SUMMARY OF
RESEARCH

ACADEMIC DEPARTMENTS

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UNITED STATES NAVAL ACADEMY

ANNAPOLIS, MARYLAND

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SUMMARY

OF

RESEARCH

1997-1998

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Foreword

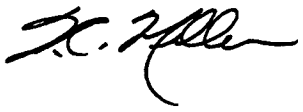
This Summary of Research presents a listing and description of the research activity and productivity of the faculty, civilian and military, and midshipmen at the United States Naval Academy for the 1997 - 1998 academic year. A total of 3.0 million dollars was devoted to research. The funding categories break down into approximately 79% Navy, 8% 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 midshipman research. Among non-DoD federal sponsors, the National Science Foundation and the Department of Energy have been the main sources of funding.

Midshipman activities in research at the Naval Academy continued with students participating in independent research courses and honors projects. Seven members of the Class of 1998 completed the Trident Scholar Program during this academic year. Their research achievements included development of a methodology for optimization of the DT648 whole body dosimetry system, control of running trim and its effects on the calm water performance of modern planing craft, development of methods in capillary electrophoresis for the detection of several toxins in the human body, development of a physics knowledge base for the ANDES Project, construction and characterization of an optical fiber grating tunable light source centered at 683 nanometers, and noise reduction in submarine propulsion systems through the use of magnetic bearings. Some of the projects involved interdisciplinary efforts between two departments. Midshipman Robert C. Carnell, whose Trident project was supervised by Professor Martin E. Nelson of the Naval Architecture, Marine and Ocean Engineering Department, was awarded the Harry E. Ward Trident Scholar Prize for his outstanding work on the project titled "Developing a Methodology for Optimization of the DT648 Whole Body Dosimetry System."

Professor Craig L. Symonds of the History Department was the recipient of the Research Excellence Award in 1998. Professor Symonds is a nationally known expert on the Civil War whose numerous publications have enjoyed both popular and critical success, several examples of which can be found in this year's Summary of Research.

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 as well as experience problem solving, an important ingredient of our teaching mission.



W. C. MILLER
Academic Dean and Provost



REZA MALEK-MADANI
Director of Research and Scholarship

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Division of
Engineering and Weapons

CAPT William R. Rubel, USN
Director

DEPARTMENT OF

Aerospace Engineering

CDR Kenneth M. Wallace, JR., USN
Chair

With sustained growth of aerospace related activities this past year such as spacecraft technology and new aircraft development, it is critical for engineering institutions to stay current in their respective fields. Faculty within the Aerospace Engineering Department continued to stay abreast of aerospace technologies by conducting research and other scholarly activity in many areas related to current issues within the Department of Defense and the National Aeronautics and Space Administration. Faculty also continued to upgrade laboratories and build the infrastructure to support future research in areas such as fluid dynamics, engineering flight test and composites. This involvement keeps the curriculum current, laboratories sustained to "state of the art" and faculty engaged on emerging technologies.

In the following descriptions, you will find a broad range of research topics including aerogels, astrodynamics, composites, measurement errors and vibrations. Also in this time period, unique undergraduate assets such as the Satellite Ground Station were utilized to track pulsars and a student built spacecraft.

Support for research was provided primarily by National Aeronautics and Space Administration, Naval Space Command, Naval Research Laboratory, Office of Naval Research, and the United States Air Force Academy. Portions of summer research were provided by the Naval Academy with matching funds.

Sponsored Research

Using Pulsars for Orbital Velocity and Position Determination

Researcher: Professor William J. Bagaria & Assoc. Professor Sonia Garcia (Mathematics Dept.)
Sponsor: Naval Space Command
Naval Research Laboratory

Pulsars that are in the Milky Way Galaxy can be used for orbital velocity and position determination. However, the pulsar signal is about 100 orders of magnitude lower than the background noise. Vibration techniques, such as cross-correlation, are being used to detect the pulsar signal, and the Doppler shift in near real time. Once the signals from three or more pulsars are measured, the velocity and position of an object, like the earth, can be determined.

Space Mission Analysis and Design Space Technology Series

Researcher: Associate Professor Daryl G. Boden
Sponsor: United States Air Force Academy

The investigator co-authored and co-edited two books written as part of the Space Technology Series. One chapter of the new book "Human Space Mission Analysis and Design" is scheduled for publication in late 1998. The investigator also co-edited the 3rd edition of "Space Mission Analysis and Design" scheduled for publication in 1999.

Independent Research

Vehicle Center of Gravity Height Measurement Errors

Researcher: Professor William J. Bagaria

The equations to determine the height of the center of gravity (e.g.) of a sprung vehicle, considering all of the vehicle compliances, were formulated. They were then compared to the classic rigid vehicle equations. It was determined that the error on the c.g. height could not be obtained using this comparison.

The errors due to instrumentation accuracies were investigated. The results incidate that the error of the c.g. height could be as high as 20-50%. Based on the sprung vehicle equations, methods are given whereby the error on the c.g. height can be significantly reduced to 2-3%.

Vibration Technique for Locating Delamination in a Composite

Researcher: Professor William J. Bagaria
Associate Professor Colin P. Ratcliffe

This paper presents an experimental nondestructive vibration-based technique for locating a delamination in a composite beam. The method operates on the fundamental displacement eigenvector, which is converted to a curvature mode shape. The application of a unique, gapped smoothing damage detection method to the curvature yields a damage index that locates the delamination, irrespective of its position along the beam or depth within the beam. The procedure can operate solely on data obtained from the damaged structure. Models or data from the undamaged structure are specifically not required or used during the analysis. The procedure reported here is highly satisfactory for experimental data, where small variations in the measurement cause false features in other published curvature-based damage detection methods. The damage location method is demonstrated with a finite element model of a composite beam, where a delamination is modeled by relaxing connectivity between elements at the desired location of the delamination. The paper also presents the results of an experimental investigation of a composite beam with a manufactured delamination. When the gapped smoothing method was used on the experimental modal data, the delamination was successfully located.

Stress Analysis of Hollow Helical Springs Including Curvature and Pitch

Researcher: Professor William J. Bagaria

Helical Springs of low pitch angle, fabricated from solid bar, have been extensively analyzed. Significant weight reduction can be achieved by fabrication them from hollow bar. This necessitates the reformulation of the entire theory. Test data is being collected to verify the theory. In addition, design charts are being created to aid the designer in quickly determining the necessary parameters of the spring.

Wing Gust Load Alleviation Using Fuzzy Logic to Control Active Ailerons

Researcher: Professor William J. Bagaria
Professor Gabriel N. Karpouzian

Currently, the structural design of a wing must account for the shear and bending loads due to both maneuvering and gusts. Active ailerons can be used to alleviate the gust loads by the appropriate defections of the ailerons when a gust is sensed. This allows the design of a lighter wing. Using fuzzy logic to control the ailerons allows the gust loads to be alleviated without having to use a classical feedback control system. This results in a faster response, with little or no overshoot.

Analysis and Practical Applications of the Newly Discovered Mikkola-Innanen Orbits

Researcher: Professor William J. Bagaria
Associate Professor Daryl G. Boden

Using numerical methods, Mikkola and Innanen were studying the long term stability of the Solar System. In doing so, they discovered new stable solar orbits which are also gravitationally bound with each planet. A satellite in their type of solar orbit has a motion relative to the planet such that the satellite also orbits the planet. This work is determining the analytical equations that govern the M-I orbits so that they may be used for practical engineering and scientific purposes.

Redesign of a Noise-Free Oscillatory Mechanism for the Control Surfaces of an F/A-18 Wing Model

Researcher: Midshipman 1/C Brian DeJarnett, USN and Midshipman 1/C J. Smotherman, USN
Faculty Advisor: Professor Gabriel N. Karpouzian

The project concerns the determination of oscillation mechanism on high angle of attack and stalled flight.

Another concern is to determine the configuration that works in a most efficient way. Redesign of the existing mechanism was achieved to reduce the induced noise by the various oscillatory modes. The process requires to implement the suggested design by fine tuning the elements of the mechanism. It is believed that the new design will alleviate the unwanted vibrations and pave the way for accurate measurements of the aerodynamic loads on the F/A-18 wing model.

