithm based on accuracy, simplicity, and experience. For future support of NIC activities at FNOC, the implementation of either the Team algorithm or a combination of the Cal/Val algorithm and the Team algorithm would be more practical.

Development of algorithms to correlate AVHRR C660 data with transmissometer data in the lower Chesapeake Bay estuary

Researcher: Midshipman 1/C T. Brent Moore, USN
Adviser: Adjunct Assistant Professor Alan E. Strong

Preliminary results from the September 1996 YP-686 USNA/NOAA research cruise with NRL showed promise for AVHRR-color. A technique for using AVHRR data to assess "Case Two" [highly turbid/productive] waters for reflectance, developed by NRL for their use in the coastal Gulf of Mexico waters, shows considerable promise for direct applicability in the Chesapeake Bay." This study showed a good correlation among transmissometer, laser particle counter and AVHRR data in the lower Chesapeake Bay estuary during the Chesapeake Bay Outfall Plume Experiment-1 [COPE-1] during all phases of the tidal cycle and record fall discharge rates.

Dynamics of Destratification in the Severn River

Researcher: Midshipman 1/C Christopher Irwin, USN
Advisers: Associate Professor Mario E. C. Vieira and Professor Reza Malek-Madani, Department of Mathematics

As part of an effort to study the hydrodynamic behavior of the Server River estuary, a mooring with several oceanographic sensors was deployed near the mouth of the river during the autumn of 1995. This mooring had two current meters located at depths of 2.3 and 4.7 meters which took readings of salinity, temperature, and current velocity. Simultaneous wind speed and direction data were taken from the top of Michelson Hall.

The purpose of this project was to document the circulatory pattern of the Severn estuary and determine how the fall Destratification occurs. The time series provided by the instruments from September to December 1995 were low low pass (LP) filtered in order to isolate the non-tidal components. Based on the non-tidal salinity and current data, it was determined that the Severn River estuary falls into the partially mixed (2a) category according to the Hansen and Rattray criteria. The gradient Richardson Number was also calculated for the observation period.

It is concluded that once the water column shows very low dynamic stability induced by surface cooling, a strong wind event can trigger the overturning of the column. Upon wind relaxation, stratified conditions may resume. The coupling between local wind forcing and subtidal flow was most significant at a period of 5 days.

An Oceanographic Survey of the Severn River Estuary in Winter

Researcher: Midshipman 1/C Charlotte Welsch, USN
Adviser: Associate Professor Mario E. C. Vieira

Between February and April, five runs were made up the Severn River estuary during spring, neap, max flood, max ebb, and slack tidal conditions. The data on temperature, salinity, density, ph, and oxygen saturation was collected using a CTD at seven specified stations. The data revealed that upper half of the Severn acted like a partially mixed estuary, while the lower half acted like a relatively well-mixed estuary. Also, due to tidal regimes, vertical gradients are viewed from greatest to least in this order: Spring tide max flood, neap tide max, flood, spring tide max ebb, neap max ebb, and slack.

Examination of the Development of an Extratropical Cyclone over the Eastern United States (6-9 Jan 1996)

Researcher: Midshipman 1/C Laura E. Holtmeier, USN
Adviser: Associate Professor David R. Smith

This study examines the development of a major winter cyclone producing record snowfall amounts in the mid-Atlantic region. PC-GRIDDS output is utilized to analyze a number of meteorological fields for the period 6-9 Jan 1996. This storm is compared to the "Storm of the Century" (12-15 Mar 1993) to determine why the current system produced such heavy snowfall compared to the Mar 1993 storm which was a more dynamically active cyclone. The determining factor for the excessive snowfall appeared to be better alignment between the area of moisture maximum and the dynamically active storm center. In the Mar 1993 case, the moisture maximum appeared to be displaced further from the storm center, hence it was less efficient in producing snow.

Synoptic Conditions and Mesoscale Characteristics of the Centreville, VA Tornado on 24 June 1996

Researcher: Midshipman 1/C Jennifer A. Meyer, USN
Adviser: Associate Professor David R. Smith

This study examines the synoptic and mesoscale features of a system that produced a tornado in the vicinity of Centreville, VA on 24 June 1996. PC-GRIDDS output is utilized to examine the synoptic scale features that contributed to the convectively active environment the preceded the formation of the thunderstorm. The moisture convergence flux appeared to appeared to offer the best signature for identifying severe weather development. The mesoscale features were demonstrated using information from the WSR-88D Doppler radar at Sterling, VA. Reflectivity and radial velocity profiles capture the tornado vortex signature which is a definitive characteristic feature associated with tornadic events.

Both such meteorological systems are valuable tools for the operational weather forecaster as demonstrated in this case study of a tornado-producing event in Northern Virginia.

The Automated Weather Source System: A Useful Research Tool

Researcher: Midshipman 1/C Matthew J. Marcuson, USN
Adviser: Associate Professor David R. Smith

The Automated Weather Source (AWS) meteorological observation system is a valuable tool for measuring in-situ weather conditions. The system is a suite of instruments that measures temperature, dewpoint temperature, atmospheric pressure, winds, precipitation, etc. above a single location. A recently installed system at the Hendrix Oceanographic Laboratory situated on the Severn River on the grounds of the United States Naval Academy provides an excellent tool for measuring atmospheric conditions near the Chesapeake Bay. During the period 31 Mar-1 Apr 1997 a coastal cyclone moved across the Chesapeake Bay near four sites (Washington D.C. Zoo, United States Naval Academy, St. Micheal's Maritime Museum, and Milford, DE High School) equipped with the AWS system. Output from these sites are examined to determine the ability of this system to capture the passage of such cyclonic events and to ascertain their utility as a research tool. This investigation suggests that if the instrument suites are properly calibrated, then a mesonetwork of AWS-equipped stations is indeed a valuable tool for research applications. Considering that some 110 sites exist in the Baltimore-Washington D.C. area, these systems are an incredible resource for studying weather situations in the vicinity of the Chesapeake Bay.

A Comparative Study of Airborne Wind Shear Systems

Researcher: Midshipman 1/C Kimberly A. Arrington, USN
Adviser: Associate Professor David R. Smith

Wind shear represents one of the most dangerous of meteorological hazards. It can cause problems from disturbing passengers on-board to structure damage or total loss of control of an aircraft. This study was an examination of wind shear and atmospheric turbulence and systems that have been developed to detect this phenomenon from the aircraft itself. An exhaustive literature review of atmospheric turbulence due to wind shear and turbulence detection equipment, especially radar/lidar systems. Five years of government and corporate research data were studied to determine the effectiveness of radar/lidar systems in detecting wind-shear induced turbulence. It was determined that the two micrometer ladar system was the most accurate.

A Numerical Model for Describing Rotating Fluid Flow

Researcher: Midshipman 3/C James E. Coleman, USN
Adviser: Associate Professor David R. Smith and Professor Reza Malek-Madani

This special topics course involved a project in which Midshipman Coleman constructed a numerical model of rotating fluid flow. He applied the equations from a paper by Serrin, 1972 for rotating flows and programmed the model using *Mathematica* to solve the equations and visualize the flow by tracking individual parcels moving through the numerical domain. He was able to produce solutions using different boundary conditions to corresponding to a variety of funnel widths. He also was able to generate a visualization showing the trajectories of the parcels moving in time.

Global Warming: The Truth Behind the Feared Phenomenon

Researcher: Midshipman 2/C Kjell Kenji Gjovig, USN
Adviser: Associate Professor David R. Smith w/ Visiting Assistant Professor Alan E. Strong

This project was the initial segment of Midshipman Gjovig's research into the phenomenon called global warming. In this phase, Midshipman Gjovig conduct an intensive literature of the topic, with particular emphasis on the controversial issue of whether global warming is real or mythical. In particular, he examined the work of both proponents (e.g., B. Santer) and opponents (e.g., P. Micheals) of the global warming issue to acquire an understanding of both sides of the issue as a first step in resolving the issue. He also suggested steps that would be taken in the future, including the types of data that he would analyze, to try to settle the controversy regarding the existence of global warming.

Publications

EISMAN, Greg A., LCDR, USN, (co-author), "The Maury Project: Providing Teachers with the Physical Foundations of Oceanography." *Proceedings of the Fourth International Conference on School and Popular Meteorological and Oceanographic Education,* Brackwell, UK, 237-240, July 1996.
See SMITH, D. R. input.

GUTH, Peter L., Associate Professor, "Computer Simulations and Graphical Data Manipulations for Teaching Earth Sciences", in Teaching and Learning in the Next Century, Essays from a Conference for the Federal Service Academies, held at West Point 27-28 September 1996, pp.17-27.

Microcomputers can greatly increase the effectiveness of earth science labs by exposing students to aspects of the natural world with which they could not otherwise easily interact. Four categories of programs work well with courses: World Wide Web pages, Windows help files, commercial tools like spreadsheets, and custom software for specific tasks. A well designed lab serves five functions: reinforce key course objectives, show the variability in nature, encourage critical thinking and problem solving, reinforce computer skills, and reinforce writing across the curriculum. Over 20 custom programs in use at West Point and Annapolis illustrate the power of computer graphics for teaching earth science.

GUTH, Peter L., Associate Professor, "Deep Springs Fault Zone: model for surficial development of a metamorphic core complex: Geological Society of America Abstracts with Programs ", Geological Society of America Abstracts with Programs, 28:6 (1997), A-512.

Synthesis of published mapping and geochronology, combined with reconnaissance bedrock mapping along the Deep Springs Fault Zone (DSFZ), suggests that active extensional faulting in the White-Inyo Mountains will eventually expose a metamorphic core complex. Two distinct lines of evidence suggest 10-12.6 km of extension directed N10W-N20W with about 2.5 km of vertical separation. Contact metamorphic zones along Birch Creek and east of Deep Springs Lake restore above each other, making preintrusion geometry of the pluton more closely resemble other local plutons. The famous Poleta folds (from west to east an anticline, syncline, syncline, and anticline) restore above a similar sequence deeper in the stratigraphic section between Deep Springs Lake and the Waucobi Embayment. This reconstruction requires a very shallow dip on the main fault, with extension paralleling regional strike slip faults. Footwall rocks along the DSFZ are developing a planar tectonic fabric of closely spaced, polished joint and fault surfaces and sheared lenses of rock The average fabric planes dip 42.3 toward N35.6W (n=84). In addition, the overall domal form of the footwall resembles turtlebacks in Death Valley. Deep Springs Valley is still actively subsiding, with syntectonic deposits not yet exposed. Regional volcanic rocks date from less than 4 Ma, marking a reasonable bound for the onset of extension and a 2.5 mm/yr lower limit for normal fault extension. Extension beginning 2 Ma requires a 5 mm/yr extension rate, similar to models for local strike-slip faults and suggesting integrated extension on normal and transform faults. The DSFZ suggests that our classic concept of high-angle Basin Range faulting actually applies to surficial faulting during metamorphic core complex formation.

GUTH. P. L., Associate Professor, (co-author), "The Maury Project: Providing Teachers with the Physical Foundations of Oceanography." *Proceedings of the Fourth International Conference on School and Popular Meteorological and Oceanographic Education*, Brackwell, UK, 237-240, July 1996.

See SMITH, D. R. input.

KREN, R. J., CDR, USN, (co-author), "The Maury Project: Providing Teachers with the Physical Foundations of Oceanography." *Proceedings of the Fourth International Conference on School and Popular Meteorological and Oceanographic Education*, Brackwell, UK, 237-240, July 1996.

See SMITH, D. R. input.

LEE, Raymond L., Adjunct Assistant Professor, "Mie theory, Airy theory, and the natural rainbow," Optical Society of America/American Meteorological Society Technical Digest Series, v.4 (1997), pp. 6-8.

LEE, Raymond L., Adjunct Assistant Professor, "Expanding the Arago neutral point: Digital imaging of clear-sky polarization," Optical Society of American/American Meteorological Society Technical Digest Series, v.4 (1997), pp. 52-54

LEE, Raymond L., Adjunct assistant Professor, "Low-visibility accidents" in National Transportation Safety Board's Highway Accident Report and Special Investigation of Collision Warning Technology" (1996), pp. 29-35.

SMITH, David R., Associate Professor, (co-author), (1997): "Mid-Atlantic AERAs Conduct Third Annual Hazardous Weather Conference". *Bulletin of the American Meteorological Society, 78(3)*, 499-505.

The American Meteorological Society held its Fifth Symposium on Education in conjunction with the 76th Annual Meeting in Atlanta, Georgia. The theme of this year's Symposium was "Atmospheric and Oceanic Sciences: Building the Future on a Solid Foundation". Thirty-four oral presentations and 41 poster presentations summarized a variety of educational programs or examined issues of importance for both the precollege and university levels. There was also a joint session with the 12th International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrography on new technologies for the classroom. Over 200 people representing a wide spectrum of the Society attended one or more of the sessions in this two-day conference, where they increased their awareness of educational initiatives of members and institutions associated with AMS.

SMITH, David R., Associate Professor, (co-author), (1997): "Meeting Report on the Fifth AMS Symposium on Education". *Bulletin of the American Meteorological Society, 78(1)*, 71-79.

For the third consecutive year mid-Atlantic AERAs conducted a regional workshop for educators on hazardous weather. This workshop attracted teachers

from New York to Georgia to sessions by Project ATMOSPHERE AERAs, meteorologists from the National Weather Service, universities, the media, and private industry, who addressed a variety of topics pertaining to the impact of severe weather. As has been the case in the previous workshops, this event represents a partnership of individuals from schools, government agencies, and the private sector to enhance science education and to increase public awareness of hazardous weather conditions.

SMITH, David R., Associate Professor, (co-author), (1997). "Using *Mathematica* to Model Thermodynamic Processes in a Hurricane". *Preprints of the 6th AMS Symposium on Education*, Amer. Meteor. Soc., Boston, MA, 72-77.

Symbolic manipulators such as *Mathematica* can be very useful tools to model complex physical phenomena. For example, atmospheric disturbances such as hurricanes can be described in terms of a system of mathematical equations which govern their behavior. The beauty of *Mathematica* is its ability to solve these fundamental equations and then graphically display the solutions. This enables a teacher to generate graphics that can be used in the classroom to describe the phenomena and how changes in specific variables cause the phenomena to react to the stimuli.

This paper describes the use of *Mathematica* to understand thermodynamic processes in a hurricane. It uses a simplified model developed by Emanuel (1988). The purpose was to understand the intensification of hurricanes through changes in thermodynamic variables. Hurricane intensity, defined in terms of maximum tangential wind velocity at the eye wall, radius of maximum surface winds, and minimum sea-surface pressure, varies with initial central pressure, sea-surface temperature and mixing ratio in the center. Assuming an ideal Carnot cycle to represent the thermodynamic process, the total pressure drop of a parcel moving to the center of the hurricane will equal the total mechanical energy available. Emanuel (1988) provides the connection between the change in mechanical energy and hurricane intensity due to differences in central pressure, sea-surface temperature and mixing ratio at the hurricane center. Using *Mathematica* to execute the hurricane model, it is demonstrated that a decrease in central pressure and an increase in sea-surface temperature and mixing ratio at the center will increase the intensity of the hurricane. While this has clear research value, the model also provides the instructor with a powerful tool to aid in the understanding of how hurricanes intensify due to changes in these thermodynamic variables.

SMITH, D.R., Associate Professor, (co-author), (1997): "The Maury Project - A Three Year Update". *Preprints of the 6th AMS Symposium on Education*, Amer. Meteor. Soc., Boston, MA, 11-15.

In 1994, the American Meteorological Society (AMS) and the United States Naval Academy initiated a pre-college teacher enhancement program called the Maury Project. The focus of this program is the physical foundations of oceanography, an area of marine science often skimmed over or entirely neglected at the-pre-college level. The central component of the Maury Project is a series of two-week workshops conducted at the U.S. Naval Academy to train precollege teachers in selected physical oceanography topics. To date, approximately 75 teachers, including teachers from the United Kingdom, Canada, and Australia have attended one of the summer workshops held annually since 1994. Upon completion of the summer workshops, the participant teachers conduct peer-led training sessions using self-contained training modules on selected topics in physical oceanography produced by the project staff.

The presentation will focus on the three Maury Project summer workshops and the activities of the participant teachers following these workshops. In addition, it will demonstrate the effectiveness of this educational partnership in the professional development of a group of K-12 teachers as well the production of scientifically accurate resources materials for teaching physical oceanography at the precollege level.

SMITH, David R., Associate Professor, (co-author), (1997): "DataStreme: Pilot Project to National Implementation". *Preprints of the 6th AMS Symposium on Education*, Amer. Meteor. Soc., Boston, MA, 16-19.

DataStreme is a program to deliver real-time weather data and instruction to the pre-college. This program began in 1995 as a feasibility study funded by the National Science Foundation. A pilot program was initiated in the Spring of 1996 at two sites. National implementation of the program began in the Fall of 1996 with 59 local implementation teams reaching 350 teachers across the country. This program is planned to function at least through the year 2000, ultimately reaching over 4000 teachers nationwide.

SMITH, David R., Associate Professor, (1996):

"Update on the Maury Project". *Current - The Journal of Marine Education*, 13(4), 3-4.

This article is a brief summary of the activities of the Maury Project, a teacher enhancement program on the physical foundations of oceanography. This program, funded by the National Science Foundation, the Navy (Commander, Navy Meteorology and Oceanography Command and the Office of Naval Research) and the National Oceanic and Atmospheric Administration (National Environmental Satellite, Data and Information Service and the National Ocean Service), provides teachers with instruction and resource materials to assist in teaching a variety of topics in oceanography at the pre-college level.

SMITH, David R., Associate Professor, (co-author), "The Life and Work of Matthew F. Maury". *Current - The Journal of Marine Education*, 13(4), 8-9 (1996).

This brief article highlights the life and contributions of Matthew F. Maury. The paper suggests how Maury's contributions to oceanography and meteorology can be used in the history classroom to demonstrate the role of scientific accomplishments in the 19th century. Most importantly, many of the original documents, including ocean charts as well as Maury's correspondence, can be an invaluable source of information for both science and social studies.

SMITH, David R., Associate Professor, (co-author), (1996): "Pre-college educational outreach programs in the marine sciences: An overview". *Proceedings of the 4th International Conference on School and Popular Meteorological and Oceanographic Education*, Royal Meteor. Soc., Bracknell, UK, 241-248.

The marine sciences represents a very broad area of study, which encompasses aspects of a variety of scientific disciplines. For example, ocean studies require an understanding of biology, chemistry, physics, geology as well as significant interrelationships with atmospheric processes. Consequently, studying the sea is an excellent mechanism for learning basic science with an interdisciplinary perspective.

Recognizing the importance of the sea not only from a scientific perspective but from a broad range of human endeavors, numerous organizations are involved in educational outreach. Government agencies, research laboratories, professional societies, and universities have undertaken a variety of activities to promote the study of marine sciences at the precollege level. The predominant theme of most educational outreach has been biological, since children (and most adults) are intrigued by the creatures of the sea. However, there has been a growing production of educational resources for subjects other than marine biology to provide a more complete understanding of the sea.

This paper will provide an overview of precollege educational outreach activities, examining how government agencies, research laboratories, professional societies, and universities are promoting the study of the marine science by schoolage children. Although marine biology appears to be the most popular subdiscipline, this paper will focus its attention on other areas, with particular emphasis on physical oceanography.

SMITH, David R., Associate Professor, (co-author), (1996): "The Maury Project: Providing teachers with the physical foundations of oceanography", *Proceedings of the 4th International Conference on School and Popular Meteorological and Oceanographic Education*, Bracknell, UK, 237-240.

In 1994, the American Meteorological Society (AMS) established a teacher enhancement program called the Maury Project. This NSF-funded program represents an educational partnership between AMS and the U.S. Naval Academy with assistance from the National Oceanic and Atmospheric Administration and the State University of New York at Brockport. The Maury Project focuses on the physical foundations of oceanography, an oft neglected subject area of marine sciences.

The central component of the Maury Project is a series of two-week workshops conducted at the U.S. Naval Academy to train precollege teachers in selected physical oceanography topics. To date, approximately 75 teachers, including teachers from the United Kingdom and Canada, have attended one of the summer workshops held annually since 1994. Upon completion of the summer workshops, the participant teachers conduct peer-led training sessions using self-contained training modules on selected topics in physical oceanography produced by the project staff. During the academic years following the first two summer workshops, Maury Project teachers have lead about 200 peer-training sessions reaching approximately 4000 of their colleagues.

The presentation will focus on the three Maury Project summer workshops and the activities of the participant teachers following these workshops. In

addition, it will demonstrate the effectiveness of this educational partnership in the professional development of a group of K-12 teachers as well the production of scientifically accurate resources materials for teaching physical oceanography at the precollege level.

SMITH, David R., Associate Professor, (co-author), (1996): "Combining Oceanography and History in the K-12 classroom: The study of the life and work of Matthew F. Maury". *Proceedings of the 4th International Conference on School and Popular Meteorological and Oceanographic Education*, Royal Meteor. Soc., Bracknell, UK, 249-252.

The history of nineteenth century science affords the precollege teacher the opportunity to develop lesson material suitable to both the science and history classroom. Students enjoy learning how scientists' discoveries caused change during their respective eras. The contributions of Matthew F. Maury's career as an oceanographer, marine meteorologist, and officer in the United States Navy are demonstrative of the pioneer spirit which brought about significant change in the world of nineteenth century science on both sides of the Atlantic Ocean. Maury's contemporaries both admired and challenged his scientific theories. Even though there were detractors, the work of Matthew F. Maury can be effectively used as a case study of the nineteenth century in both the science and history classroom.

The purpose of this poster presentation is to demonstrate the interdisciplinary curriculum possibilities in the precollege classroom. The information presented in this study can be used easily in both the physical science as well as the social studies curriculum. The lesson material developed from this study will utilize available historical scientific documents which will challenge the student's critical thinking skills and interpretative abilities. Using Matthew F. Maury as an example, the intellectual history of the nineteenth century is rich with scientific inquiry and advancements suitable for teaching across the precollege curriculum.

SMITH, David R., Associate Professor, (co-author), (1996): "Chronicling the emergence of an Atmospheric Science education program in a professional society: The experience of the American Meteorological Society", *Proceedings of the 4th International Conference on School and Popular Meteorological and Oceanographic Education*, Royal Meteor. Soc., Bracknell, UK, 266-271.

Prior to about 1984, the American Meteorological Society, in the area of K-12 education, offered relatively few services and had no organized programs. Awards were presented at "science fairs", and an annual review of books and aging educational materials was presented in Bulletin of the American Meteorological Society. Educational matters were thought to be largely the purview of Weatherwise, a commercial weather magazine to which the Society has a very loose historical connection. Discussions of K-12 education at meetings were confined to brief meetings of a small committee. However, beginning in the middle of the last decade, all this changed rapidly. Under its overarching Project Atmosphere, the Society focused on teacher enhancement and the production of scientifically authentic resource material, and quickly developed a range of very successful K-12 outreach programs in atmospheric science. In recent years this effort has been extended under the Maury Project to include physical oceanography as well. Now the Society is embarking on Project DataStreme, an electronically-based distance learning course for precollege teachers based on the study of current weather. It is anticipated that over 4000 teachers will enroll in the course that is being offered nationally over a four-year period. Finally, a formal symposium on education issues is being held each year as part of the Society's Annual Meeting; the fifth such symposium is scheduled for January 1996.

How did all this come about in little more than 10 years? Here we attempt to answer this question by presenting and discussing a chronology of events that lead to the Society's present family of successful programs.

SMITH, David R., Associate Professor, (co-author), (1996): "Project ATMOSPHERE: Five years of K-12 education for the Atmospheric Sciences".
Proceedings of the 4th International Conference on School and Popular Meteorological and Oceanographic Education, Royal Meteor Society,

Bracknell, UK, 104-107.

Project ATMOSPHERE is the K-12 educational initiative in the atmospheric sciences of the American Meteorological Society. The purpose of this program is to utilize the study of the atmospheric environment to generate interest in science, mathematics, and technology. Project ATMOSPHERE has succeeded well beyond original expectations in enhancing precollege education in the atmospheric sciences. For example, during the five years of operation

approximately 150 teachers have attended Project ATMOSPHERE summer workshops, and Project ATMOSPHERE teachers have conducted over 1700 peer training sessions reaching 60,000 teachers across the United States.

The cornerstone of the program is a national network of Atmospheric Education Resource Agents (AERAs), master teachers who are trained in the fundamentals of atmospheric science and who conduct workshops and information sessions for peer teachers. Recently, the AERA network reached full-strength at 80 teachers with at least one representative in nearly all of the 50 states. In addition to conducting training sessions for their colleagues, AERAs provide leadership at state, regional and national levels in science education organizations and serve as advocates to promote the study of the atmospheric environment across the K-12 curriculum.

Project ATMOSPHERE has also developed a variety of instructional resource materials for improving the background of teachers as well for use in the classroom. The primary resource is a series of written teacher's guides that provide content about a single atmospheric topic. Eleven teacher's guides have been developed during the tenure of Project ATMOSPHERE. These guides serve as the resource materials for AERAs to conduct peer-training sessions. In addition, a publication, entitled *Look Up!*, provides articles and news updates on educational issues as well as classroom ready activities. *Look Up!* is printed yearly and accompanies *Weatherwise* magazine to teachers nationwide.

This presentation will examine Project ATMOSPHERE activities over the past five years, exploring ways that the program is benefitting precollege education in the United States and how it can serve as a model for atmospheric science education worldwide. In addition, the paper will also consider future directions for Project ATMOSPHERE as it continues its mission to promote precollege atmospheric science education.

SMITH, David R., Associate Professor, (co-author), (1996): "The DataStreme Project: Teacher enhancement via the Internet". *Proceedings of the 4th International Conference on School and Popular Meteorological and Oceanographic Education*, Royal Meteor. Soc., Bracknell, UK, 181-184.

The DataStreme Project is a program conducted by the American Meteorological Society with funding from the National Science Foundation. Its purpose it to provide real-time weather information and instruction for pre-college teachers. This program was initiated as a feasibility study in 1995 with plans for nationwide implementation by the Fall of 1996. This paper describes the activities to date with plans for how this program will be fully implementation in the future.

STRONG, Alan E. Adjunct Assistant Professor, (co-author), 1997: Sea Surface Temperature and the 1995 Hurricane Season. *Proc. 22th Conf. on Hurricanes and Tropical Meteorology*, Ft. Collins, CO, 18-23 May 1997, p 84-85.

Many different factors such as sea surface temperature (SST), sea level pressure, upper level winds, and humidity, play important roles in the formation and development of tropical cyclones. Although hurricane generation depends on a combination of all of these, this study focuses on the role played by SST in hurricane development. In order for a powerful hurricane to develop from a weak tropical wave, tremendous amounts of energy are required. Emanuel (1986) suggests that the steady-state hurricane is comparable to a simple Carnot engine: air flowing inward along the boundary layer acquires heat from warm surface waters, and as it rises, releases this heat energy at lower temperature in the upper atmosphere. Consequently, hurricanes usually develop only over waters with SST exceeding 26°C.

STRONG, Alan E., Adjunct Assistant Professor, (co-author), 1997: Coral Reef Bleaching in the Belize Barrier Reef and Western Caribbean during 1995, *Proc. 8th Global Warming Conf.*, vol 8, pp. 38, 25-28 May 1997.

Scleractinian coral of most coastal and insular reef communities in the Caribbean Sea and in contiguous waters of the Gulf of Mexico and the Gulf Stream-warmed North Atlantic (e.e., Bermuda and the Bahama banks) have experienced significant periodic reductions in algal pigmentation and the loss of dinoflagellate symbionts characteristic of the bleaching stress response during the 1980s and 1990s. These events were extremely rare or unknown in the 1950s, 1960s, and 1970s. Some of these bleached coral colonies, especially among the most frequently affected species, have experienced high mortality resultant to bleaching.

STRONG, Alan E., Adjunct Assistant Professor, (co-author), 1997: The Maury Project: A Three-Year Update. Proc. 6th Symp. on Education, Amer. Met. Soc., Boston, MA., 2-7 Feb 1997, p 11-15.

See SMITH, D.R. input.

VIEIRA, Mario E. C., Associate Professor, (co-author), 1997 "Dynamics of Destratification in the Server River Estuary", *Transactions of the American Geophysical Union*, vol. 78, no.21/supp.