Flow Simulation of a Co-Flowing Laminar Diffusion Flame

Researcher: LCDR David D. Myre, USN
Faculty Advisor: Professor Catherine Mavriplis, George Washington University

A computational study of an ethylene-air co-flowing laminar diffusion flame will be compared with results in literature including experimental studies and other numerical calculations. The computational method solves the incompressible Navier-Stokes equations with variable properties and a Boussinesq buoyancy term. This solution is coupled to the convection-diffusion of a conserved scalar representing mixture fraction. The mixture fraction field is used to determine temperature directly without solving the energy equation. The chemistry is assumed to be a fast single-step reaction. The temperature mapping is derived from a curve fit of experimental temperature data that were correlated to predicted mixture fraction values. The mixture fraction solution is enhanced by variable diffusivity and viscosity derived from curve fits for mixture quantities as a function of mixture fraction and temperature while assuming that the Lewis number is one. The numerical calculation uses the spectral-element method. The spectral-element method combines the best attributes of the finite element method and spectral methods for the solution of complex incompressible flows. The method takes advantage of the high accuracy possible using spectral methods and the generality and geometric flexibility of the finite element method. The velocity, temperature and mixture fraction fields will be presented for several co-flowing axisymmetric cases which will then be compared to experimental and other numerical results.

Contour Smoothing of Mixture Fraction Data Using Luminescence Images

Researcher: LCDR David D. Myre, USN
Faculty Advisor: Professor J. Houston, George Washington University

Previously, workers at the National Institute of Standards and Technology (NIST) and George Washington University (GWU) have measured laser-induced luminescence from soot particles, and quantitative concentrations for carbon dioxide, carbon monoxide, and methane using tunable diode laser absorption spectroscopy (TDLAS). The latter measurement can be used to calculate mixture fraction. To improve the quality of this calculation, we are applying a contour smoothing technique recently used by groups at the University of Sydney and Yale University. A charge coupled device (CCD) camera has been used to image luminescence from a time-varying flame at various phase values. The luminescence data obtained with the CCD will be used to smooth the mixture fraction data. In both experiments, a co-flowing methane-air laminar diffusion flame was modulated at a 10 Hz rate and data were taken by synchronizing the data acquisition to the correct phase angle. Measurements were taken in 10% phase increments. The CCD camera provides a high shutter speed and triggered acquisition capability

allowing the synchronization required above. The 1024 x 1024 detector can collect luminescence values with 18-bit accuracy. Images at the same phase value are coadded to increase signal-to-noise rate (SNR). The image data is converted to laboratory coordinates and tomographically inverted using a three point Abel transformation. Contour smoothing makes use of two images that are highly spatially correlated. The image with the high SNR is used to smooth the image with the lower SNR. The luminescence images are used to direct the way in which the mixture fraction data is smoothed because the luminescence contours and mixture fraction contours are similar. A spatial sub-domain in the luminescence data. In this way, the luminescence contours are used to align the contours in the mixture fraction data. Once this is completed for the entire data set, smooth mixture fraction profiles are used to calculate the scalar dissipation rate for the time varying methane-air flame.

Research Course Projects

Mechanical Properties of Silica Aerogels

Researchers: 2nd Lieutenant Bryan Forney and Midshipman 1/C Kelley A. George
Faculty Advisors: Associate Professor Michael D. A. Mackney and
LCDR David D. Myre, USN
Sponsor: The Advanced Research Projects Agency

The Advanced Research Projects Agency (ARPA) project referred to as the Integrated Biosensor Program (IBP) has the mission of developing a micro-unmanned aerial vehicle (M-UAV) carrying a biosensor for the detection and identification of biological weapons. The material selected as the filter medium for the biosensor are silica aerogels. Aerogel is an innovative low-density porous material which is capable of filtering microbes out of the air. It also has a very high strength to weight ratio, which gives the material potential applications for structural components of the M-UAV. In order to facilitate the development of aerogel structural components, the Aerospace Engineering Department of the United States Naval Academy was assigned the task of determining the mechanical properties of silica aerogels. The extremely low weight, density, tensile and shear strength make working with silica aerogels very challenging. These properties also restrict the use of traditional engineering testing methods for determining mechanical properties. An extensive literature survey was conducted by Lt Forney which resulted in increased understanding of conventional destructive testing as well as alternative testing methods for aerogels. Lt Forney developed a prototype light-weight tensile testing rig to examine basic concepts of cutting, bonding and holding aerogel samples in future full scale tests. This has provided extensive practical knowledge about handling these materials which lead to the development of an appropriate sample geometry. Lt Forney developed a detailed design of a low-cost light-weight tensile, compressive and torsional test apparatus. This will be further developed and tested by Midshipman George using precision motorized traverse and an optical extensomoter. Her effort will involve the integration of the test rig, design of the aerogel holding mechanism and test and analyses of aerogels. This work is intended to validate the test methods and provide useful data on the mechanical properties of aerogels to the IBP.

Design and Construction of a T-34 Wing Wind Tunnel Model

Researcher: Midshipman 1/C Dana S. Fitzpatrick
Faculty Advisor: Professor David F. Rogers

Continued development of the computer data base for computer aided manufacturing of a lift distribution wing wind tunnel model. The model is to be machined in six (6) stages on an UC milling machine. The finished model will contain more than 150 pressure taps. The resulting experiment will be capable of both pressure and force measurements.

Publications

KARPOUZIAN, Gabriel, Professor, "Fuzzy Control of Aeroelastic Wing Section," American Institute of Aeronautics and Astronautics, April 1998, 98-1797.

A simple non-adaptive fuzzy controller is devised to stabilize an aeroelastic wing section in bending and torsion. The controller consists of an applied torque that counteracts the pitching and bending instabilities. An intuitive rule base for the input to the aeroelastic system, the displacement modes, and the required action by the controller, the applied torque, is used to simulate the stabilization process of the wing section in an otherwise unstable mode. The wing response to the controller approaches rapidly the static stable mode before the onset of instability for the case of a wing section in pitching oscillation.

ROGERS, David F., Professor, Procedural Elements for Computer Graphics, Second Edition. New York: McGraw-Hill, 1998.

The first edition has been translated into at least four languages. It is a standard reference work and text in computer graphics.

ROGERS, David F., Professor, "Weight Effects, Part 2.," Newsletter of the World Beechcraft Society, July/August 1997.

ROGERS, David F., Professor, "Turbulent Penetration Speed," Newsletter of the World Beechcraft Society, November/December 1997.

Presentations

BAGARIA, William J., Professor, "Vehicle Center of Gravity Height Measurement Errors", Society of Automotive Engineers, International Congress and Exposition, Detroit, MI, February 1998.

KARPOUZIAN, Gabriel N., Professor, "Fuzzy Control of an Aeroelastic Wing Section," Structures, StructuralDynamics and Materials Conference, Long Beach, California, 20-22 April 1998.

ROGERS, David F., Professor, "High Altitude Effects on Flight Performance," North East Bonanza Society, Ashland, North Carolina, November 1997.

ROGERS, David F., Professor, "Flight Testing with an A-36," Regional American Bonanza Society, April 1998.

ROGERS, David F., Professor, "Turnback After Engine Failure," Southeastern Bonanza Society, Ashland, North Carolina, July 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; multi-instrument sensor fusion for an automated hull maintenance vehicle; exploratory research for development of a drydock painting robot; computer simulation of shipboard generator and power circuit breakers systems; 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. 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

Implementation and Verification of a Buck-Boost / Inverter Simulation

RESEARCHER: Professor Richard L. Martin
SPONSOR: Naval Surface Warfare Center (NSWC), Carderock

Background: Computer simulations of mathematical models for solid state buck-boost and inverter models were previously developed for NSWC by outside contractors. Certain test runs had been performed at NSWC on the hardware which had been simulated.

Objective: The objective of this project was to implement the models on the NSWC computer system, exercise those models with inputs similar to the actual test runs, and compare the simulation results with those from the actual test runs.

Methodology and Results: The system which was simulated consisted of a bi-directional buck-boost converter linked to a high frequency PWM inverter. The system may be run in either ACgenerate (ACmaster) or DCgenerate (ACmaster) mode. In DCgenerate mode, the system is energized from a three phase AC line which directly feeds AC loads as well as DC loads on the output of the buck-boost converter which is fed from the inverter. In ACgenerate mode, the system is energized from a DC source which directly feeds DC loads as well as DC loads on the output of the inverter which is fed through the buck-boost converter. When a step load is added to the DC bus in DCgenerate mode or to the AC bus in the ACgenerate mode, the inverter's modulation adjusts itself to maintain the link bus voltage at a constant value after a transient period.

Contractor's preliminary and final reports were obtained with their simulation listings and results. Also obtained were PC based software simulations which were then converted into the UNIX base used by

NSWC. Changes in the simulation software, which had not been clearly documented, and which resulted in discrepancies between the software and the documentation, were found and have been documented. Several computer simulation runs have been performed.

Wavelength-division Multiplexed Solitons for Fiber Communications

RESEARCHER: Assistant Professor R. Brian Jenkins
SPONSOR: Naval Academy Research Council

The goal of this ongoing project is to analyze the feasibility of using wavelength-division-multiplexed (WDM) solitons for optical fiber communications. Communication systems using soliton data pulses are unorthodox since the propagation of data is inherently dependent on nonlinear properties of the fiber. Nonlinear interactions between solitons cause frequency/timing shifts which may distort data in ways that are different from typical linear communication systems. The analysis accounts for practical system issues such as loss, amplification, filtering and dispersion management in more traditional WDM systems as well as in bit-parallel systems, where data is encoded with a single bit-per-wavelength (BPW). Thus far, analytic estimates of timing jitter in the pulse arrival times at the fiber output have been derived for both types of systems. Jitter in a BPW system is more severe than that which occurs in a traditional WDM system for shorter fiber links (roughly less than several thousand kilometers), while estimates of jitter are comparable over longer transoceanic distances. This is significant since a BPW system would be more common in shorter intra-continental data links. In addition, while four-wave mixing has a significant impact in wave length multiplexed communication systems, its effect on soliton communications is still being investigated.

Advanced Packaging Applications

RESEARCHER: Assistant Professor Deborah Mechtel
SPONSOR: The Johns Hopkins University Applied Physic Laboratory

A new technique to test circuit structures in MCMs has been demonstrated recently for the first time. This technique employs a noninvasive, laser-based instrument to probe MCM structures fabricated with poled polyimide interlayer dielectrics and thin film metallizations on silicon carriers. The electro-optic interaction between the poled dielectric and the laser beam allows the strength of the internal fields within the MCM to be determined as a function of position. Electric field measurements and mappings can be useful in diagnosing module performance, locating sites of circuit shorts and opens, and determining the efficacy of field containment structures. In this work, electric field detection results for several surface and buried circuit elements characteristic of MCM-D structure were obtained. In addition, basic electrical, mechanical, and optical properties of these electro-optic dielectric layers were studied along with details of the associated poling and processing operations.

The laser-based instrument responds to a change in index of refraction of MCM dielectric layers caused by a corresponding change in the poled material's electro-optic coefficients produced by the electrical signals in the MCM circuit. These changes are dependent on the strength and spatial extent of the internal field associated with the signal. Our work begins with the recognition that certain organic polymers, when doped with nonlinear moieties and poled, exhibit the electro-optic effect. Doped organic polymers are poled by insertion into a strong electric field as the polymer is heated to near its glass transition temperature .Typical polymers that exhibit the electro-optic effect after poling include conditioned photosensitive polymers such as PMMA poly(methyl methacrylate). While these polymers are common in the processing of semiconductor wafers, they are typically not part of the packaging structure. Similarly, we have observed that certain key packaging polymers such as polyimide and BCB exist in photosensitive forms. Hence, our study has concentrated in its initial phases on whether polyimide, when appropriately doped, can be made electro-optic upon poling and, if it

could, how might the poling be done in normal MCM-D-type construction.

To date, we have demonstrated noninvasive laser probing of the electric fields in a series of test circuits built on doped and poled polyimide dielectric layers. In our work, we have paid particular attention to not only demonstrating the potential for this new and novel measurement technique, but also to the requirements for MCM-D fabrication. We selectively change the temperature and electric field during the poling process. The effect of chromophore density was also investigated. Studies to determine the materials efficacy as a dielectric layer, including TGA studies, moisture absorption, residual stress, glass transition temperature, and dielectric constant, were conducted. The extension of the chromophore doping to traditional MCM polymers, such as Dupont PI 2610 and Dow Chemical BCB is planned.

Autonomous Path Planning and Scheduling

RESEARCHER: Assistant Professor Kelly A. Korzeniowski
SPONSOR: The Johns Hopkins University Applied Physics Laboratory

The investigator conducted research under an Office of Naval Research contract at The Johns Hopkins University Applied Physics Laboratory to develop a hierarchical system for dynamic path planning and scheduling among a field of moving obstacles. This was accomplished by developing a space / time domain representation and specifying motion control for the agent in that domain. In this space / time domain representation, time requirements can be imposed upon the goal(s) and therefore scheduling can also be accomplished.

This algorithm is directly applicable to many autonomous navigation scenarios, such as movement on a manufacturing floor, navigation of surface/ subsurface ships or coordination of air traffic. In terms of real-time system performance, the algorithm makes path planning tractable.

A Distributed Code Division Multiplexed Fiber Optic Sensor System

RESEARCHER: Professor Antal A. Sarkady
SPONSOR: Naval Surface Warfare Center (NSWC), Annapolis

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 sensor values.

In this year, we built and tested a portable version of the TDR system that can be used in ship-board applications. The code generator was compressed to fit on a full-size PCI board and the time critical part of the software was rewritten in Borland 4.5 C++. The external Tektronix (model TDS 460A) digital oscilloscope was replaced by the Gage Inc. single board CompuScope (model CS8012A/PCI). The CompuScope is a dual channel data acquisition system with 12 bit Analog to digital Converters (ADCs), 1Mbyte of memory and a programmable clock with maximum sampling rate of 100 MHZ. The entire data acquisition and analysis system (TDR) was configured and housed in a portable "Lunch-Box" computer that easily fits through a 21" hatch.

Wireless System Innovation and Design

RESEARCHER: CDR Thad B. Welch III, USN

My research is a continuation of my dissertation research. I am working with Dr. Rodger Ziemer (University of Colorado at Colorado Springs) and Dr. Mike Walker (United States Air Force Academy) on a variety of wireless/cellular design and analysis projects. This includes, but is not limited to, the bit error probability determination for a differentially coherent direct-sequence spread-spectrum multicarrier modulation system operating in a double spread channel and the effects on the spaced-time correlation function of highly directive antenna arrays being designed for use in mobile radio applications. These and other projects are progressing very well. Success and publication of each result is expected.

Research Course Projects

FIRST Robotics Competition

RESEARCHER: Midshipman 1/C Brian Eisenhuth, USN
FACULTY ADVISER: Assistant Professor Kelly A. Korzeniowski and MAJ Edward McCarthy, USMC
SPONSOR: Electrical Engineering Department / USNA

This project is a combined effort of Midshipman Eisenhüth (Electrical Engineering), a group of mechanical engineering students, CDR S. Chism (NAOME) and Prof. S. Miner (Mechanical Engineering). The FIRST organization gives each participating group a list of design criteria and a set of parts with which to build the robot. The purpose of the 1998 competition was to build a robot that can pick up and stack balls in a scoring configuration. This was both a defensive and offensive competition. The robot with the most points won the two minute round.

The USNA team built and tested the robot over a six week period ending in late February. Midshipman Eisenhuth's primary task was integrating the microprocessor that controls the motors. He succeeded in designing a robust system. The robot competed in both the regional and the national competition. In the regional, the USNA team advanced to the finals and received the "Best Rookie Team" and "Lightest Entry" awards.

Robot Object Recognition and Maze Navigation

RESEARCHER: Midshipman 1/C Ryan C. Eul, USN
FACULTY ADVISER: Assistant Professor Kelly A. Korzeniowski
SPONSOR: Electrical Engineering Department

The purpose of this project was to develop and implement the necessary control laws in order to accomplish navigation, data collection and object recognition with the Khepera robot. The following issues were addressed:

1. Coordinate system mapping
2. Surface tracking control law development
3. Data collection for object recognition.

Midshipman Eul successfully developed a surface tracking algorithm and coordinate system mapping technique for the robot. These algorithms made it possible for the robot to navigate the work environment. When an unknown object was encountered, the robot moved around the surface, collecting data points. This data may be used to find distinguishing shape features and thus recognize the object.

Robotic Motion Control Using Neural Networks

RESEARCHER: Midshipman 1/C George S.Major, USN
FACULTY ADVISER: Assistant Professor Kelly A. Korzeniowski
SPONSOR: Electrical Engineering Department

The purpose of this two credit EE495 research project was to investigate the use of neural networks in robotic motion control, specifically applied to the problem of surface tracking. The chosen experimental platform is the Khepera robot. This robot obtains environmental information by actuating proximity sensors around the base. This data can be used to move along a surface, while maintaining a constant distance from the surface. The ability to track a surface is important to automatic control because it is the very basis of navigation and object recognition.

The purpose of this project is to investigate the benefits of integrating a neural network into the real-time control loop. It is found that the neural network shielded the system from some of the effects of noisy sensor data. Since the neural network was trained offline, the advantage was gained without significant computational expense at runtime.

Publications

KORZENIOWSKI, Kelly A. and Mechtal, Deborah, "Teaching Engineering to Non-Electrical Engineering Majors", *American Society for Engineering Education*, CDROM, Seattle, June 1998.