The Severn River, a tributary of the Chesapeake Bay estuary, is believed to maintain a distinct density stratification of the column during the summer. With the onset of Fall, the Destratification of the column is expected. To study the hydrodynamic behavior of the Severn, a mooring with several sensors was deployed near the mouth of the river from September to December of 1995 at a depth of 8 meters. Two current meters located at 2.3 and 4.7 meters below the surface provided time series of salinity, temperature and current velocity. These data were low-pass filtered. The resulting non-tidal records have been analyzed, along with wind information taken in the vicinity. The Severn River estuary falls into the partially mixed, slightly stratified 2a category in the Handen and Rattray diagram. The gradient Richardson number was computer for the 3 month period; a very clear pattern of vertical stratification and Destratification emerged. These results are correlated with local wind forcing events.

VIEIRA, Mario E. C., Associate Professor, (co-author), "The Maury Project: Providing Teachers with the Physical Foundations of Oceanography." *Proceedings of the Fourth International Conference on School and Popular Meteorological and Oceanographic Education*, Brackwell, UK, 237-240, July 1996.
See SMITH, D. R. input.

WHITFORD, Dennis J. Captain, USN, Associate Professor, "Bed Shear Stress Coefficients for Longshore Currents over a Barred Profile." *Coastal Engineering*, Vol. 27, P. 243-262, July 1996.

Quantitative estimates are obtained of various terms in the momentum equation governing the mean alongshore flow in the surf zone on a barred beach. A movable sled was instrumented with pressure, current, and wind sensors to measure wave forcing during the SUPERDUCK experiment. Mean currents and bottom shear stress at various locations across the surf zone were determined. Particular attention is devoted to precise estimation of the cross-shore gradient of the radiation stress. Wind forcing is found to be a first-order term, along with wave forcing, under certain conditions. Time dependence of the mean longshore current is due to variable wave forcing inside the surf zone as the tide modulates the depth of waves breaking on the bar. Bed shear stress coefficients, determined as a residual of the local alongshore momentum balance, tended to decrease in magnitude shoreward. Mean bed shear stress coefficients and estimated error are 0.004 $\pm$ 0.0013, 0.003 $\pm$ 0.0006, and 0.001 $\pm$ 0.0003 for offshore the bar, and in the trough.

WHITFORD, Dennis J., Captain, USN, Associate Professor, (co-author), "The Maury Project: Providing Teachers with the Physical Foundations of Oceanography." *Proceedings of the Fourth International Conference on School and Popular Meteorological and Oceanographic Education*, Brackwell, UK, 237-240, July 1996.

See SMITH, D. R., input

WHITFORD, Dennis J., Captain, USN, Associate Professor, "Littoral METOC Factors and Impact on Expeditionary Warfare." Published in interactive computer format and demonstrated at the *Naval Warfare Symposium*, Norfolk, VA, September, 1996. Naval Oceanographic Office METOC Dept., Stennis Space Center Ms.

With today's U.S. Navy focus on Littoral Warfare, operational forces must be cognizant of littoral Meteorology and Oceanography (METOC) factors and their subsequent impact on Expeditionary Warfare. This interactive CD-ROM describes littoral METOC factors and its tactical impact on the battlespace through the use of a three-dimensional littoral image. Users simply click on the METOC factor and the tactical implication is portrayed. The CD-ROM can be executed on standard Navy CD-ROM players.

Presentations

GUTH, Peter L., Associate Professor, "Computer Simulations and Graphical Data Manipulations for Teaching Earth Sciences," Teaching and Learning in the Next Century, a conference for the Federal Service Academies, West Point, NY, 27-28 September 1996.

GUTH, Peter L, Associate Professor, “Deep Springs Fault Zone: model for surficial development of a metamorphic core complex: Geological Society of American national meeting, Denver, CO, 28-31 Oct, 1996.

LEE, Raymond L., Adjunct Assistant Professor, “Mie theory, Airy theory, and the natural rainbow,” invited paper presented at the Optical Society of America/American Meteorological Society topical meeting at Santa Fe, NM on 10 Feb 1997.

LEE, Raymond L., Adjunct Assistant Professor, “Expanding the Arago neutral point: Digital imaging of clear-sky polarization, “ presented at the Optical Society of America/American Meteorological Society topical meeting at Santa Fe, NM on 11 Feb 1997.

SIKORA, Todd, D., Adjunct Assistant Professor, “Linking real aperture radar data from the sea surface to convective atmospheric boundary layer depth,” Second International Airborne Remote Sensing Conference and Exhibition, San Francisco, CA, 24-27 June 1996, Vol II, 414-421.

SIKORA, Todd D., Adjunct Assistant Professor, “Extracting quantitive information about the marine atmospheric boundary layer from SAR imagery,” Progress in Electromagnetic Research Symposium, Innsbruk, Austria, July 1996.

SIKORA, Todd D., Adjunct Assistant Professor, “Brightness variability on synthetic aperture radar imagery of the sea surface caused by kilometer-scale atmospheric convective eddies,” Oceans ‘96 Conference, Fort Lauderdale, FL, 23-26 September 1996, 1396-1399.

SIKORA, Todd D., Adjunct Assistant Professor, “An overview of a warm-fresh front moving west toward Duck, NC in May 1996,” Fall Meeting, American Geophysical Union, San Francisco, CA, 15-19 December 1996.

SIKORA, Todd, D., Adjunct Assistant Professor, “A method for relating SAR backscatter from the sea surface to atmospheric boundary layer turbulence statistics,” Fourth Thematic Conference on Remote Sensing for Marine and Coastal Environments, Orlando, FL 17-19 March 1997, Vol. 11, 201-210.

SMITH, David, R., Associate Professor, “Using *Mathematica* to Model Thermodynamic Processes in a Hurricane" (with C.W.L.Huyssoon), at the 6th AMS Symposium on Education, Long Beach, CA [Feb 97].

SMITH, David, R., Associate Professor, "The Maury Project - A Three Year Update" (with P.L. Guth, M.E.C. Vieira, D.J. Whitford, D.W. Jones, G.A. Eisman, A.E. Strong, R.J. Kren, D.S. Dillner, I.W. Geer, D.E. McManus, and J.T. Murphree), presented at the 6th AMS Symposium on Education, Long Beach, CA [Feb 1997].

SMITH, David, R., Associate Professor, "DataStreme: Pilot Project to National Implementation" (with I.W. Geer, J.M. Moran, R.S. Weinbeck, D.R. Smith, K.M. Ginger, and T.A. Wells), presented at the 6th AMS Symposium on Education, Long Beach, CA [Feb 97].

SMITH, David, R., Associate Professor, "Pre-college educational outreach programs in the marine sciences: An overview" (with J.V. O'Connor), at the 4th International Conference on School and Popular Meteorological and Oceanographic Education, Edinburgh, Scotland [Jul 96].

SMITH, David, R., Associate Professor, "The Maury Project: Providing teachers with the physical foundations of oceanography", (with P.L. Guth, M.E.C. Vieira, D.J. Whitford, D.W. Jones, E.J. Miller, G.A. Eisman, A.E. Strong, R.J. Kren, D.S. Dillner, D.E. McManus, I.W. Geer, and J.T. Murphree), at the 4th International Conference on School and Popular Meteorological and Oceanographic Education, Edinburgh, Scotland [Jul 96].

SMITH, David, R., Associate Professor, "Combining Oceanography and History in the K-12 classroom: The study of the life and work of Matthew F. Maury", (with P.K. Smith), at the 4th International Conference on School and Popular Meteorological and Oceanographic Education, Edinburgh, Scotland [Jul 96].

SMITH, David, R., Associate Professor, "Chronicling the emergence of an Atmospheric Science education program in a professional society: The experience of the American Meteorological Society", (with J.T. Snow and I.W. Geer), at the 4th International Conference on School and Popular Meteorological and Oceanographic Education, Edinburgh, Scotland [Jul 96].

SMITH, David, R., Associate Professor, "Project ATMOSPHERE: Five years of K-12 education for the Atmospheric Sciences", (with I.W. Geer, R.S. Weinbeck, K.T. Ginger, J.M. Moran, and J.T. Snow), at the 4th International Conference on School and Popular Meteorological and Oceanographic Education, Edinburgh, Scotland [Jul 96].

SMITH, David, R., Associate Professor, "The DataStreme Project: Teacher enhancement via the Internet", (with J.M. Moran, I.W. Geer, R.S. Weinbeck, and K.T. Ginger), at the 4th International Conference on School and Popular Meteorological and Oceanographic Education, Edinburgh, Scotland [Jul 96].

VIEIRA, Mario, E.C., Associate Professor, "Dynamics of Destratification in the Severn River Estuary," presented at the Spring Meeting of the American Geophysical Union, Baltimore, MD, 27-30 May 1997.

VIEIRA, Mario, E. C., Associate Professor, "Fall Destratification in the Severn River Estuary," presented at the Spring meeting of the Atlantic Estuarine Research Society, Cape Charles, VA, 20-22 May 1997.

VIEIRA, Mario E. C., Associate Professor, "Observations of a Disturbance to Estuarine Flow During a Strong Meteorological Event, Presented at the Fall meeting of Atlantic Estuarine Research Society, Pine Knoll Shores, NC 7-9 November 1996.

VIEIRA, Mario E C., Associate Professor, "Outreach and Cooperative Programs in Estuarine Oceanography at the US Naval Academy," presented at the 2nd Joint Estuarine Coastal Science Association/Estuarine Research Federation Conference, Middleburg, Netherlands, 1-20 September 1996.

WHITFORD, Dennis J., Captain, USN, Associate Professor, "Proposal for the Permanent Military Professor Program," presentation to the Oceanographer of the Navy and his staff, Washington, DC, 6 May 1997.

DEPARTMENT OF PHYSICS

Professor D. J. Treacy
Chair

During the 1996 - 1997 academic year the Physics Department was very productive. There were midshipman independent research projects and an impressive array of faculty research. The topics represented in this research effort ranged across the abundance of elements in the galaxy, vibrations within a nucleus and psychologically founded models of how students learn basic physics. The areas which the department emphasizes are astronomy, physical and non-linear acoustics, electrical and structural

properties in condensed matter, non-linear optics, current educational initiatives and accelerator technology applied to a wide-ranging field from nuclear physics to ecological topics. This research was made possible both by the excellent facilities in the department as well as cooperation with other laboratories.

The Physics Department has been successful in attracting external funding from the Office of Naval Research, the Naval Surface Warfare Center, the Naval Research Laboratory, the National Science Foundation, the Applied Physics Laboratory of the University of Washington and corporate sponsors. The department received internal support from the Naval Academy Research Council and the Curriculum Development Committee.

This work is of immeasurable importance in maintaining the exciting intellectual atmosphere which carries into the classroom and becomes apparent to our students. The student involvement in this effort is designed to give the midshipmen a real lesson in the rigors and excitement of probing new areas of science. The results are apparent because they have resulted in invited presentations and well-received talks. It is particularly gratifying to see a paper appear which demonstrates the collaboration of officers who contributed several years ago when they were midshipmen along with our current class of midshipmen. In all, thirty presentations were given by the faculty and midshipmen.

The Physics Department's research program is vital, wide-ranging, and has continuity. This bodes well for continued excellence.

Sponsored Research

Optical Studies of Chalcogenide Glasses

Researcher: Assistant Professor Philip R. Battle
Sponsor: Naval Research Laboratory

Chalcogenide glasses are transparent in the mid-infrared region (3-12μm), making them a suitable material for mid-IR devices. In particular optical waveguides made from chalcogenide glass can be used to deliver and detect mid-IR radiation and thus are being developed for a variety of applications including chemical sensors, IR countermeasures, laser surgery, and machining

We will refurbish a F-center laser to be used as an IR source for measuring transmission through chalcogenide glass and fibers. In addition, we will build an apparatus which will be used to side-write gratings in both single mode fibers and planar waveguides

This work is still in progress. We have demonstrated that holographic structures can be recorded in both bulk glasses and multimode fibers, but we have not been able to successfully "read" them using the tunable F-center laser.

Infrared Studies

Researcher: Professor Donald W. Brill
Sponsor: Naval Surface Warfare Center, Carderock, MD

A total of twenty one two-hour classes in calculus were distributed throughout the summer. This course was essentially a review of the basic calculus with an emphasis on its development and an introduction to vector calculus.

A review of electromagnetic theory was presented which proceeded through a detailed treatment of the radiating dipole. This is all done in preparation for a subsequent theoretical description of the infrared data which Mr Sarman will be obtaining with the Bi-Directional Reflectometer at Carderock.

An informal report of this work was submitted at the end of the summer to Mr. Peter Sarman of the Naval Surface Warfare Center in Carderock , MD.

ANDES: A Tutoring System For Classical Physics

Researcher: Professor F.D. Correll
Sponsor: Office of Naval Research, Cognitive Sciences Division

The goal of this project is to build a computer-based tutoring system, named ANDES, that will help students learn classical physics. The development team includes physicists, cognitive scientists, computer scientists, and programmers.

My activities on the project this year have included selecting or developing instructive problems in kinematics, Newtonian dynamics, and work-energy methods, authoring detailed tutorial solutions for several of them, developing production rules for solving work-energy problems, and consulting on the design of an interface for tutoring conceptual problem-solving skills and workbench tools for work-energy problems. In addition, I participated in student-testing an early version of the workbench for solving Newtonian dynamics problems.

A Propagator Study of Resonance Phenomena

Researchers: Associate Professor John P. Ertel
Sponsor: Naval Surface Warfare Center

The current studies involve the extension of the Propagator Solution to point and line driven panels with application to several acoustics problems of interest to the Navy and the numerical evaluation of certain significant measurable parameters. Of the parameters evaluated, the "partial radiation efficiency" has proved most interesting in that it predicts that damping does not always reduce radiated power. In fact, it has been shown that the radiated power may well be significantly enhanced at certain frequencies when damping is arbitrarily applied.

Propagator Study of Some Simple Resonance Phenomena

Researchers: Associate Professor John P. Ertel
Sponsor: Naval Surface Warfare Center

This study involves the 1st and 2nd level development of the Propagator Solution to several standard idealized acoustics problems in Physics. In the 1st level, some simple physics problems normally solved via eigenvalue methods were completed to validate the technique unambiguously. These problems have very well known and accepted solutions which the Propagator method will reaffirm. Actually, this first level should be completed during the summer intersessional period under Code 804.1 funding. At the 2nd level of this project, several very idealized eigenvalue resonance problems (examples: 1D, a perfectly uniform string; 1D, a uniform string with periodic bead masses; 2D, multiple simply connected quadrilateral structures; etc.) were solved using the Propagator method which are then very matter-of-factly be extended to include deviations from symmetry. The well known perturbation methods of extending the standard eigenvalue solutions are, in contrast, long, difficult, and, in many cases, fail to reliably converge.

Heavy-Ion Backscattering Analysis Using A Magnetic Spectrometer

Researcher: Associate Professor James R. Huddle
Sponsor: Naval Research Laboratory

The purpose of this project is to develop a method for materials analysis using heavy ions instead of alpha particles. Since the scattering cross section increases as the square of the projectile charge, using heavy ions can greatly enhance the sensitivity of the method. By using a magnetic spectrometer for mass resolution and a position-sensitive detector (PSD) for efficiency, we hope to push the technique to sensitivity sufficient to detect iron impurities on silicon substrates at the level of a few tens of billions of iron atoms per square centimeter.

During the summer of 1996, the magnetic spectrometer was resurrected, and the position-sensitive detector was installed and de-bugged. A few spectra were taken at the end of the summer. The spectra indicate that an effect known as "scalloping" or "pebbling" may be due to the magnetic spectrometer itself, and not due to the PSD as had been thought. Scalloping is an effect that causes a quasiperiodic structure in spectra that are reasonably expected to be flat. Work during the summer of 1997 will focus on resolution of the scalloping problem.

Experiments During a Total Solar Eclipse

Researcher: Associate Professor James R. Huddle
Sponsor: Innovations in Travel, Inc.

The sun's chromosphere is a layer approximately 5000 km thick just outside the photoshpere, the surface of the sun we see from Earth. Outside the chromosphere is the corona, which extends several million kilometers into space. Many questions about these outer regions of the sun remain unanswered, such as the mechanisms by which the corona is heated to its temperature of 1.6 million degrees, and the changing temperature and elemental composition of the chromosphere. Since the sun is a rather common G2-type star, information about the chromosphere and corona is of interest to stellar astrophysicists as well as to solar physicists. Because the photosphere is brighter than the chromosphere and corona by five to seven orders of magnitude, these active and dynamic parts of the sun can be observed only if the photoshpere is blocked out. Coronagraphs obscure the photosphere with a small disk placed inside a telescope, but these instruments suffer from diffraction around the edges of the disk, and from scattering by molecules and dust particles in the atmosphere. Also, it is difficult to completely occult the photosphere but leave the chromosphere unobscured with a coronagraph because the chromosphere is so thin. For these reasons, the most effective land based studies of the chromosphere and of the corona are executed during total solar eclipses, when the moon occults the sun. Since the moon is large and distant, diffraction effects are negligible, and since it resides outside the atmosphere, scattering effects are absent.

A total solar eclipse will be visible from the small island of Aruba in the Netherlands Antilles on 26 February 1998. In return for help in planning an expedition to observe the eclipse, Innovations in Travel, Inc., has agreed to provide air travel and hotel accommodations for the principal investigator, one midshipman and two technicians from the U.S. Naval Academy, and for one faculty member and one cadet from the U.S. Coast Guard Academy. After consultation and negotiation with the Judge Advocate General, the Associate Dean for Faculty Affairs has granted permission to accept this support.

The experiments that will be done in Aruba are under development, but include plans to study the spectrum of the chromosphere, timings of certain special events during the eclipse, polarization of the corona, and shadow bands.

Properties of Electrode Materials and Ion-Exchange Membranes

Researcher: Professor John J. Fontanella and Assistant Professor P. E. Stallworth
Sponsor: Office of Naval Research

The goals of the project are to study the structure and electrical properties of electrode materials and ion-exchange membranes. Electrical conductivity studies will be carried out over a wide range of temperatures and pressures on lithium, cobalt and vanadium oxide materials. In addition, nuclear quadrupole resonance

techniques will be developed for use on these materials. For ion-exchange membranes, work will be carried out primarily on acid doped polybenzimidazole (PBI). The materials will be studied over a wide range of frequencies, temperatures and pressures. The structure and electrical conductivity of electrode materials are of fundamental interest. Structural studies are important because this class of materials is known to exhibit different phases in different temperature and (presumably) pressure regimes. Ultimately, it is the structure, in conjunction with the nature of the atoms, which determines whether or not a material can function as an electrode material. Since it is necessary that an electrode be a good conductor, the electrical conductivity is also important. In the case of the PBI and other ion-exchange membranes, the variable temperature and pressure experiments will provide insight both into the transport mechanism and into the nature of the diffusing species.

Resonant Sound Transmission From A Bubbly Liquid Encapsulated In A Thin Elastic Shell Submerged In Water

Researcher: Professor Murray S. Korman
Sponsor: Applied Physics Laboratory, University of Washington, Seattle, WA

The investigation of resonant sound from a spherical cloud of air bubbles in water is made practical for experimentation by using bubbly castor oil enclosed in a thin elastic shell which is submerged in water. The resonant transmission theory involves placing a small spherical transducer element at the center of the bubbly spherical cloud. If the particle velocity $u(r=a,t) = U_o e^{j\omega t}$ is known at the surface of the transducer of radius a, then the boundary conditions (imposing continuity of the acoustic pressure and the radial component of acoustic particle velocity) can be used to find the pressure inside and outside the cloud. The sound speed, density and wave number in a bubbly medium are formulated using the expressions developed by Commander and Prosperetti [J. Acoust. Soc. Am., Vol. 85, No. 2, 1989]. At sufficiently low frequencies the sound speed can be predicted from the volume void fraction β (when β is small but not too close to zero). The theoretical pressure amplitude radiating outside the cloud, $|p|$, is plotted vs ω from 0 to 10,000 radians/s (corresponding to a frequency range of 0 to 15.9 kHz) using a program that was developed on *Mathematica*. The radius b of the bubbly cloud is b= 5.08 cm and a = 0.508 cm.

Resonance curves are computed for bubbly water and bubbly castor oil for volume void fractions of β= 0.01, 0.001 and 0.0001. The average bubble radius is taken to be $5x10^{-3}$ cm which corresponds to bubble radii measured when casor oil is whipped up in a micro blender in our laboratory. For β= 0.001 the first few resonant peaks in the transmission spectrum occur at roughly 1,000 ; 3,000; 5,000 rad/s for bubbly water (there are more than 10 noticeable peaks) and the Q of the first peak is about 12. However, for bubbly castor oil there are only two noticeable peaks (at 1,000 and 3,000 rad/s) and the Q of the first peak is about one. This study compliments the more difficult procedure (both experimentally and theoretically) of determining the resonant frequencies from the backscattering of sound from an incident plane wave off of a bubbly sphere. Transmission experiments are scheduled in the USNA Hydrodynamics Tow Tank Facility during the summer of 1997.

Midshipman Physics Laboratory Workstation Development

Researcher: Associate Professor Steven R. Montgomery
Sponsor: United States Naval Academy, Curriculum Development Project

This work entails the updating and development of computer interfaces used by the midshipmen in the physics laboratory. Hardware and software evolution requires the continuous development of the workstations to meet current and future data acquisition requirements. The software presently used was developed in a version of National Instrument's LabVIEW programming language that is no longer supported by the company. The goals of this project include translation of the software presently used into

the new version of LabVIEW as well as the implementation of new tools that can help clarify physical principles in a laboratory experiment.

HyperText Physics Tutor (HyPT)

Researcher: Associate Professor Eugene P. Mosca
Sponsor: Bob Worth

I am working with a team of programmers and graphics artists on a prototype of HyperText Physics Tutor (HyPT) to be released on compact disk. This educational tool will teach physics problem solving integrating QuickTime movies of simulations and video out-takes with more traditional instructional media.

Optical Spectroscopy of Upconversion Processes in Rare Earth Doped Crystalline Solids

Researcher: Assistant Professor Anne-Marie d. Novo-Gradac
Sponsor: Naval Academy Research Council

Upconversion is a process which results in the emission of light from a material that is being optically pumped by light lower in frequency than the emission. This is achieved by converting two or more low frequency input photons into a single high frequency output photon. As a result, it is possible to produce blue emission from a crystal that is being pumped by an infrared diode laser. The upconverting crystal can be coupled with the diode pump laser into a compact package to produce a visible light laser. Such systems have immediate applications in the optical data storage industry. Lasers of this nature have been constructed, but are not yet commercially viable due to limitations in performance of known upconverting materials. It is the purpose of this ongoing project to identify new upconverting materials, determine the particulars of the upconversion process itself, and identify the conditions necessary to optimize the process sufficiently to produce laser emission.

Magnetic Hysteresis in Navy Hull Steel

Researcher: Professor Carl S. Schneider
Sponsor: Naval Surface Warfare Center, Annapolis, MD

Precise (0.5 per cent) data was collected using a carefully demagnetized cylindrical sample of Navy hull steel. Magnetization and susceptibility levels were measured for various sequences of magnetic field from the demagnetized state. Additional data was taken on the magnetization induced for various stress states applied to the sample with and without magnetic field. A theory of hysteresis was envisoned but not yet confirmed or published. Computational magnetoelastic theory has not yet been implemented to compare with the data.

ANDES: A Tutoring System For Classical Physics

Researcher: Professor Robert N. Shelby
Sponsor: Office of Naval Research

Classical physics is a prerequisite for virtually all university level studies of science and technology yet is a notoriously difficult subject for students to learn. We are building a tutoring system , named ANDES, that will help students learn physics. ANDES is based on the latest research in Cognitive Science as well as input from a team of physics instructors with years of experience in instructional reform. When completed, ANDES will be used at the U. S. Naval Academy to enhance the introductory physics course, SP211, which is taken by approximately 1000 students per year.
The coding and cognitive science portions of the system is being done by Professor Kurt VanLehn's group at the Learning Research and Development Center at the University of Pittsburgh, the domain knowledge will furnished by Professors Correll, Wintersgill and Shelby of the USNA Physics Department, and knowlege base construction, coding, and coordination will be done by Professor Schulze of the USNA Computer Science Department.

Structure and Conductivities of Ion-Exchange Membranes

Researchers: Assistant Professor Phillip E. Stallworth, Professor John J. Fontanella and Professor Mary C. Wintersgill
Sponsor: Office of Naval Research

The structure and electrical properties of ion-exchange membranes are currently being studied. Nuclear magnetic resonance (NMR) and electrical conductivity studies have been carried out over a range of pressures on NAFION thin-film samples hydrated with varying amounts of D_2O or CH_3OD. The goal is to systematically explore proton mobilities in these samples and correlate these motions with segmental motions of the NAFION polymer matrix. Deuteron NMR spin-lattice relaxation measurements of isotopically enriched methanol/water mixtures in NAFION 117 at elevated pressures demonstrate greater molecular-level interactions between methanol and NAFION than between water and NAFION. This is consistent with the plasticizing effect observed in the conductivity results.

Applied Imaging

Researcher: Professor Lawrence L. Tankersley
Sponsor: Naval Research Laboratory

All work undertaken was in support of ongoing efforts at the Naval Research Laboratory in Code 5640. Under this program, the current studies of optical detection and analysis of debris in turbine engine lubrication fluids, imaging through turbid media and correlator studies using multiple quantum well devices were extended. Elements included in the program were:

1. Modification of image analysis software
2. Lubricant optical transmission studies
3. Optical studies of small wear particles in lubricants
4. Real-time evaluation of debris in turbine engine lubricants
5. Quantum well photorefractive image correlators
6. Development of support electronics

Structure Mixing in the Mid-Shell Tellurium Nuclei

Researchers: Associate Professor Jeffrey.R. Vanhoy,
Brian Champine (USNA '97), Mark Skubis (USNA '96)
Sponsor: National Science Foundation

The stable tellurium nuclei have two valence protons with respect to Z = 50 and a range of neutron numbers. Three different types of structure are thought to be active in these nuclei: collective, two-particle, and particle-hole excitations known as intruders. Because there are seven stable even-even Te nuclei, one can study the evolution of these excitation modes over a wide range in neutron number. Emphasis centers on understanding the interplay between particle and collective features and on the aspects of the nuclear forces that determine the relative importance.
The level schemes of the even-mass ^{124}Te, ^{126}Te, ^{128}Te, and ^{130}Te nuclei have been constructed by measuring gamma rays following excitation of a target nucleus by inelastic neutron scattering. Using a recently developed γ-γ coincidence technique, we were able to contruct the level scheme up to approximately 3300 keV. Angular distributions and Doppler shifts were measured to extract level spins, parities, and lifetimes and calculate transition rates between levels required for comparison to nuclear models. A standard Interacting Boson Model (IBM-2) treatment produced moderate agreement with measured level energies and transition rates. Two implementations of the more refined Particle-Vibrational Core Model (PCM) treatment were completely unable to adequately describe these nuclei. The simpler IBM-2 treatment produces more reliable explanations than these two "more advanced" PCM calculations. An explanation of the nuclear structure of the 6+ state in the tellurium nuclei remains elusive.

Developement of Intelligent Tutoring System.

Researchers: Professor Mary C. Wintersgill, Professor David Correll,
Professor Robert Shelby, Associate Professor Kay Schulze.
Sponsor: Office of Naval Research

The student modeling module of an intelligent tutoring system (ITS) infers a student's line of reasoning given the student's user interface actions. It thereby determines what pieces of knowledge a student employed in taking those actions, and thus what pieces of knowledge are known by the student. The ITS makes important pedagogical decisions based on both the student's line of reasoning and the student's knowledge mastery.

The existing technology for student modeling needs improvement. Its first problem is combinatorial. Because the ITS assigns the problem the student is working on, student modeling is usually done by pre-computing the whole problem space for the problem, then searching it to find a solution path that matches the student's actions. In many task domains, the problem spaces are too large to use this technique, so the ITS designers artificially reduce their sizes by designating only some possible solution paths as "correct." In many task domains, it appears possible to vastly reduce the size of the pre-computed data structures by taking advantage of certain redundancies in the problem space.