One of the challenges that the Electrical Engineering Department at the United States Naval Academy (USNA) meets every year is teaching Electrical Engineering to all Academy students including Non-Engineering majors. It has long been recognized in the Engineering education community that it is useful to convey some core knowledge of underlying physical system components. For instance, Mechanical Engineers may study electric circuits and Electrical Engineers may study thermodynamics. The idea of a core competency also exists at the USNA where it includes not only non-electrical engineering but also liberal arts majors. As a result, this core introductory electrical engineering course may translate to an overview of electrical engineering for introductory engineering students at non-military institutions or to an accessible, informative engineering course for liberal arts majors.

This paper reports on the implementation of a two semester course for liberal arts majors. In the Electrical Engineering curriculum, the underlying purpose of the core courses is to instruct students, regardless of the major course of study, in the basics of electronic circuits, machinery, communications and instrumentation. The first semester course concentrates on building basic circuit analysis tools including, but not limited to, KVL, KCL, Thevenin's Theorem, AC analysis using phasors, transient analysis, three phase power and transformers. The second semester covers motors and generators, AM/FM communications systems, Diodes, Filters, Oscillators, and Combinational and Sequential logic. This paper discusses how the foundation established in the first semester is employed to cover the broad range of topics presented in the second semester. Students leave the second semester course, with its introduction to a wide variety of electrical engineering topics, with a clearer picture of the electrical engineering curriculum. The depth and breadth of the topics included and their illustration by laboratory exercises is also presented.

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

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.

WOOTEN, Ellen C. and Newcomb, Robert W., "An Artificial Model for Biological Computation and Control for a Locomotion System," *1998 IEEE International Symposium on Circuits and Systems*, Monterey, Ca., (May 31-June 3, 1998).

Each discipline has its own methods of modeling its components and developing the mathematical analysis of the systems which they want to describe. Investigating these systems from different perspectives can provide a means of discovering system operation. Specifically, when approaching the reverse engineering of a biological system, the best description of the elements should include the biological parameters and their known relationships. The modeling should be carefully tied to the biological experimental data and the results of the simulations should provide outputs comparable with actual output data from the original system. Once the model has been thoroughly tested, the mathematical description of the model can be redefined with new variables of interest for the discipline involved. This paper describes the design of a neural network capable of providing simulated output comparable to the intact flight neural control behavior of the locust, using GENESIS (General Neural Simulation System).

SELLAMI, Louiza.and R. W. Newcomb, "An Inverse Hollis-Paulos Artificial Neural Network," *IEEE Transactions on Neural Networks*, Vol 9, No. 5, Sept 1998, pp. 979-986.

The Hollis-Paulos artificial neural network (HPANN) is convenient in terms of its possibility for realization of variable weight artificial neural networks (ANNs) in VLSI by MOS transistor circuits, though it is non-dynamical and not driven by external inputs. Here we introduce dynamics and inputs into the HPANN and show that over the range of operation covered by the Hollis-Paulos theory the system has an inverse. In particular, we derive that inverse, in semi-state form, and give simulation results on its operation, showing how well the input to the original HPANN can be recovered from the output of the HPANN when fed into the inverse system. A comparison is made with the previous inverse Hopfield ANN. Possible applications of these inverse systems are to decoding of transmitted ANN signals and to inverse filtering for the extraction of input signals from processed signals.

SELLAMI, Louiza and R. W. Newcomb, "Computable Real Lattice Structures for Cochlea-Like Digital Filters," *Journal of Circuits, Systems, and Signal Processing,* Vol. 17, No. 1, 1998, pp 103-116

A synthesis algorithm for a pipelined lattice implementation of cochlea-like digital filters is presented, based upon the properties of the real, lossless lattice synthesis of ARMA filters. The algorithm operates on a simplified characterization elementary lattice sections of degree one or two. This leads to a structure that is recursively designed for which each lattice is precisely implemented by a pair of complex conjugate transmission zeros via Richard's function extractions. Except for zeros of transmission on the unit circle, all other types and multiplicities are allowed. Necessary and sufficient conditions are derived for the degree-two lattice to guarantee computability, i.e., realizability with no delay-free loops. In addition to being suitable for VLSI implementation, the structure enables a systematic cochlea characterization from the scattering parameters.

SELLAMI, Louiza, S. K. Singh, R. W. Newcomb, and G. Moon, "Bilateral Linear MOS Resistor for Neural-Type Cells," *Proceedings of the 40th Midwest Symposium on Circuits and Systems,* pp. 1330-1333, Sacramento, CA, August 3-6, 1997.

A previous CMOS bilateral linear resistor is analyzed and shown to be reducible from four to two transistors with improved linearity. This is developed for neural-type circuits to allow its use in emulating both excitatory and inhibitory voltage variable synapses. Simulation results using parameters from MOSIS transistors are presented to verify the theory.

SELLAMI, Louiza S. K. Singh, R. W. Newcomb, A. Rasmussen, and M. E. Zaghloul, "CMOS Bilateral Floating Linear Resistor for Neural-Type Cell Arrays," *Proceedings of the Asilomar Conference on Circuits, Systems, and Computers,* pp. 1136-1140, Pacific Grove, CA, Nov. 3-6, 1997.

A previous CMOS bilateral linear resistor is modified into two different configurations of floating resistors using the structure of a two-transistor CMOS bilateral linear resistor in the first configuration and two two-transistor CMOS bilateral linear resistors and current mirrors int he second configuration. Simulation results are presented to support the theory. These floating resistors can be used for coupling weights in VLSI neural-type cell arrays.

SELLAMI, Louiza, R. W. Newcomb, J. M. Ferrandez, V. Rodellar, P. Gomez, and L. Roa, "Analog VLSI Circuits for learning Rate Adaptation in Self-organizing Neural Networks," *Proceedings of the International Joint Conference on Neural Networks*, pp. 541-546, Anchorage, AL, May 1998.

This paper presents analog VLSI circuits for the learning rate adaptation in self-organizing neural networks using the Mulier-Cherkassky learning rate adapted to the continuous-time case. The circuit design uses the solution of the Riccati equation as a basis for implementing the learning rate schedule.

SELLAMI, Louiza M. E. Zaghloul, and R. W. Newcomb, "VLSI Pulse Coded Modulator Using Neural Type Cells," *Proceedings of the IEEE International Symposium on Circuits and Systems,* Vol 3, pp. 21-24, Monterey, CA, June 1998.

A means of modulating information signals using both additive and multiplicative ways by chaotic signals is considered. The chaotic signals are obtained from neural type cells set to their chaotic oscillation mode. The information containing signals are modulated by these chaotic signals by introducing each as the input to a differential pair.

ABLOWITZ, M. J., G. Biondini, S.S. Chakravarty, R. B. Jenkins,. and J. R. Saur,"Four-wave mixing in wavelength-division-multiplexed soliton systems: ideal fibers," *Journal of the Optical Society of America B, 14*, July 1997, pgs 1788-1794.

Analytic expressions for four-wave-mixing terms in an ideal, lossless wavelength-division-multiplexed soliton system are derived with an asymptotic expansion of the N - soliton solution of the nonlinear Schrödinger equation. Four-wave energy contributions are shown to grow from a vanishing background to a maximum during the collision and then to decay as the solitons separate in physical space. The analysis also accurately describes interesting effects such as frequency shifts and resonant oscillations which occur during soliton interactions. The analysis is accurate to second order with respect to the frequency spacing between soliton wavelength channels. It provides an important framework for describing four-wave mixing in real, nonideal fibers, where the energy grows by an order of magnitude and equilibrate to a stable value as an effect of periodic amplification.

Presentations

KORENIOWSKI, K.A., "Path Planning in a Dynamic Environment", Johns Hopkins Applied Physics Laboratory, Columbia, September 1997.

KORENIOWSKI, K.A. and D. Mechtel, "Teaching Engineering to Non-Electrical Engineering Majors", American Society for Engineering Education, Seattle, June 1998.

KORENIOWSKI, K.A. "Digital Design with Programmable Logic Devices", American Society for Engineering Education, Seattle, June 1998.

WOOTEN, Ellen C., "Design of a Coordinated Controller based on a Neuron Model of Flight Locomotion in a Locust, " Parallel Genesis Conference, Pittsburg, Pa. (June 11-13, 1997).

WOOTEN, Ellen C., "Speech Coding and Phoneme Classification Using MATLAB and NeuralWorks," Frontiers in Education Conference, Pittsburg, Pa., (Nov 5-8, 1997).

WOOTEN, Ellen C., "An Artificial Model for Biological Computation and Control for a Locomotion System," 1998 IEEE International Symposium on Circuits and Systems, Monterey, Ca., (May 31-June 3, 1998).

SELLAMI, Louiza S. K. Singh, R. W. Newcomb, and G. Moon, "Bilateral Linear MOS Resistor for Neural-Type Cells," 40th Midwest Symposium on Circuits and Systems, Sacramento, CA, August 3-6, 1997.

SELLAMI, Louiza R. W. Newcomb, J. M. Ferrandez, V. Rodellar, P. Gomez, and L. Roa, "Analog VLSI Circuits for Learning Rate Adaptation in Self-organizing Neural Networks," International Joint Conference on Neural Networks, Anchorage, AL, May 1998.

SELLAMI, Louiza, M. E. Zaghloul, and R. W.

Newcomb, "VLSI Pulse Coded Modulator Using Neural Type Cells," IEEE Internaon circuits and Systems, Monterey, CA, June 1998.

DEPARTMENT OF

Hydromechanics Laboratory

Professor David L. Kriebel, P.E.
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 smaller 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 which includes five 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 a hands-on laboratory learning experience for Naval Academy Midshipmen. In addition, however, the laboratory facilities are used for both basic and applied research by faculty and by 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)
- Proof of concept testing for the CVX class aircraft carrier (Sponsor: Naval Sea Systems Command)
- Resistance and flow testing for the DD-21 hull form (Sponsor: Naval Sea Systems Command)
- Ocean wave group (Sponsor: Office of Naval Research)
- Measurement of breaking wave loads on a periscope (Sponsor: Naval Underwater Warfare Center - Newport)
- Motions of an Unmanned Underwater Vehicle in wind and waves (Sponsor: Northrop Grumman)
- Evaluation of added mass of a group of moored ships (Sponsor: Naval Facilities Engineering Services Center)
- Porpoising studies for modern planing craft (w/ Trident Scholar Midshipman Tullio Celano)

In addition to supporting Midshipmen 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

Measurements of Breaking Wave Loads on a Moving Submarine Periscope Model

Researcher: John J. Zseleczky, Naval Architect (HydroLab)
Sponsor: Naval Undersea Warfare Center (NUWC) - Newport

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.

Motions of an Unmanned Underwater Vehicle in Wind and Waves

Researcher: John J. Zseleczky, Naval Architect (HydroLab)
Sponsor: Northrop Grumman

The Northrop Grumman Electronic Sensors and Systems is developing an Unmanned Underwater Vehicle (UUV) that will spend part of its time near the water surface. A major concern of the project design team was the range of pitch and roll motions that the vehicle would experience when partially submerged. No data were found to substantiate predictions of motions for the partially submerged condition so Northrop Grumman elected to conduct 1/3rd scale model tests in the 380 foot long towing tank at the U.S. Naval Academy Hydromechanics Laboratory.

Motions of the model were measured using a two-axis integrating rate-sensor, with the vehicle subjected to scaled waves corresponding to sea states one, two and three. A series of different appendages were installed on the model and several variations were made to the ballast conditions. The Laboratory's wind generation capability was also used to study the effect of wind on the vehicle when partially submerged.

The model tests showed some unexpected results regarding the orientation of the vehicle in different wind and wave conditions. These tests were documented with time history records of the motions and wave conditions as well as video taped coverage from above and below the water surface. Over one hundred tests were conducted over a range of conditions, which gave the designers considerably more confidence in their predictions of motions for the full scale vehicle.

USS CONSTITUTION Model Testing Program - Towing in a Seaway

Researchers: James J. Shaughnessy, Naval Architect (HydroLab)
Mrs. Nancy Harris, Naval Architect (HydroLab)
Sponsor: NAVSEA Hydrodynamics Division

The USS CONSTITUTION Model Testing Program was continued with a series of towline tests in the 380 ft Towing Tank. The model was tested in calm water, regular waves, and Sea States 3, 4, 5 and 6 at ship speeds of 3, 6, 9 and 12 knots in head and following seas.

Two phases of tests were conducted. In the first phase, the model was towed by a towing hawser at a constant velocity with the model free to respond in four degrees of freedom and restricted in yaw and sway. In the second phase, the model was attached to the carriage by a conventional heave post and was only free to heave and pitch. Neither method fully simulates the complex system of a tug boat/towed vessel system, but using both methods resulted in an envelope that could be used to determine the worst case.

In both sets of tests, test results included towline force, pitch displacement and acceleration, heave displacement and acceleration, speed and wave height. The motions were measured using two separate data acquisition systems: conventional electronic transducers and a video tracking system by Motion Analysis. This also allowed comparison between the two methods to validate the data acquisition methods.

Characterization of Breaking Waves in Random Seas

Faculty Investigator: Dr. Thomas Dawson, P.E.
Staff Investigator: Ms. Louise Wallendorf, P.E. (HydroLab)
Sponsor: Office of Naval Research

The laboratory has been involved in the study of wave groups and breaking waves for the Office of Naval Research from 1987 to the present. A large set of wave data has been obtained in the 380' wave tank for various types of wave spectra. The data has been analyzed to refine theoretical techniques for extreme wave analysis by comparing the statistics of the very highest waves in both linear and non-linear seas with wave breaking. Efforts are being made to determine the statistical parameters which indicate the occurrence of wave breaking.

USS CONSTITUTION Towing Trials

Researchers: James J. Shaughnessy, Naval Architect (HydroLab)
Stephen W. Enzinger, Naval Architect Technician (HydroLab)
Sponsor: NAVSEA Hydrodynamics Division

After the successful sail event of the USS CONSTITUTION in July 1997, there was a growing interest in the possibility of conducting additional sail events and/or port visits. There was also a growing concern over the condition and safety of the ship. The Naval Academy Hydromechanics Laboratory (NAHL) is one of several test teams currently supporting the effort to establish an operational profile for the CONSTITUTION. On 20 May 1998, the ship was taken out into Massachusetts Bay to conduct towing trials. Representatives from NAHL were present to instrument and acquire data in the following areas:

- Tension in the towline
- Tension in the ropes operating the tiller
- Roll and Pitch

The results of these tests were presented to the Naval Sea Systems Command (NAVSEA) to be collated with the other teams' data such that the condition/capabilities of the ship could be evaluated.

CVX Resistance, Seakeeping, and Flow Characterization Tests

Researchers: James J. Shaughnessy, Naval Architect (HydroLab)
Donald R. Bunker, Naval Architect Technician (HydroLab)
Sponsor: NAVSEA Hydrodynamics Division

The U.S. Navy is currently in the process of developing a new class of aircraft carrier for the 21st century. One of the designs being evaluated is the "Stealth Monohull." This hull form concept incorporates advanced design features that are presently being implemented in other designs for next generation combatants. The Hydromechanics Laboratory conducted a series of tests on a 1/64 scale "proof of concept" model of this CVX carrier design. Resistance and seakeeping tests were completed by the NAHL staff. Working in conjunction with NSWC-CD (David Taylor) personnel, additional tests were performed in the 380 foot Towing Tank to evaluate the hydrodynamic flow characteristics of this hull form.

DD-21 Resistance and Flow Characterization Testing

Researchers: James J. Shaughnessy, Naval Architect (HydroLab)
Stephen W. Enzinger, Naval Architect Technician (HydroLab)
Sponsor: NAVSEA Hydrodynamics Division

The DD-21 hull form model, designed with interchangeable bow sections, was evaluated in the Hydromechanics Laboratory 380 foot Towing Tank. Resistance tests on the 1/26.43 scale model provided a comparison of three different bow sections over the operating speed range for this 21st century combatant. Working with NSWC-CD (David Taylor) personnel, the NAHL test program also included a hull form hydrodynamic flow characterization evaluation.

Added Mass and Damping Characteristics of Multiple Moored Ships

Researcher: Midshipman 1/C Brad Hipp, USN
Midshipman 1/C Sarah Rollings, USN
Professor David L. Kriebel
Sponsor: Naval Facilities Engineering Services Center

The Hydromechanics laboratory performed a series of small-scale laboratory experiments to determine the hydrodynamic forces acting on a group or "nest" of ships moored abreast in a common spread mooring in shallow water. Because the mooring lines act like springs, the entire group of ships may undergo dynamic oscillations. The loads on the mooring lines are then determined by the added mass and damping characteristics of the group or nest of ships. At present, little is known regarding how these parameters change as a function of the number of ships in the moored group or as a function of the ship draft relative to the water depth.

The experimental test program evaluated the added mass and damping in the sway mode of motion for single ships and for groups of two to fie ships, using available models of the Naval Academy Yard Patrol craft. Tests were performed with a four point spread mooring simulated by rubber bands with the appropriate scaled stiffness. Four different water depths were tested, including one case where the ship draft was a 95 percent of the water depth.

Results indicate that the added mass and damping increase in shallow water, with values of about 1.5 to 2 times the ship mass in deep water conditions and increasing to about 4 times the ship mass at the shallowest depths. For multiple ships, the added mass did not increase in proportion to the total ship mass, as for example, the added mass for two ships was less than twice the added mass for one ship.