The second problem is that inferring a line of reasoning from student actions is fraught with uncertainty. Students may know a rule, but fail to recall and use it. Sometimes students generate correct actions via lucky guesses. Often an action can be derived by both correct and incorrect lines of reasoning. Existing student modeling systems often use heuristics to cope with such uncertainties.

We will use sound, probabilistic reasoning instead. In particular, the system will use Bayesian belief networks. Because the reasoning is sound, the systems' assessments should be able to hold up to the same psychometric and legal standards that are applied to conventional multiple choice tests. We will develop a student modeling module based on these ideas, and demonstrate its combinatorial feasibility by using it in the context of simple ITS for university physics. We will evaluate the internal validity of the assessments using artificial students. We will evaluate the external validity using real students and verbal protocols.

Independent Research

An Optical Survey of Large Interstellar Structures

Researchers: Professor C. Elise Albert

Over the past decade, studies of the interstellar medium in our galaxy have highlighted the prevalence and importance of large scale structures in the distribution of gas in the disk and halo. Heiles (1984) presented a catalog of H I shells, shell-like loops and worms. Some of these structures are believed to be several kiloparsecs in size and show coherent structure in space and velocity. We obtained interstellar absorption spectra of Ca II H and K lines and Na I D1, D2 lines at high resolution (about 7 km/s) toward 61 stars in the directions of interstellar H I shells. Intermediate velocity gas is observed toward a number of our program stars. Results from the optical observations are being compared to H I data on the shells to evaluate their distances, kinematics and abundances.

Temporal Image Processing For Optical Coherence Tomography

Researcher: Assistant Professor Philip R. Battle

Optical coherence tomography is used to map out sub-surface structure in both organic and inorganic samples. In order to create the image, the sample is placed at the end of one arm of a Michelson interferometer. The reference arm has a mirror at the end and can be varied in length. Light from a braodband source is injected into one port of the interferometer; the other port is used to detect the output signal of the interferometer. As the length of the reference arm is varied, light reflected from the sub-structure in the sample will be correlated with the light from the reference arm. The correlated signal is detected at the output of the interferometer using a photodiode. The three dimensional image is reconstructed by combining the depth information at each point along the surface of the sample.

The goal of this research is to develop temporal image processing techniques. These techniques will be used to enhance the contrast of 3 dimensional images taken using an optical coherence microscope (OCM). Preliminary work has shown that deconvolving the point transfer function from the temporal scan data can lead to enhanced contrast. However, do to limited signal to noise, the reconstructed signal is necessarily band-limited. Following well known analytical techniques developed for spatial image processing, we expect to extend bandwidth of the object spectrum which will lead to further improvements in image contrast.

Investigation Of The Human Voice Mechanism

Researcher: Professor Samuel A. Elder, P. E. Castellanos, (University of Maryland
School of Medicine, Baltimore, MD 21201)

For more than a generation, there has been a search for the time profile of the defining pulse produced by oscillation of the glottal folds, made difficult because the primary sound is obscured by laryngeal cavity resonances. Previous attempts to isolate the seminal pulse have included time-frequency voice displays, highspeed optical devices, inverse filtering and reflectionless tubes. In the present investigation attention has been confined to the vocal fry range (gestures at rep rates less than 100 Hz.), using a Sondhi reflectionless tube with variable damping. In this way it is possible to study the signature of single glottal pulses. The conventional source of sound attributed to action of vocal folds is modulation of air volume flow through the glottis, generating monopole acoustic radiation. However, from examination of single glottal pulses uttered in the vocal fry range, using Sondhi tube and strobed video, an additional quadrupole source has been detected which stems from the fluctuating forces of the glottis on surrounding

fluid. It is the quadrupole source, in fact, that seems to define the shape of observed pressure trace in the single glottic pulse. This pulse, which lasts 10 ms or less, resembles a single cycle of negative sine wave beginning at closing phase, followed by a weaker response at opening phase, as indicated by Electroglottograph (EGG) activity. Monopole sound which is emitted in short pulses during the abrupt closing and opening action of the glottis shows up as small superposed peaks along the quadrupole wave in a reflectionless tube. The quadrupole pressure trace, or q-wave, forms the acoustic signature of the single glottic pulse or SGP, and may be observed in ordinary sound emissions outside the tube, where glottic pulse wave trains with embedded monopole pulses and head echoes become tone samples. The new approach appears to have possible clinical applications and could be useful for studying such diverse phenomena as voice stress, singers ring, gender-specific factors, and pathological vocal folds.

Magnetospheric Physics

Researcher: Professor Irene M. Engle

There are several projects upon which are thought about or worked upon intermittently.

1. Modeling, from first principles, a representation of the Jovian magnetosphere during a semi-inflated state, as observed during the Voyager II flyby. The expanded version of the Voyager II Era magnetosphere field model was the one most applicable to correct predictions and useful data analysis for the July 1994 Shoemaker-Levy 9 Encounter with the Jovian magnetosphere, (which culminated in the collision with the planet). A manuscript co-authored with Ens. Todd Bode has been favorably received by the editor of *Planetary and Space Science*. Other works, generally in collaboration with European colleagues regarding the application of IME results to observations of the SL9 encounter with Jupiter have been presented or are in process. One paper is currently in press for a forthcoming special dedicated issue of Planetary and Space Science. A floppy magnetodsk to replace a rigid magnetodisk is currently being incorporated.

2. New investigations will be made on the Mercury magnetospheric field, in response to a published review on Mercury which contains some conclusions which are not supported by this investigator's experience. Also, I was contacted by an investigator interested in obtaining time dependent configuration modeling for analysis of some more recently observed photo-ionization of heavy ions (especially sodium) near the disc of Mercury. IME presented her work at the European Space Agency Workshop for planning a new mission to Mercury and her model has been formally requested and supplied for use in mission planning. The associated paper has been published in a special issue of Planetary and Space Science (January 1997). Midshipman Jacob Scott will undertake as a special project the mapping of the boundaries of the magnetospheric models being used by ESA investigators for mission planning

3. Adapting alternate sets of orthogonal functions for three-dimensional representation of magnetospheres for earth and other planets with intrinsic planetary magnetic fields.

4. Modeling, from first principles, as in #1, or by scaling from a function set, as in #3, self-consistent, three-dimensional global magnetospheres of Uranus and Neptune.

5. The relation of observed temporal variations of magnetospheric configurations to the proximate causes and consequential phenomena are being studied which will include investigations of the mechanisms for transport of particles, momenta, and energy related to the aforesaid phenomena. Attempts are being made to model upstream shock waves attributable to diurnal variations of Jovian magnetopause position.

6. IME has modeled, from first principles, a representation of the Saturnian magnetosphere as observed during the Pioneer 11 and Voyager I and II flybys. An expanded (from original version) paper written jointly with Sylvestre Maurice had been published in the *Journal of Geophysical Research.*. Midshipman Mark Skubis worked on an "upgrade" of the model by incorporating a non-equatorial plane incidence of the solar wind as his 1995-96 Trident Project. A follow-up paper has been published on details of possible size and shape configurations when a plausible range of directions of incident solar wind and solar wind pressure are considered with co-authors Trident Scholar Mark Skubis, as well as French nationals Sylvestre Maurice and Michel Blanc. The model has been adopted by the CASSINI mission investigators as their basic magnetic field model for planning purposes for the planned orbiting mission to Saturn. Several presentations based upon the work

have been made in Europe. A current project "upgrade" is the affixing of a realistic model of a magnetotail to the global model.

New Experiments for the Physics of the Atom Laboratory

Researcher: Associate Professor James R. Huddle

Work progressed on several improvements to experiments used in the Physics of the Atom sequence of courses for physics majors.

Aristarchus' Experiment: Students are to determine the size and distance of the moon by making a simple observation during a lunar eclipse. Two lunar eclipses occurred in the past year. Although direct observation of the eclipse was not possible due to poor weather during both eclipses, we worked out a technique to make the required measurements using images of the eclipses from videotaped newscasts.

Spatially Resolved Self-Pumping in Photorefractive Materials

Researcher: Associate Professor Steven R. Montgomery

Self pumping in photorefractive crystals is easily observed for continuous wave laser beams and is well documented. During a previous period of NARC sponsored funding it was found that self pumped phase conjugation is easily observed in BSKNN when the input laser beam consists of pulses of about 120 picoseconds duration and 82 MHz rep rate from a modelocked argon ion laser. In fact, the response is very similar to that from a CW beam. However, self pumping with trains of 3 picosecond pulses with the same rep rate derived from the synchronously pumped dye laser produce only a very weak self pumped response from the crystal. It is the difference in behavior between the CW and pulsed cases that is the primary focus of this study. The main objective is to understand why the self pumping response in photorefractive crystals is different for CW laser beams and modelocked pulse trains. Possible benefits to gaining this insight are: 1) Since it occurs completely inside the crystal it is difficult to probe self pumping. Short pulses can provide a spatial or temporal probe so that better physical models can be developed and tested, 2) Self pumping is rather a slow process that takes several seconds to thirty minutes to achieve.

Friction, Torque and the Tablecloth Trick

Researchers: Assistant Professor Anne-Marie d. Novo-Gradac
and Kirsten A. Hubbard

The "tablecloth trick" has been used by physicists and magicians for many years. The audience is delighted as a tablecloth is pulled from beneath the pieces of an elegantly set table. This demonstration is often used to discuss inertia and friction with no attention given to torque. However, the frictional force acting on the stemware is applied tangentially, often resulting in the glassware tipping over rather than be dragged off the table. A careful analysis of this situation provides a wealth of information about the more subtle aspects of friction and torque. Objects may tip over while still sliding on the cloth, or as they decelerate they may tip on the tabletop after the cloth has departed. We have designed an apparatus that allows variation of parameters such as cloth speed, surface roughness, and moment of inertia of the tipping object. We have also developed equations to predict stability conditions for the system. Research has centered on testing the apparatus and evaluating the validity of our predictions. The apparatus and results will be presented at the August 1997 meeting of the American Association of Physics Teachers. It is the ultimate intention to use the apparatus in the upper level physics major laboratory for studying frictional forces and torque.

Low-Field CW and Pulsed Solid State NMR At USNA

Researcher: Assistant Professor Phillip E. Stallworth

There is a continuing effort to upgrade low-field Nuclear Magnetic Resonance (NMR) at the Academy. This project is being developed by bringing the 0-21 kG electromagnet on line and by upgrading the existing pulsed and continuous wave (CW) NMR/NQR equipment.

The Varian electromagnet has been interfaced with a 1 ppm field stabilization unit (Walker Scientific rotating coil unit and console). This unit will operate in both field sweep and static mode. Currently, the magnet is cooled using continuously running tap water. A more efficient method of temperature maintenance is proposed by incorporation of a Neslab water chiller.

Non-adiabatic superfast-passage NMR experiments (NASP) are currently being planned. NMR equipment currently maintained such as the Mid-Continent continuous wave receiver/transmitter unit, Varian crossed-coil NMR probes, the Kepco power supply and the Nicolet signal averager will be employed to carry out NASP experiments.

A Ritec 1-45 MHz pulsed unit has been obtained and is currently being set up as a pulsed NMR/NQR spectrometer. This device has a distinct advantage over the currently owned Matec equipment in that it uses a dual channel quadrature detection scheme. This unit will measure NQR resonances and spin-lattice relaxation times for a variety of solid state systems. Research projects involving midshipmen will commence when the above systems are made operational. Such projects will involve fabrication of NMR probes and development of various lineshape simulation programs in analyzing solid state spectra.

Research Course Projects

An Acoustical Comparison Of Male Speech Versus Female Speech

Researcher: Midshipman 1/C Michael P. Touse
Faculty Advisor: Professor Samuel A. Elder

The purpose of this study was to evaluate the acoustical differences between male and female speech to determine how listeners identify the gender of a given speaker while also determining the actual word (vowel) being spoken. In order to further understand these differences, the same words used in Peterson and Barney (1952) were recorded and analyzed using the CSL (Computerized Speech Laboratory) and ASL (Analysis-Synthesis Laboratory) programs. The actual analysis included only the center vowel of each of the ten words. The analysis that followed included determining the fundamental frequency (F0), and first and second formants (F1 and F2). To compare the differences between male and female speech, differences in absolute frequencies were noted as well as ratios of F2 to F1. Using only the methods described above, it is most likely that vowel recognition is accomplished by noting the ratio of F2 to F1, while gender is determined primarily by the absolute fundamental frequency of that vowel.

Electrical Properties of Materials

Researcher: Midshipman 1/C Kevin Macy
Faculty Advisor: Professor John J. Fontanella

The goal of the project is to make measurements of materials under dry conditions and at high pressures. As the first step towards achieving this end, a glove box was instrumented and made operational. This included adding a pumping and circulation system, an exchange gas system, and installation and calibration

of oxygen and water sensors. The completed glove box provided an environment with less than 0.15 ppm of water. Both sample loading and experiments can be carried out inside. The first application was to load samples of dry polybenzimidazole for measurement at high pressures. The samples were then transferred to a high pressure vessel and measurements of the effect of pressure on the electrical conductivity were carried out.

Observations of 3C10 at 332.9 and 1,375 MHz

Researcher: Midshipmen 1/C Ryan O'Donnell, and Theodore Brenner
Faculty Advisor: Assistant Professor Debora Katz-Stone

Using Very Large Array (VLA) observations at 332.9 and 1,375 Mhz, spectral indices of various features in 3C10 were analyzed with tomography techniques. A ring of emission with spectral index ~ -0.5 was found perpendicular to a NE-SW axis (position angle ~ 73°). The ring is not present in the total intensity maps at either wavelength. The remainder of 3C10 was found to be relatively featureless, with a spectral index of -0.52 at the rim and steepening to -0.85 toward the center. In addition, a steep spectrum wind was discovered to the east of the source.

A Fanaroff and Riley Scale and the Radio and Optical Properties of the Associated Radio Galaxies

Researcher: Midshipman 1/C Jon Hager, and Andrew Richards
Faculty Advisor: Assistant Professor Debora Katz-Stone

In an attempt to find whether the correlation between optical and radio luminosity of radio galaxies and the Fanaroff and Riley (FR) classification can be further broken down into subsets, we use Fanaroff & Riley's original definition of their classification scheme (Fanaroff & Riley, 1974) to re-measure 191 galaxies and divide the two FR classes in sub-groups using an FR scale. We find that no correlation exists between radio and optical luminosity and the associated FR classification using Fanaroff and Riley's original definition of the two classes of radio galaxies. We also find that no group of ratios is favored over any other. These results challenge Fanaroff and Riley's original correlation as well as our basic understanding of the nature of radio galaxy morphology.

Design and Development of PC-IMAT: Teaching Strategies For Acoustical Oceanography

Researcher: Midshipman 1/C Jacob A. Foret
Faculty Advisor: Professor Murray S. Korman

PC-IMAT (Interactive Multisensor Analysis Training) was developed in 1994 by NPRDC as a set of software tools to satisfy the initial need to enhance the training of aviation ASW operators. While Navy training opportunities have decreased (reductions in deployments, encounters and shore-based training facilities) training requirements have increased. The PC-IMAT project is proving to be a flexible and effectively evolving computer based training / educational platform needed to help tackle ASW and other tasks which require extensive analysis, classification and interpretational skills. Students taking SP411 (Underwater Acoustics and Sonar) are currently using PC-IMAT to help investigate what are the effective instructional strategies which convey understanding of a complex multivariate domain (like ray tracing or propagation loss models). Recent research on "scientific visualization" (to enhance comprehension and retention) and modeling from student feedback will be used to help develop and

evaluate existing training materials. Questions arise naturally. What are the issues of the educational platforms to successful learning? What is the best computer utilization so that there is efficient evolution in the distributed training - whose contents have been reviewed, overhauled and accepted by experts in the field? Finally, ship-board training is limited by the senior person's knowledge. Solutions to these questions will be investigated with midshipman participation.

Underwater Sound Radiation From A Spherical Bubble Cloud Encapsulated By A Thin Spherical Shell

Researcher: Midshipman 2/C Sandra Lee Koslowski
Faculty Advisor: Professor Murray S. Korman

Measurements of sound transmission vs frequency are performed (in the Rickover Hall Hydrodynamics Tow Tank Facility) for a submerged spherical bubble cloud that is encapsulated by a thin spherical shell. The bubble cloud is driven by a miniature spherical PZT transducer unit that is suspended in the center. A theoretical model has been developed which predicts the resonant frequencies for the case where the shell thickness has negligible effect. Therefore, the resonances will depend on the radius of the cloud and the sound speed in the bubbly media (which is a function of the air volume void fraction). A shell of urethane elastomer is molded as a single piece by using the "lost wax technique." Hemispherical molds are used. The first set is for making the "inner" spherical wax ball. The second set forms the "outer" boundary of the casting for the spherical shell with filling ports on the north and south poles. The shell's inner wax material is then melted out to complete the process. The shell is nearly acoustically transparent since r =1.03 g/cm^3, c_{long} ~ 1450 m/s and c_{tran} ~ 70 m/s. The bubbly fluid consists of castor oil that has been whipped in a microblender.

Publications

ALBERT, C. Elise, Professor, Coauthor, "A Mini-Survey of Interstellar Titanium from the Southern Hemisphere," *The Astrophysical Journal Supplement*, in press.

We describe the results of a mini-survey of interstellar Ti II and Ca II absorption towards 42 early-type stars observed from the southern hemisphere at a spectral resolution of 4.5 km/s. Results are also presented for the Na I ultraviolet line (3302 A) detected towards nine of these targets. We examine the dependence of the integrated column densities N(Ti II), N(Ca II), and N(Na I) on distance, reddening, neutral hydrogen column density, and their galactic elemental abundance. Our findings support the proposition that Ti II and Ca II absorption originate in the same regions of the pervasive, warm and neutral intercloud gas of the interstellar medium. We have observed a clear correlation of decreasing Ti and Ca abundance with increasing line-of-sight gas density. The Ti II/Ca II abundance ratio has been found to be essentially constant under all the interstellar density conditions we have sampled. Thus, we conclude that the general absorption properties of titanium (and calcium) are similar throughout the entire disk of our galaxy.

EDMONDSON, C. A, LCDR, USN, Coauthor, "High pressure NMR and electrical conductivity studies of gel electrolytes based on poly(acrylonitrile)" Solid State Ionics, **85**, 173-179 (1996).

The effect of high pressure on electrical conductivity and NMR in gels prepared from lithium or sodium perchlorate, ethylene carbonate, dimethyl carbonate and poly(acrylonitrile) (PAN) has been determined. The corresponding liquids were also studied. Complex impedance studies at frequencies from 10 to 10^8 Hz and NMR measurements of T_1 were carried out as a

function of pressure up to 0.25 GPa. Activation volumes for NMR relaxation and ionic conductivity were calculated from the variable pressure data. Both

activation volumes were found to be approximately the same in the liquids. For the gels, however, the NMR activation volumes are the same or lower than for the liquid while the electrical conductivity pressure dependencies are larger. The implications of these results are discussed in terms of possible effects of the PAN on the ionic solvation shell.

ELDER, Samuel A., Coauthor, Fluid Physics for Oceanographers and Physicists, 2nd ed., Butterworth/Heinemann, Oxford, UK, 1996.

This is the second edition of a text designed for teaching undergraduate fluid dynamics. The book has benefited greatly from the fact that an earlier version has now been used in the classroom for six years, giving the authors a chance to correct errors and improve the intelligibility of the text. Feedback from students has been helpful in deciding which topics to omit and which to expand more fully. New material includes instability of stratified flows and introduction to geostrophic flow. The text is less demanding, mathematically, than most other fluid mechanics texts on the market, though it covers essentially all the basic equations of incompressible flow. The most appreciative audience for Fluid Physics has proven to be among undergraduate students in oceanography, geology, biology and other environmental sciences, who tend to lack a rigorous background in math and physics. Furthermore, because it is short, the book is priced attractively.

ENGLE, Irene M., Coauthor, "The Geometry Of Saturn's Magnetopause,"*Journal of Geophysical Research* **101**, 27053-27059 (1996).

We report upon a simple parameterization of the idealized three-dimensional model of Saturn's magnetopause, which is described in Maurice and Engle [1995][1]. For a subsolar point at $R_{sub} = 24\ R_s$, the parameterization is based on a series of ellipses which reproduce the shape of the magnetopause in planes parallel to the solar-ecliptic YZ plane. The 3D model is easily scaled for $17\ R_s < R_m < 40\ R_s$. This representation of Saturn's magnetopause is found to be consistent with the Voyager 1 magnetopause crossing observations. The same representation applied to Pioneer 1 and Voyager 2 confirms the variations of the subsolar point distance during these encounters. The model is intended for use in support of the Cassini mission planning.

S. Maurice and Irene M. Engle, "Idealized Saturn Magnetosphere Shape and Field", *Journal of Geophysical Research* **100**, 17143-17151, (1995).

ENGLE, Irene M., "Mercury's Magnetosphere: Other Views," *Planetary and Space Science* **45**, 127-132 (1997).

The measurements made of the Mercury magnetic field during the Mercury I flyby and the Mercury III flyby have been incorporated into models of the Hermean magnetosphere-magnetotail system. Because Mercury was coincidentally at the same position in its orbit for both flybys, both data sets have customarily been used together to fit the parameters of any particular model for characterizing the intrinsic Mercury planetary field. This paper presents results of simultaneously fitting the separate data sets with the assumption that the interior planetary magnetic field was the same during both the Mercury I and Mercury III flybys but that the solar wind pressure and/or direction of incidence could have been different during the times of the two flybys.

ENGLE, Irene M., Coauthor, "Magnetic Mapping Of Auroral Signatures Of Comet Sl9 In The Jovian Magnetosphere,"* *Planetary and Space Science* (final copy submitted April, 1997)

The electrodynamic interaction of Comet Shoemaker-Levy 9 (SL9) with the Jovian magnetosphere gave rise to the detection of several unique phenomena in the UV, X ray and radio wavelength ranges. Among them, the detection of an unusual FUV bright spot in Hubble Space Telescope images of the southern polar cap on July 20, just before P2 collision, may be attributed to auroral-like processes triggered by the charged environment of the comet fragments. We model here in detail the time-varying morphology of the instantaneous magnetic field lines passing through the comet fragments during their crossing of the magnetosphere, with special focus on the location of the magnetic footprint and the nature of the field line. We show that the FUV bright spot, not corotating with the planet, is likely to be related with a fragment still in the magnetosphere, and that fragment Q is the most presumable source of the interaction, as its footprint can easily be resolved from fragment P2's, and also, although less easily, from the more distant fragment R to W's ones. We show also that Q, as well as the other fragments, was on an open magnetic field line at the time of the observations, in agreement with the absence of observable conjugate emission in the north. But, the deformation of the magnetic field line passing through Q during the following few hours is such that

it presumably became closed to the northern hemisphere during two separate periods between the observations under study and fragment Q's collision. A series of X ray bursts detected in the north precisely during the first of these periods could be related to the same process and strengthen our identification. A second UV set of data was taken during the same period of closed field lines, but due to an unfavourable viewing geometry, the identification of observed bright spots with fragment Q footprint is more ambiguous. Finally, we estimate crudely the energy of the particles precipitating in the FUV spot, and discuss briefly possible plasma processes.

Ertel, John P., Coauthor, General Physics Laboratory Manual, American Heritage Custom Publishing, Hamden, CT, (1996).

This most recent edition of the General Physics Laboratory Manual, 1997 - 1998 contains five principle parts.

I. The first part gives the student

1) a feeling for the purpose of doing physics laboratories — why are laboratories integral to the understanding of physical phenomena;
2) a description of the elements of a physics laboratory report — what we expect from them in laboratory write-ups;
3) a familiarization of graphing techniques and what should be included with any graph;
4) an introductory lesson in error propagation and uncertainty concepts.

II. Once the student understands in general what we are doing and why we are doing it all physics laboratories we move on to the second part of the book. With the addition of the Real Time Physics component in our laboratories, the nature of the laboratory experience was substantially changed (from previous years) and a new set of fall or 1st-term Mechanics and Waves Experiments in Real Time Physics had to be crafted. This section consists of seven new experiments as well as five more that are of our old style in the Lab View idiom.

III. The third part of the manual consists of nine Mechanics and Waves experiments for the fall or 1st-term with Lab View software. Some of these laboratories had to be extensively rewritten from our previous edition while others required only modest corrections and updates due to software and hardware improvements.

IV. Then comes the fourth part of the manual which consists of nine more experiments with Lab View software for the 2nd-term in Electricity, Magnetism, and Optics. Many of these experiments were extensively rewritten from our previous edition to cover updates due to software and hardware improvements while others required only modest corrections.

V. The fifth and last part is composed of "appendices" which give the student an understanding of the theory and practical use of some of the equipment and instruments used in a physics laboratory. This part is closed off with sets of problems for the entire academic year in Mechanics, Waves, Electricity, Magnetism, and Optics that are typical of those that the student will see on exams and quizzes in both style and degree of difficulty. Arguably, this is the most popular section of the entire book for our students!

FONTANELLA, John J., Coauthor, "High pressure NMR and electrical conductivity studies of gel electrolytes based on poly(acrylonitrile)" Solid State Ionics, **85**, 173-179 (1996).

The effect of high pressure on electrical conductivity and NMR in gels prepared from lithium or sodium perchlorate, ethylene carbonate, dimethyl carbonate and poly(acrylonitrile) (PAN) has been determined. The corresponding liquids were also studied. Complex impedance studies at frequencies from 10 to 10^8 Hz and NMR measurements of T_1 were carried out as a function of pressure up to 0.25 GPa. Activation volumes for NMR relaxation and ionic conductivity were calculated from the variable pressure data. Both activation volumes were found to be approximately the same in the liquids. For the gels, however, the NMR activation volumes are the same or lower than for the liquid while the electrical conductivity pressure dependencies are larger. The implications of these results are discussed in terms of possible effects of the PAN on the ionic solvation shell.

FONTANELLA, John. J., Professor, Coauthor, "High Pressure Electrical Conductivity and NMR Studies in Variable Equivalent Weight NAFION Membranes" Macromolecules, **29**, 4944-4951 (1996).

Measurements of the electrical conductivity and proton and fluorine-19 NMR spin-lattice relaxation times (T_1) in acid form NAFION 105, 117 and 120 conditioned at various levels of relative humidity have been carried out. Complex impedance studies were made along the plane of the polymer film at frequencies from 10 to 10^8 Hz at room temperature and pressures up to 0.3 GPa. The NMR measurements were made at room temperature and pressures up to 0.25 GPa. Both types

of measurement were also carried out on various concentrations of sulfuric acid in water. The electrical conductivity decreases with increasing pressure for low water content acid solutions and low water content NAFION samples. This behavior (positive activation volumes) is that expected for "normal" liquids and for ions in polymers where the motion of the ions is determined by the host matrix. However, for high water contents, the reverse is true. The electrical conductivity increases with increasing pressure which gives rise to a negative activation volume. The results show that at high water contents, the electrical conductivity mechanism in NAFION is essentially identical to that for a dilute acid where the transport is controlled by the aqueous component. The activation volumes extracted from the proton NMR T_1 data are in qualitative agreement with those obtained from the electrical conductivity measurements at intermediate and low water contents, suggesting that motion of the sulfonic acid-terminated pendant chains contribute to the conduction mechanism at low water contents.

HUDDLE, James R., Coauthor, "A Note on Benford's Law," *Mathematics and Computer Education*, **31**, 66 (1997).

At first blush, one would think that if a number were chosen at random from a table, the probability that the first (or most significant) digit of that number will be k would be constant for all first digits k = 1, 2, ..., 9. Benford's Law states that the probability that the most significant digit is k is given by P(k) = log [(k+1)/k]. That is, the probability that the most significant digit of such a number is 1 is about 30%, that it is 2 is about 18%, ..., and that it is 9 is about 5%.

In an empirical test of Benford's Law, the frequencies of the most significant digit of 2000 numerical answers to problems given in the back of four physics and mathematics textbooks were tabulated and plotted as a function of the integers from 1 to 9. The chi-square statistic for these data was 12.0085, leading the authors to accept Benford's Law for homework problems with a high degree of confidence. The authors show that Benford's Law is valid for any collection of integers that has finite maximum value, and therefore that Benford's Law is to be expected for answers to homework problems.