Independent Research

An Updated Study of Planing Craft Porpoising Using Towing Tank Models

Researchers: Midshipman 1/C Tullio Celano, USN
Professor Roger H. Compton
John J. Zseleczky, Naval Architect (HydroLab)

Porpoising is one of the most common forms of dynamic instability found in planing boats. In descriptive terms, it is a coupled oscillation in pitch and heave that occurs in calm or rough water. The coupled oscillations can be divergent in amplitude, which can lead to loss of control of the craft. In general, once a boat begins to porpoise, it can be made stable by reducing running trim angle or reducing speed, however if running trim is reduced too much, the boat may risk bow diving or "ploughing in."

The mechanics of porpoising have been studied from theoretical and experimental perspectives for many years. Various studies have shown that the inception of porpoising is influenced by displacement, center of gravity location, and various hull characteristics such as deadrise and chine definition. A study conducted by Day and Haag in the 1950's produced the most systematic experimental data on porpoising known. Their experimental program was designed specifically to study the effects of the various parameters on porpoising inception. Other studies only noted porpoising inception when it interfered with standard planing boat resistance tests. In the present study, new model experiments of porpoising were undertaken at the United States Naval Academy with the following three goals: 1) Repeat the Day and Haag experiments using models approximately five times larger to study the effects of scale ratio on porpoising, 2) Expand the matrix of hull characteristics tested by Day and Haag to encompass hull shapes more typical of designs 45 years later, and 3) Investigate the effect of trim tabs and outdrive thrust angle on porpoising inception.

These experiments were conducted in the Naval Academy's 380 foot towing tank using larger models and more conventional towing methods and instrumentation. The new test results agreed relatively well with the Day and Haag experiments and differences are discussed in the paper. New tests were also conducted with higher deadrise angles, various trim tab configurations, and a new towing method intended to simulate the thrust produced by stern-mounted outdrives that could be inclined up or down. Details of the test equipment, test procedures and an overview of results are presented in a Trident Scholar project report.

NAHL Trimaran Hull Concept

Researcher: Mrs. Nancy Harris, Naval Architect (HydroLab)

The NAHL Trimaran Hull, which meets the Coast Guard's Deepwater Surface Platform Circular of Requirements, was designed by ENS Erik Odom (Class of '97), and built by Bill Beaver in the USNA Model Shop. The model was then tested in the 120-foot towing tank of the Hydromechanics Laboratory. The purpose of this program is to develop trimaran model construction techniques and to compile a resistance and seakeeping database for the USNA trimaran concept. Tests will continue in the summer of 1998 to further develop the seakeeping database. In the Fall 1998, the calm water resistance database will be expanded by Midshipman 1/C Jones, USN to include a comparative evaluation of the trimaran hull form and the Coast Guard's 378 Hamilton Class Cutter in shallow and deep water.

Publications

ZSELECZKY, John J., Naval Architect, Co-author, "Investigation of a Hybrid Wave-Piercing Hull Form," FAST '97 Conference, 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, John J., Naval Architect, Co-author, "Impact of Plunging, Breaking Waves on Towed Antenna Masts," Naval Undersea Warfare Center Division, NUWC-NPT Technical Memorandum 972116, NUWC, Newport, RI, August 97.

This report summarizes the work cited in the previous publication and adds to it the test results obtained at the University of Maryland using a considerably smaller model. Comparisons are made between the independently obtained sets of data in non-dimensional form and show extremely good agreement, especially considering the dynamic nature of the event.

ZSELECZKY, John J., Naval Architect, Co-author, "An Updated Study of Planing Craft Porpoising Using Towing Tank Models," 25th American Towing Tank Conference, Iowa Institute of Hydraulic Research, Iowa, September 1998.

This paper describes an extensive series of model tests conducted as part of a U.S. Naval Academy Midshipman Trident Project. The tests repeated a set of tests conducted in the 1950's using models approximately five times larger to study the effects of scale ratio on porpoising. The existing database was expanded using additional models with hull characteristics more typical of designs 45 years later, and an investigation was made into the effect of trim tabs and thrust outdrive thrust angle on porpoising inception.

Technical Reports

ZSELECZKY, John J., Naval Architect, "Measurements of Breaking Wave Loads on a Moving Partially Submerged Cylinder," U.S. Naval Academy Division of Engineering and Weapons Report No. EW-02-97, March 97.

Model tests were conducted in the 380 foot towing tank of the Hydromechanics Laboratory to investigate the loads induced by a breaking wave impacting a model of a submarine mast while underway and heading into a breaking wave. A cantilevered structure was designed and built to hang from the towing carriage and support themodel underwater. The model mast was designed to have appropriately scaled flexural stiffness and loads were measured using an array of strain gages. Specialized hardware and software were created to synchronize the towing carriage with the wave maker so that tests could be repeated with the model passing through different parts of the breaking wave. The tests had good agreement with some smaller scale tests conducted at the University of Maryland and provided the sponsor with useful data for predicting loads on full scale masts.

ZSELECZKY, John J., Naval Architect, "Motions of an Unmanned Underwater Vehicle (UUV) in Wind and Waves," U.S. Naval Academy Division of Engineering and Weapons Report in-progrress, May 1998.

Model tests are documented for a one-third scale model of a UUV operating at the water surface in wind and waves. Tests were conducted with a diverse assortment of appendages and ballast conditions to study the motions and general behavior of the vehicle. Measurements were recorded for pitch and roll motions, wave elevation and wind speed. The model tests showed some unexpected results regarding the orientation of the vehicle in different wind and wave conditions. Over one hundred tests were conducted over a range of conditions, which gave the designers

considerably more confidence in their predictions of motions for the full scale vehicle.

Presentations

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

ZSELECZKY, John J., Naval Architect, Co-author, "An Updated Study of Planing Craft Porpoising Using Towing Tank Models," 25th American Towing Tank Conference, Iowa Institute of Hydraulic Research, Iowa, September 1998.

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. 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.

Projects active in this period included internal combustion engines, fracture mechanics, fluid mechanics of pumps, thermal systems design, materials processing and engineering, corrosion, continuum mechanics, vibrations and flow field studies. In summary, the department was involved in 30 projects, of which 14 were sponsored research, 10 were midshipmen projects earning academic credit and 6 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, the U.S. Department of Energy, and the U.S. Naval Academy Research Council. Industrial sponsors included Peugeot Sport, the Ford Research Laboratory and Fin Worldwide. The department is grateful for the cooperation and support by sponsoring agencies and organizations.

Sponsored Research

Ductile-Brittle Fracture Toughness Characterization of Ferritic Steels

Researchers: Assistant Professor Karen A. Flack and R. 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 vorte flow fields generated by the wing. Experimental measurements of velocity were obtained using a Particle Image Velocimetry (PIV) system in the open return sub-sonic wind tunnel in the Aeronautics laboratory. The results are currently being analyzed.

Elastic Plastic Fracture Mechanics of LWR Alloys

Researcher: Professor James A. Joyce
Sponsor: U S Nuclear Regulatory Commission

Major work during this period is directed at experimental verification of the new Master Curve approach to defining the lower bound toughness of ferritic steels in the ductile to brittle transition.

A new standard has been balloted by ASTM in this area, but additional requirements are likely to be added before this procedure is allowed to be used for nuclear applications. The materials to be tested are A533B, A515 and A516 steels. A range of test rates, specimen sizes, and test temperatures are being used for this verification project.

Verification of the Structural Integrity of Nuclear Storage Casks

Researcher: Professor James A. Joyce
Sponsor: U S Nuclear Regulatory Commission

The project is an experimental and analytical verification that welded storage casks are suitably designed for this intended use. Fracture toughness tests will be conducted on welds and weld HAZ regions to determine the elastic-plastic JIc and J-R curve properties.

Critical flow sizes will be evaluated for the expected loading of the casks in use. This should define how suitable the casks will be for their expected use.

Ductile-Brittle Fracture Toughness Characterization of Ferritic Steels

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

Standardized methods for determining the fracture toughness of ferritic steels in the ductile-brittle transition region have just recently been developed and accepted by the engineering community. These standards do not address the more complex problem of the transferability of laboratory measurements of fracture toughness to predicting behavior of cracked structures in the ductile-brittle transition. New micromechanics-based models of fracture in the ductile-brittle region are being proposed as the solution to the transferability problem. These models make many assumptions about the material constitutive behavior that must be validated. This research seeks to assess the validity of the micromechanics models through critical experiments aimed to characterize the micromechanical parameters and their sensitivity to temperature, loading rate and mode of loading.