HUDDLE, James R., "Eigenfunctions and Eigenvalues," *Macmillan Encyclopedia of Physics*, Macmillan, New York, p. 392, 1996.

In many problems in engineering and physics, it is required to find a function which is not only a solution to a specified differential equation, but also has a specified behavior on the boundaries of some region of space. Generally, such functions, called eigenfunctions, exist only for certain special values of one of the parameters in the differential equation. These special values of the parameter are called eigenvalues. In this article, the conditions under which eigenfunctions and eigenvalues can be found are reviewed, two theorems about the orthogonality of the eigenfunctions and the real-valuedness of the eigenvalues in certain important cases are presented, and the important role eigenfunctions and eigenvalues play in the theory of quantum mechanics is discussed.

HUDDLE, James R., "Ground State," *Macmillan Encyclopedia of Physics*, Macmillan, New York, p. 690, 1996.

In quantum mechanics, states of definite energy are called stationary states or allowed states. The stationary state for a particular system with the lowest possible energy is called the ground state for that system. In this article, the ground-state energies for several important quantum-mechanical systems are discussed.

HUDDLE, James R., "Van de Graaff Accelerator," *Macmillan Encyclopedia of Physics* Macmillan, New York, p. 1665, 1996.

An accelerator is a machine used to produce a beam of swiftly moving charged particles, either electrons or positively charged ions. Originally designed for nuclear and high-energy physics research, accelerators have found uses in studies of atomic and molecular structure, in materials science, and in medicine. One type of accelerator derives the energy to accelerate charged particles from an electrostatic generator developed by Robert J. Van de Graaff at Princeton University in 1929. This article discusses the principles of the operation and control of the Van de Graaff accelerator.

KATZ-STONE, Debora. M., Coauthor, "A Spectral Analysis of Two Compact Steep Spectrum Sources," *Astrophysical Journal* , 479, 258-267 (1997).

We have added new high-resolution Very Large Array (VLA) and Very Large Baseline Array (VLBA) data of two compact steep-spectrum sources (CSSs)(3C 67 and 3C 190) to existing data. We find that both sources have a complex spectral structure that is not completely resolved with these data.

A standard aging analysis of 3C 190 predicts an unusually steep injection index of -0.8 and a young age. If CSSs are found to have steep injection indices in general, then it suggests that they are not simply younger, smaller version of large radio sources, but a different type of object. Another possibility is that the injection index is -0.5 and that the superposition of aged spectral components makes the injection index appear steeper. Whichever explanation is appropriate, interpretation of spectral data in such conventional terms as aging must be made cautiously.

KATZ-STONE, Debora M., "Get Serious on Science" 21AUG96 USA Today

This general audience article encourages adults to get involved with science education. Adults with a genuine interest in science can encouraged children to consider a future in scientific pursuit.

STALLWORTH, Phillip, Assistant Professor, Coauthor, "X-ray Absorption and Magnetic Resonance Spectroscopic Studies of $Li_xV_6O_3$," accepted to *J. Appl. Phys*, 1997.

Polycrystalline $Li_xV_6O_3$, samples, $0.5 < x < 6$, were prepared by chemical intercalation in n-butyl lithium and investigated spectroscopically by x-ray absorption, electron paramagnetic resonance (EPR), and ^{7}Li solid state nuclear magnetic resonance (NMR). Both the EPR results and the vanadium K-edge x-ray absorption fine structure spectra show that the average oxidation state of the vanadium decreases with the addition of lithium. Furthermore, the x-ray results provide evidence of lithium-deficient and oxygen-deficient impurity phases. The local symmetry of the vanadium atoms first decreases with increasing x, from $0 < x < 1$, and then increases with increasing x as the vanadium octahedral environment becomes less distorted. These changes are revealed by both the intensity of the first V-O peak in the radial distribution function and by the decrease in the x-ray absorption pre-edge intensity. However, structural correlations beyond the nearest neighbor atoms rapidly decrease with increasing lithium content above $x = 1.5$, reflecting increased disorder. The observed increase in V-O distance implies a modest lattice expansion with intercalated lithium, from 1.93 angstroms at $x = 0$ (in agreement with x-ray diffraction results) to 2.02 angstroms at $x = 5$. Variable temperature ^{7}Li NMR linewidth and spin-lattice relaxation measurements demonstrate that, dynamic processes govern the spin-lattice relaxation when $0.5 < x < 2$; but paramagnetic (as well as homonuclear) dipolar interactions have a pronounced effect in reducing the s p i n - l a t t i c e relaxation time as lithium content is increased beyond $x = 2$. Analysis of the ^{7}Li NMR lineshape verifies the presence of impurity phases. Paramagnetic and diamagnetic chemical shifts yield evidence for local magnetic ordering which accompany the structural changes upon lithium intercalation.

STALLWORTH, Phillip, Assistant Professor, Coauthor, "Electrical Conductivity and NMR Studies of Methanol/Water Mixtures in NAFION Membranes," accepted to *Solid State Ionics*., 1997.

Complex impedance studies have been carried out in acid form NAFION 117 treated with various amounts of methanol and methanol-water mixtures. At room temperature and atmospheric pressure the conductivity for NAFiON treated with "pure" methanol is about a factor of ten less than for NAFION which contains the same wt.% of water. In samples treated with water-methanol mixtures, the conductivity is lower than for samples having the same total wt.% of water. However, for low mixed fluid wt.% the conductivity is significantly higher than for samples with the same amount of water, only, as was in the mix. This enhancement of conductivity over that for the corresponding water uptake is attributed to a plasticizing effect of the methanol facilitating the segmental motion of the polymer. At higher water concentrations, the conductivity is generally lower in the mixed solution-treated samples than in samples treated with the corresponding amount of water. This is to be expected since in this regime, proton conduction occurs in fluid-rich regions, which in the solution case includes a large fraction of methanol. For a 40 wt.% 1.4:1 molar ratio film, the studies were carried out at pressures up to 0.3 GPa. It is found that the electrical conductivity decreases with increasing pressure. Both the electrical conductivity and the activation volume are similar to the result for NAFION containing the same amount of water only. Deuteron NMR spin-lattice relaxation measurements of isotopically enriched methalol/water mixtures in NAFION 117 at elevated pressure demonstrate greater molecular-level interactions between methanol and NAFION than between water and NAFION. This is consistent with the plasticizing effect observed in the conductivity results.

TANKERSLEY, Lawrence L., "Real-Time Optical Debris Monitoring", Integrated Monitoring, Diagnostics, and Failure Prevention Meeting

Proceedings, 51st Meeting of the Society for Machinery Failure Prevention Technology (MFPT).1, pp. 443-448, (1997, Virginia Beach,VA.).

The status of two optical debris monitoring programs is described. The optical debris monitors are directed at developing on line technology for identifying type and severity of faults in machinery through measurement of size, shape and morphology of debris particles in real time. Operational characteristics of the monitors in two different size ranges is described.

WINTERSGILL, Mary C., Professor, Coauthor, "High pressure NMR and electrical conductivity studies of gel electrolytes based on poly(acrylonitrile)" Solid State Ionics, **85**, 173-179 (1996).

The effect of high pressure on electrical conductivity and NMR in gels prepared from lithium or sodium perchlorate, ethylene carbonate, dimethyl carbonate and poly(acrylonitrile) (PAN) has been determined. The corresponding liquids were also studied. Complex impedance studies at frequencies from 10 to 10^8 Hz and NMR measurements of T_1 were carried out as a function of pressure up to 0.25 GPa. Activation volumes for NMR relaxation and ionic conductivity were calculated from the variable pressure data. Both activation volumes were found to be approximately the same in the liquids. For the gels, however, the NMR activation volumes are the same or lower than for the liquid while the electrical conductivity pressure dependencies are larger. The implications of these results are discussed in terms of possible effects of the PAN on the ionic solvation shell.

WINTERSGILL, M. C., Professor, Coauthor, "High Pressure Electrical Conductivity and NMR Studies in Variable Equivalent Weight NAFION Membranes" Macromolecules, **29**, 4944-4951 (1996).

Measurements of the electrical conductivity and proton and fluorine-19 NMR spin-lattice relaxation times (T_1) in acid form NAFION 105, 117 and 120 conditioned at various levels of relative humidity have been carried out. Complex impedance studies were made along the plane of the polymer film at frequencies from 10 to 10^8 Hz at room temperature and pressures up to 0.3 GPa. The NMR measurements were made at room temperature and pressures up to 0.25 GPa. Both types of measurement were also carried out on various concentrations of sulfuric acid in water. The electrical conductivity decreases with increasing pressure for low water content acid solutions and low water content NAFION samples. This behavior (positive activation volumes) is that expected for "normal" liquids and for ions in polymers where the motion of the ions is determined by the host matrix. However, for high water contents, the reverse is true. The electrical conductivity increases with increasing pressure which gives rise to a negative activation volume. The results show that at high water contents, the electrical conductivity mechanism in NAFION is essentially identical to that for a dilute acid where the transport is controlled by the aqueous component. The activation volumes extracted from the proton NMR T_1 data are in qualitative agreement with those obtained from the electrical conductivity measurements at intermediate and low water contents, suggesting that motion of the sulfonic acid-terminated pendant chains contribute to the conduction mechanism at low water contents.

Presentations

ELDER, S. A., Professor, "Evidence for a Second Laryngeal Sound Source," 133rd Meeting of the Acoustical Society of America, 18 June 1997.

ENGLE, I. M., Professor, “Jovian Magnetosphere, Including the Dayside Solar Wind Interaction and the Khurana Jovian Magnetodisk,” Magnetospheres of the Outer Planets, Boulder CO, 17 March 1997.

ERTEL, J. P., Associate Professor, “W22: Introduction to Interactive Physics III and Its Use in the Undergraduate Classroom/Laboratory,” Winter Meeting of the American Association of Physics Teachers, Phoenix, AZ, 4-9 January 1997.

ERTEL, J. P., Associate Professor, “W33: Intermediate and Advanced Interactive Physics III and Its Use in the Undergraduate Classroom/Laboratory,” Summer Meeting of the American Association of Physics Teachers , Boulder, CO, 4-9 August 1997.

HUDDLE, J. R., Associate Professor, "Total Solar Eclipses: Expeditions to Peru and to India." Westminster Astronomical Society, Westminster, MD, 12 June 1996.

HUDDLE, J. R., Associate Professor, "Solar Eclipses in Peru and in India," Physics Department Colloquium, Annapolis, MD, 16 October 1996.

FONTANELLA, J. J., Professor, "Complex Impedance Measurements on NAFION," Fifth International Symposium on Polymer Electrolytes, Uppsala, Sweden, 11-16 August 1996.

FONTANELLA, J. J., Professor, "Electrical Conductivity and NMR Studies of Methanol/Water Mixtures in NAFION Membranes," Fifth International Symposium on Polymer Electrolytes, Uppsala, Sweden, 11-16 August 1996.

FONTANELLA, J. J., Professor, "High Pressure Electrical Conductivity Studies of Acid Doped Polybenzimidazole," Fifth International Symposium on Polymer Electrolytes, Uppsala, Sweden, 11-16 August 1996.

FONTANELLA, J. J., Professor, "Electrical Transport in Fuel Cell and Battery Components," ONR Electrochemistry Review, Atlanta, GA, 3-4 April 1997.

KATZ-STONE, D.M., Assistant Professor, "The Evolution of the Relativistic Particles and the Structure of the Magnetic Field in Extragalactic Radio Sources," American Astronomical Society 188th Conference, Madison, WI, 9-13 June 1996.

KATZ-STONE, D.M., Assistant Professor, "Spectral Tomography Reveals the Hidden Structures of Radio Sources," Hubble Space Telescope Science Institute, Baltimore, MD, 26 September 1996.

KATZ-STONE, D.M., Assistant Professor, "A Spectral Analysis of 3C67 and 3C190," IAU 164th Conference, Socorro, NM, 21-26 April 1997.

KORMAN, Murray S., Professor, "Musical Acoustics Demonstrations Play A Role In Teaching Underwater Acoustics And Sonar," 133th meeting of the Acoust. Soc. of Am., State College, PA, 15 - 20 June 1997.

KORMAN, Murray S., Professor, "Computer Analysis Of The Resonant Scattering Of Sound By A Bubbly Fluid Encapsulated By A Submerged Spherical Shell," 133th meeting of the Acoust. Soc. of Am., State College, PA, 15 - 20 June 1997.

KORMAN, Murray S., Professor, "Design and Development of PC-IMAT: Teaching Strategies For Acoustical Oceanography," 133th meeting of the Acoust. Soc. of Am.,State College, PA, 15 - 20 June, 1997.

KORMAN, Murray S., Professor, "Underwater Sound Radiation from a Spherical Bubble Cloud Encapsulated by a Thin Spherical Shell," 133th meeting of the Acoust. Soc. of Am., State College, PA, 15 - 20 June 1997.

NOVO-GRADAC, A.M., Assistant Professor, "An Introduction to Lasers," Girls and Women in Science Conference, Beloit College, Beloit, WI, 4 April 1997.

SCHNEIDER, C. S., Professor, "The Physics of Magnetic Signatures," Mine Warfare Symposium, Monterey CA, 18 November 1996.

STALLWORTH, P. E., Assistant Professor, "X-ray Absorption and Magnetic Resonance Spectroscopic Studies of $Li_xV_6O_3$," Gordon Research Conference on Solid State Ionics, New London, NH, 16-21 June 1996.

STALLWORTH, P. E., Assistant Professor, "NMR and Electrical Conductivity Studies of Methanol/Water Mixtures in NAFION Membranes," DARPA Fuel Cell Review, Arlington, VA, 14-15 November 1996.

STALLWORTH, P. E., Assistant Professor, "X-ray Absorption and Magnetic Resonance Spectroscopic Studies of $Li_xV_6O_3$," Meeting of the American Physical Society, Kansas City, MO, 17-21 March 1997.

STALLWORTH, P. E., Assistant Professor, "NMR Studies of Cathode Materials and Ion-Conducting Membranes," ONR Electrochemistry Program Review, Atlanta, GA, 3-4 April 1997.

TANKERSLEY, L. L., "Real-Time Optical Debris Monitoring," 51st Meeting of the Society for Machinery Failure Prevention Technology (MFPT), Virginia Beach,VA, 14-18 April 1997.

VANHOY, J. R., Associate Professor, "Nuclear Structure Trends in the Tellurium Isotopes," Conference Program and Abstract Book, p 363, Eleventh National Conference on Undergraduate Research NCUR-97, Austin, TX, 24-26 April 1997.

VANHOY, J. R., Associate Professor, "^{124}Te Spectroscopic Studies Using (n,n'γγ) Coincidence Techniques," April Meeting of the American Physical Society, Washington, DC, 18-21 April 1997

VANHOY, J. R., Associate Professor, "Decay Properties and Lifetimes of States in ^{124}Te from (n,n'γ) Reaction Studies," Texas Section Meeting of the American Physical Society, Houston, TX, 13-15 March 97.

WINTERSGILL, M. C., Professor, "Complex Impedance Measurements on NAFION," Fifth International Symposium on Polymer Electrolytes, Uppsala, Sweden, 11-16 August 1996.

WINTERSGILL, M. C., Professor, "Electrical Conductivity and NMR Studies of Methanol/Water Mixtures in NAFION Membranes," Fifth International Symposium on Polymer Electrolytes, Uppsala, Sweden, 11-16 August 1996.

WINTERSGILL, M. C., Professor, "High Pressure Electrical Conductivity Studies of Acid Doped Polybenzimidazole," Fifth International Symposium on Polymer Electrolytes, Uppsala, Sweden, 11-16 August 1996.

DIVISION OF PROFESSIONAL DEVELOPMENT

Capt. William R. Mason, USN
Director

DEPARTMENT OF LEADERSHIP, ETHICS AND LAW

Captain (sel) Patrick M. Walsh, USN
Chair

The 1996-1997 academic year was a period in which the Department of Leadership, Ethics and Law was engulfed in scholarly advancements and pursuits in realms which contributed to the efforts not only of the Brigade of Midshipmen, but also the entire military profession. In addition to presenting psychology, leadership and ethics papers, members of the faculty undertook sponsored research projects in a variety of topic areas. A curriculum development relationship was established with NETC-Newport and Pensacola as Karel Montor's research on combat leadership continued. This research promises to provide fascinating information for both midshipmen and warfare-specialized officers alike. Psychology papers addressing learning styles and leadership as well as eating disorders at the Naval Academy were presented by CAPT (sel) Elizabeth Holmes, while LCDR Rocky Lall published articles on personality, self-esteem, and psychological distress. New to the Psychology Section this year is LCDR Leigh Lucart. Joining David Johnson, Paul Roush, and George Lucas in the Ethics Section are Aine Donovan, Shannon French, and the Distinguished Ethics Chair, Nancy Sherman. Members of this section designed the methods of instruction for the study of ethics at the Academy and explored the role of ethics in the military and other disciplines. Legal and historical contributions were made by the department that provided a theoretical overview and pragmatic application of military law. Finally, the department was very proud to announce the singular achievements of two of our faculty: Dr. Paul Roush was recognized for his promotion to the rank of a full professor and Dr. George Lucas was recognized for his promotion to the rank of an associate professor. Also, Admiral Leon A. Edney, USN (Ret) was named as the Distinguished Professor of Leadership Studies. The independent research, published works, and presentations of the faculty members in the department reflect their high level of commitment to a scholarly and viable method of instruction for future naval officers. These areas of research have provided a significant contribution to the study and understanding of relevant leadership, ethical, psychological, and legal issues that are in existence in the fleet today.

Sponsored Research

Naval Air, Surface, and Submarine Combat Leadership

Researcher: Professor Karel Montor
Sponsor: Chief of Naval Education and Training

CNET has taken on the sponsorship of this continuing research dealing with combat and high tempo leadership case development, along with tasking to assist the Newport Command Leadership School. A significant curriculum development relationship was established with NETC-Newport & Pensacola.

Update to "Naval Leadership: Voices of Experience"

Researcher: Professor Karel Montor
Sponsor: Commandant of Midshipmen and Academic Dean

To ensure the "Voices" text reflects current military thinking, this 1987 leadership text was reviewed by 225 active duty officers of the Naval Service along with 59 midshipmen currently at the Naval Academy. In addition to topical refinements significant inputs were made by the Chief of Naval Operations, the Commandant of the Marine Corp, and Admiral Frank Kelso, USN, the former CNO, along with a foreword by the Secretary of the Navy. The revised text has gone to the printers and will be available in the summer of 1998.

Long Term Evaluation of the Class of 1980 Profile Data

Researcher: Professor Karel Montor
Sponsors: USNA Matching Grant Program and Government Agency

This was the third and final year of a data analysis effort associated with the evaluation of 192 factors collected on the Class of 1980. A final report was issued, whose results are extensive and available from the researcher along with a summary thereof on pages 46-47 of the Naval Postgraduate School Thesis by LT Matthew G. Reardon, USN, dated June 1997 entitled: "The Development of Career Naval Officers from the USNA: A Statistical Analysis of the Effects of Selectivity and Human Capital."

Independent Research

The Ethical Issues Raised by Poverty

Researcher: Professor David E. Johnson

This project is new, begun in the spring of 1997. There are many conceptual issues involved with poverty, including shifting from the focus on individuals and groups using the concept "the poor" to some abstraction known as "poverty." The history of these concepts as traced by scholars like Gertrude Himmelfarb, raises many moral issues and shows a shift in moral issues over time. Are the poor to blame for their own poverty because of bad habits and assorted vices (like drunkenness, laziness, etc.)? Are the poor victims of social and economic conditions beyond their control which keep them in the condition called poverty (for instance the need of a capitalist economy to maintain some level of unemployment)? What is the role of the military in industrialized countries in enforcing poverty on citizens of third-world countries for the sake of inexpensive raw materials? Does the presence of poverty show a social, political and economic breakdown around the central value of equity and fair distribution of global resources and the rights of all people to have the wherewithal to meet basic needs? The methodology of this project will focus on reading and writing. The researcher hopes to produce one or more articles in refereed journals.

Applications of Psychological Preferences in the Military

Researcher: Professor Paul E. Roush

This is a continuation of a research project begun in July 1987. 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 fifteen 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, counseling feedback, transformational and transactional leadership, voluntary attrition, time management, preference stability over time, and accuracy of self-assessment. It has resulted to date in nine presentations; two at international leadership research conferences, three at regional conferences and one at an international conference of the Association for Psychological Type, one at the Institutional Research Conference of the service academies, one at the bi-annual leadership conference of the Center for Creative Leadership, and one at a leadership conference at the United States Coast Guard Academy. Thus far, the project has resulted in the publication of articles in the Journal of Psychological Type, Military Psychology, Personnel Psychology, a chapter in an edited book, The Impact of Leadership, and a chapter in a second edited book, Leadership and the Myers-Briggs Type Indicator: Theory, Research, and Practice. To date, presentations have been made locally to the faculties of three departments, English, Language Studies, and History in order to acquaint those faculty members with the use of the MBTI to account for differing learning styles as a function of type differences.

Midshipmen Values Assessment

Researcher: Professor Paul E. Roush

This research project involves having midshipmen respond on a survey about the values they hold. The survey began with the class of 1995. The survey is administered upon entry during the first week of plebe summer, upon completion of plebe summer, at the end of plebe year, and at the conclusion of each subsequent academic year. At the conclusion of Academic Year 1996-1997 the class of 1997 had taken the survey six times, the class of 1998 five times, the class of 1999 four times, and the class of 2000 three times. The values survey was developed by the Institutional Research Office at West Point and has been in use there for nearly two decades. The results of the survey administrations will enable us to assess the effectiveness of values inculcation during plebe summer and all of plebe year. In addition, we should be able to track the maturation of values as midshipmen progress through the four-year curriculum. Another potentially rich area for related research is correlational studies in which values are linked with a series of other variables. Finally, survey results are being compared with those at West Point to ascertain if changes follow the same pattern (are comparable in magnitude and direction) at both institutions.

Publications

DONOVAN, Aine, Associate Professor "Moral Reasoning for Military Officers," Heritage Press, New York, 1997.

FRENCH, Shannon E., "Can We Motivate Students to Apply Applied Ethics?" in The Pedagogy of Becoming: Perspective on Moral Education, Jon Mills and George David Miller, eds., Value Inquiry Series (The Journal of Value Inquiry), Rodopi: Amsterdam, forthcoming.

JOHNSON, David E., "Can the Military Afford to be

Ethical?" in Joram Graf Haber, ed., *Ethics for Today and Tomorrow*. Jones and Bartlett Publishers, Boston, 1997.

This essay raises provocative questions about military ethics. It begins by noting that while the military is a profession, the issues that concern it differ from other professions inasmuch as its task is the unique one of fighting and being prepared to die for a way of life. This understood, the essay move to an examination of some questions of military ethics against the backdrop of the *Republic* where Plato suggests that every nation must sooner or later engage in warfare to either keep what is has or procure what it wants. This suggests the questions, "When is it permissible to wage a war?" and "What may a nation do within a war?" After discussing these questions within the context of the just-war tradition, the essay deals with questions including whether technology has rendered the just-war tradition obsolete, whether the nation the military serves is itself ethical, whether some practices in the military, such as not allowing homosexuals to serve, are ethical, and whether warfare is the necessity that Plato and we believe it to be.

LALL, R., LT, USN, "Salient Personality Characteristics Among Navy Divers," *Military Medicine*, 1996.

LALL, R., LT, USN, "Contraceptive Knowledge, Contraceptive Use and Self-esteem Among Navy Personnel," *Military Medicine*, 1997.

LALL, R., LT, USN, "Contemporary Norms for the Coopersmith Self-Esteem Inventory - Adult Form," *Perceptual and Motor Skills*, 1997, 1136-1138.

LALL, R., LT, USN, "Personality Traits of Successful Navy Submarine Personnel," *Military Medicine*, 1996, 161.

LALL, R., LT, USN, "Personality Style of Nurses," *Psychological Reports, 78*,1996, 938.

LALL, R., LT, USN, "Effects of Locus of Control, Occupational Stress, and Psychological Distress on Job Satisfaction Among Nurses," *Psychological Reports, 78*, 1996, 1-3.

LUCAS, George R. Jr., Associate Professor, "Philosophy, Its History, and Hermeneutics," *The Philosophy of Hans-Georg Gadamer*,ed. Lewis E. Hahn, "The Library of Living Philosophers, Vol. 29" (Chicago: Open Court Publishers, 1997), pp. 173-189.

LUCAS, George R. Jr., Associate Professor, "Philosophy's Recovery of its History," *The Recovery of Philosophy in America*, State University of New York Press, Albany, NY, 1997, 11-37.

LUCAS, George R. Jr., Associate Professor, and JOHNSON, D.E., "Designing Instruction in Professional Ethics at USNA," *Teaching and Learning for the Next Century: Proceedings of the West Point Conference*, USMA Press, 1997, 63-72.

LUCAS, George R. Jr., Associate Professor, co-authored with Jonathan Larkin and Jennifer Esposito, "Sexual Harassment at Mitsubishi Motors," *Case Studies in Business, Ethics, and Society*, 4th edition, ed. Tom L. Beauchamp, Englewood Cliff, N.J., Prentice-Hall, 1997.

MONTOR, Karel, Professor, "Fundamentals of Naval Leadership I," Kendall/Hunt Publishing Company, 1996.

A "readings" text used in the NL102 leadership course. During academic year 1996-1997 it was used as a basic "readings" text by the NROTC.

MONTOR, Karel, Professor, "Ethics for the Junior Officer," Naval Institute Press, 1996.

A case book dealing with multi-service ethical issues that was also adopted for use by the NROTC in academic year 1996-1997.

ROUSH, Paul E., Professor, JOHNSON, D.E., Professor, and LUCAS, G.R. Jr., "Readings in Philosophy and Ethics for Naval Leaders," American Heritage Custom Publishing Group, New York, 1996.

This book of readings was used as the primary text in the core course in ethics (NE203: Ethics and Moral Reasoning for Naval Officers) taken by all 3/C midshipmen in academic year 1996-1997. This volume for the NE203 Ethics course has so far been published in two editions, one in fall, 1995, the other in spring, 1996. The focus is a collection of essays by classical and contemporary philosophers and dramatists which deliberate an assortments of views in theoretical and applied ethics. In addition to these articles there are case studies in military ethics.

ROUSH, Paul E., Professor, "A Tangled Webb the Navy Can't Afford," Proceedings, United States Naval

Institute, Annapolis, Maryland, (Article accepted for publication May 1997).

Former Navy Secretary James Webb on several occasions has written disparagingly concerning the role of women in the Navy. The article is a response to those writings by Mr. Webb. It attempts to refute his major theses and to demonstrate the positive aspects of women in the Navy.

Presentations

HOLMES, E.K., PhD., CDR, USN, "Learning Styles and Leadership," Surgeon General's Conference, Alexandria, VA, 26 Aug 1996.

HOLMES, E.K., PhD., CDR, USN, "Eating Disorders Program at USNA," Pennsylvania State University, 13 Jun 1997.

JOHNSON, David E., Professor, and George R. LUCAS, Jr., "Designing Ethics Instruction at the Naval Academy" *Teaching and Learning in the Next Century*, sponsored by the Center for Teaching Excellence, U.S. Military Academy (West Point), 28 Sep 1996.

JOHNSON, David E., Professor, "How do Philosophical Views Bear on Changes in the Real World? The Relation of Traditions to Judgement," at The Association for Core Texts and Courses, Temple University, Philadelphia, PA, 12 Apr 1997.

JOHNSON, David E., Professor, "The Moral Obligations of Corporate Executives" at the 25th Conference on Value Inquiry, "Values in Business," Appalachian State University, Boone, NC.

LUCAS, George R. Jr., Associate Professor, "Morality and Self-Interest: the Role of Applied Ethics in College Life," Convocation Address at Bloomsburg University, Bloomsburg, PA, 26 Aug 1996.

LUCAS, George R. Jr., Associate Professor, "Nicholas Rescher on Process Metaphysics," presentation for the Society for the Study of Process Philosophies, American Philosophical Association Pacific Division Meeting, 28 Mar 1997.

LUCAS, George R. Jr., Associate Professor, "Philosophy and its History," at the Powell-Linfield College Distinguished Philosophy Lecture series, Linfield College, McManville, Oregon, 5-6 May 1997.

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