Computational Fluid Dynamics Analysis of the Flow through an Axial Flow Pump Impeller

Researcher: Associate Professor Steven Miner
Sponsor: Naval Surface Warfare Center, Carderock Division

The commercial CFD code FLOTRAN is used to model the flow in the impeller of an axial flow pump. The purpose is to compare results from FLOTRAN to previous results from another code used at Carderock.

The mesh used in this study maintains the same arrangement of nodes as the previous study to facilitate comparison.

CFD Analysis of the Flow Distribution in the Oily Waste Ultrafiltration System

Researcher: Associate Professor Steven Miner
Sponsor: Naval Surface Warfare Center, Carderock Division

CFD is being used to analyze the distribution of flow to a bank of five parallel filters in an oily waste ultrafiltration system. The purpose is to determine how uniform the distribution of flow is within the system. Several different combinations of inlet and outlet locations will be considered.

High Temperature Materials

Researcher: Associate Professor Angela L. Moran and Midshipmen 1/C A. Beattie, D. Coe, C. Westover, B. Smith, USN
Sponsor: Department of Energy

Thermophotovoltaic (TPV) energy conversion has the potential for high efficiency while exhibiting characteristics that may prove advantageous to the military and to commerical 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 parameters. Additional applications for high temperature materials are also under investigation.

High Temperature Copper Alloys for the Automotive Industry

Researcher: Associate Professor Angela L. Moran, LT Sandy Kwiatek, USNR and Midshipman 2/C J. Schroeder
Sponsor: Ford Research Lab

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 are being utilized.

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

Researcher: Assistant Professor P.V. Puzinauskas
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

Researcher; Assistant Professor P.V. Puzinauskas

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.

This project officially commenced in July of 1997. Some work has continued during the school year, but the bulk of the remaining tasks are to be completed this summer.

Dynamic Investigation of a GRP Deck Panel

Researchers: Assistant Professor Colin P. Ratcliffe and

Assistant Professor Oscar Barton, Jr.

Sponsor: Naval Surface Warfare Center, 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 tested 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, and a paper has been submitted to Composite Journal.

Dynamic Characterization of Urethane Damping

Researcher: Assistant Professor Colin P. Ratcliffe

Sponsor: Naval Surface Warfare Center, 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.

Dynamic Characterization of Squash Racquets

Researcher: Assistant Professor Colin P. Ratcliffe

Sponsor: Fin Worldwide

With the advent of GRP and CRP composite sports racquets, the incidence of injuries has increased. Of major concern is the much higher level of vibration and shock when compared to older style equipment. Fin Worldwide has designed a split frame technology which intends to reduce this vibration. This project is primarily run by midshipmen on the EM423 vibrations course. They compared the performance of different racquets and damper designs.

Intelligent Computer Aided Instruction (ICAI)

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 was 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 explode the effects that changing design parameters have on the behaviour 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

Improved Methods for Turbine Blade Cooling

Researchers: Assistant Professor Karen A. Flack and
Assistant Professor Ralph J. Volino

Turbine performance in gas turbine engines is limited by the maximum inlet temperature to the turbine. Materials restrictions are generally the cause for this limitation. Even though advanced materials have

allowed for higher inlet temperatures, hot spots still occur within the turbine that push the material limits. These hot spots generally occur near regions of recirculating flow and vortices. One such hot spot is found near the endwall of a turbine blade as the footprint of a horseshoe vortex that is wrapped around the blade within the turbulent boundary layer. The ability to diffuse this vortex by mixing the hot fluid in the vortex with the cooler free stream fluid would improve turbine performance by increasing the allowable inlet temperature.

The object of this research it to test the feasibility of breaking up this horseshoe vortex using the technique of boundary layer blowing. Fluid is injected through the endwall of the turbine blade near the vortex core to "blow" the vortex into the free stream. The tests will be performed in a low-speed wind tunnel in the Aeronautics Laboratory at the Naval Academy that was designed for turbine blade research. The feasibility test was performed in the recirculating water tunnel in the Hydromechanics lab.

This project will be a Trident project with Midshipman Nicole Aunapu the 1998-1999 academic year.

The Effect of Environment on The Mechanical Behavior of Advanced Materials

Researcher: Professor Dennis F. Hasson

Future naval structural and power systems establish the requirement for high performance engineered materials. These materials must retain their integrity when subjected to or after soaking at elevated temperatures in an oxidative atmosphere. Two advanced material systems which are of interest are ultralight metal structures (ULMS) and titanium aluminide (TiAl) intermetallics. It is noted that most of the ULMS metals achieve their ultra light weight by porosity. While there is some knowledge of ULMS materials, a more fundamental understanding of their mechanical properties after high temperature exposure is required. The currently available ULMS metal is aluminum, while future applications, such as, internal cooling of turbine blades requires porous superalloys. The use for the other advanced material, TiAl, is for lighter weight turbine compressor blades. High temperature tensile test could provide information for understanding of the mechanical behavior.

Research activity for FY97 on the two materials was as follows:

(a) For the porous metal study two Al-11Si-5v/oSiC plates were obtained. These were produced by the ALCAN process. They had relative densities of 6 and 10%. Compression tests to find the valid height to width ratio are in progress. Other compression tests were performed on specimens from plate which was heated by a propane torch. Higher strengths were obtained in the area near the flame. This increase could be due production of alumina in the hottest area. On other porous material plates which were produced by the powder metallurgy process, instrumented impact tests are planned for some of the plates.

(b) For the high temperature tensile behavior of TiAl intermetallic (T-44Al-11Nb), subscale tensile specimens are on order. They will be cast and then electrodischarge machined. Procurement of a hot tensile furnace has been initiated, the furnace will include suitable grips. Room temperature tests of polycrystalline specimens will be performed to determine the materials ductility. If the ductility is satisfactory, that is, about 10%, this might eliminate the need for higher cost directionally solidified materials. Creep testing might also be performed in the future.

Locating Delaminations in a GRP Beam

Researcher: Assistant Professor Colin P. Ratcliffe and Professor W. J. Bagaria

This project continues an initial study in which a new damage detection procedure that could be used to locate crack damage in homogenous beams was developed. The investigation for this project continued to enhance and refine the new damage detection procedure. A significant part of this work was to determine whether the damage detection procedure could also be used to locate a delamination in a glass reinforced composite beam.

A composite beam was modeled in Nastran using a non-conventional modeling strategy. An incorporated delamination was correctly located, wherever it was placed. An experimental study verified that the revised location procedure correctly located a delamination that was manufactured into a GRP beam.

Intra Galactic Space Navigation Using Pulsar Signals

Researchers: Assistant Professor Colin P. Ratcliffe and Professor William J. Bagaria

It is well known that many pulsars exhibit a high degree of stability. They are therefore likely subjects to be used as fixed references for intragalactic navigation. Measuring the Doppler shift on the signal gives a measure of the speed toward or away from the pulsar. Combining this information from several pulsars gives sufficient information to enable absolute navigation. Unfortunately, while the pulsar signals are extremely broad band, the signals received from pulsars are often of a very low amplitude. For reception in the radio frequencies, the signal is often an order of magnitude or more lower than the signal noise. This project is in its initial phase. A new signal processing technique tailored to the pulsar signal has been developed, enabling the Doppler shifted frequency to be measured using a few minutes of data. This technique needs refinement and extension to become useful and automatable.

Dynamic Characterization of Squash Racquets

Researcher: Assistant Professor Colin P. Ratcliffe

With the advent of GRP and CRP composite sports racquets, the incidence of injuries has increased. Of major concern is the much higher level of vibration and shock when compared to older style equipment. Fin Worldwide has designed a split frame technology which intends to reduce this vibration. This project is primarily run by midshipmen on the EM423 vibrations course. They compared the performance of different racquets and damper designs.

Research Course Projects

Intake Flow Through an Internal Combustion Engine

Researchers: Midshipman 1/C Micah Smith, Midshipman 1/C Mark Close and
Midshipman 1/C Susanne Wienrich, USN
Advisor: Assistant Professor Karen A. Flack and
Assistant Professor Paul V. Puzinauskas

The velocity and pressure of the flow in the intake manifold of an internal combustion engine was modeled both numerically and experimentally. The numerical model assumed the flow to be one-dimensional, isentropic, unsteady and compressible. The Crank-Nicholson numerical method was used as the second order differencing technique, along with iterative schemes to resolve the non-linearities from the Navier-Stokess equations. The basic system of equations was solved for a small number of nodes within the manifold. The solution needs to be expanded with more nodes for better spatial resolution. Complementing the numerical solution was an experiment. The experiment modeled the manifold as a pressurized tube. Preliminary pressure measurements were obtained when a plug was released at a specified pressure. Further experimental work will focus on taking simultaneous pressure and velocity data.

Effect of Exposure to High Temperature Air on the Impact Behavior of Unceramed and Ceramed BMAS Glass Matrix Composites with Various Fibers

Researcher: Midshipman 1/C N. A. Williams
Advisor: Professor Dennis F. Hasson

The impact behavior of ceramed and unceramed barium magnesium aluminosilicate (BMAS) glass matrix composites with various fibers is described. The unidirectional composites contained 53-57 volume percent fibers. The various types of fibers were FT700, Lox M Tyranno, S-1 Hi Nicalon and the C-coated CG Nicalon. Both as received and specimens which were heated to 450 deg C for 25 hours, 100hours, and 400hours were impact tested at room temperature. Toughness of these ceramic matrix composites is largely based on the amount of fiber pull-out. The ceramic matrix composites (CMCS) received in the as-fabricated condition have a greater fiber pull-out than the ceramed condition. The ceramed CMC's tend to lose the fiber/matrix interface more quickly and therefore have less fiber pull-out. Even so, fiber condition (as fabricated or ceramed). All four of the ceramed CMC's lost toughness as the length of temperature soak increased, although the S-1 Hi Nicalon/BMAS's loss ofo properties was much less pronounced than the other three. These CMC's likely exhibited their loss of toughness because the layer of fiber/matrix interface became bonded to the matrix due to the high temperature air soak. This bond does not allow for fiber pull-out which is the cause for the improved toughness of the CMC's.

Efficiency And Drag of a Fish

Researchers: Midshipman 1/C S. K. Varma and Midshipman 1/C R. C. Powers, USN

Advisor: Professor Robert A. Granger

A model of a rode fish made from an elastic polymer of 1.1 scale was tested in the Hyudrolab's recirculating water tunnel. The fish has gills and an air bladder to study the oscillatory elastic properties of a fish, to inject nucleus into the boundary layer, and the effect of riblets on the fish skin and how these properties affect drag and dish efficiency. A scale 1.1 model was tested first to gain values upon which the elastic body could be compared.

The side force and drag were measured at various Reynolds numbers for a fixed angle-of-attack. The frequency was varied by a variac attached to an air compressor. The nucleus was injected by a series of plunges connected too a pump. Dye was used to visualize the results.

Ceramic Matrix Composites Evaluation

Researchers: Midshipman 1/C Catherine Westover and Midshipman 1/C Britton Smith, USN

Advisor: Associate Professor Angela L. Moran

An overview of the current literature concerning composites and composites testing was done to determine the advantages and problems associated with mechanical testing of high temperature composites, with an emphasis on Ceramic Matrix Composites (CMC). The literature indicated that mechanical testing of ceramic composites is difficult and costly due to the brittle nature of the materials, their anisotropic properties and the time-consuming fabrication and machining processes. It would be advantageous to define a simple, cost-effective screening test to assess mechanical strength. A simple 3-point bend test was utilized in conjunction with Archimedes density measurements and scanning electron microscopy to determine the effect of fiber architecture, CMC structure, and specimen orientation on specimen strength. It was found that an increased amount of fiber pullout and running of the cracks indicated and caused a higher fracture stress. Additionally, the methods used for obtaining densities and fracture stress were evaluated and determined to be inconsistent in determining component properties.

Tribology and Wear

Researcher: Midshipman 1/C J. Carsten

Advisor: Associate Professor Angela L. Moran

Wear in engine components, seals, bearings, etc. can be detrimental and produce catastrophic component failure. This project involves the development of controlled wear testing of bearing materials in various lubricants. The student is demonstrating an understanding of the various wear mechanisms and identification of the modes of failure.

The canning electron microscope is sutilized to qualitatively and quantitatively measure the degree of

wear and an assessment of the performance of different lubricants and additives is underway.

Using an Oil-fired Furnace to Measure Combustion and Heat Transfer Properties

Researcher: Midshipman 1/C Davis and Midshipman 1/C Limbert, USN

Advisor: Assistant Professor Sheila C. Palmer and

Commander Mark G. Shofner, U. S. Navy

A lab facility has been built at the Naval Academy to measure combustion efficiency, adiabatic flame temperature, air-to-fuel ratio (AFR), and the effects of non-stoichiometric combustion on flame temperature and exhaust products. The major components of the facility include an oil-fired, low efficiency home furnace instrumented with thermocouples, a Bionair home humidifier, a portable Quintox gas analyzer and a MPM2000 Solomat portable flow meter-relative humidity meter. This lab facility will be used at the Naval Academy in the Applied Thermodynamics course as a laboratory which illustrates the principals of energy conversion.

Tuned Intake System

Researcher: Midshipman 1/C R. J. Weingart, USN

Advisor: Assistant Professor P. V. Puzinauskas

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 breathe through a single throttle body and 20mm restrictor. Because the displacement restriction effectively limits the students to motorcycle engines that typically have a carburetor and thus a throttle body for each cylinder, the students must design and build an intake manifold for their engine. This project was initiated to design, build and evaluate an intake manifold 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 a simple Helmholz-resonator which predicts the behavior of the runner-plenum combination using a spring-mass analogy. The model predicted pipe lengths and plenum volumes required to cause resonance between the piston-initiated filling process and intake charge motion at specified engine speeds, thereby enhancing volumetric efficiency.

An adjustable intake-tuning evaluation system was to verify the system behavior and optimize manifold design. Once the final configuration is decided upon, a composite manifold will be built for use in the competition.

Experimental and theoretical Analysis of Flow in an Intake Runner

Researchers: Midshipmen 1/C M. Smith, S. Wienrich and M. Close, USN

Advisors: Assistant Professor P. V. Puzinauskas and Assistant Professor K. A. Flack

The flow inside an intake runner is unsteady and driven by the reciprocating motion of the piston. Several mechanisms exist by which the flow can be improved by synchronizing the intake event with the flow dynamics. The dimensions of the intake runner connecting plenums can be designed such that this synchronization occurs at desired engine speeds. This optimization is known as tuning the intake manifold. Early efforts in tuning consisted of trial and error experimentation with various geometries evaluated on an engine running on a dynamometer. Over the last two decades, computer simulation techniques have been developed which allow prediction of the flow in an engine intake manifold. Models available in the literature vary widely in sophistication and accuracy. Some techniques have been experimentally verified using dynamic pressure variations throughout the manifold. Actual mass flow verifications are less common.

This work consists of reproducing a 1-D unsteady numerically-solved flow model and verifying its accuracy using dynamic-pressure measurement, total mass-flow measurement and instantaneous local flow velocity. The flow velocity measurements will be made using Laser-Doppler Velocimetry. The first stage of the project examines a simplified configuration of a pressurized tube that is closed on one end and suddenly opened to atmosphere at the other. The next step will be to use this single tube as the intake runner for one cylinder in a multiple cylinder engine. The model will then be expanded to include the unsteady forcing function created by the cylinder. The same measurements will be carried out on the engine.

Qualification and Experiments in a Wind Tunnel Facility

Researcher: Midshipman 1/C Ryan Stoddard, USN

Advisor: Assistant Professor Ralph Volino

A new, low-speed wind tunnel facility has been designed and constructed in the TSD shop for use in experiments. The tunnel is modular, allowing arrangement in various configurations for wide range of investigations. Flexibility and the ability to incorporate specialized test sections will be much greater than possible with other existing facilities. Included will be the flexibility for study of both low and high free-stream turbulence flows. Two test sections have been constructed. The first consists 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 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. Final assembly of the facility and preparation of data acquisition routines was completed during Summer 1997. The facility became fully operational in December 1997, when the last motor controller for the blowers arrived. Midshipman Stoddard completed an EM496 project during the spring semester. His first task was to qualify the facility under low free-stream turbulence conditions, taking velocity measurements at the exit of the tunnel contraction to checking for uniformity and turbulence level. This was successfully completed. Midshipman Stoddard followed this by qualifying the tunnel under high free-stream turbulence conditions. This required the re-design of a turbulence grid to improve uniformity. He succeeded in achieving an acceptable flow. This work will be continued by faculty researchers future midshipmen during Summer 1998 and into the future.

Gas Turbine Design for Large Naval Ships Using Computer-Aided Design Software

Researcher: Midshipman 1/C John A. Bowman, usn

Advisor: Professor Chih Wu

This paper explores the possibility of combining the Brayton and Ericsson cycles to produce a high efficiency gas turbine for use onboard large navy vessels. The advantages should be quick startup, less manning and less space requirements. Efficiencies were fouind to equal and surpass those of a typical Rankine cycle. Analysis is done using CyclePad, a computer aided design program.

The navy has not used a gas cooled reactor for propulsion. It is highly recommended that the navy explore this option further for use onboard its large ships, primarily the new CVX and the proposed missile barge.

Publications

BARTON, O., Jr. Assistant Professor and Raouf, R.A., Associate Professor, "Vibration of Variable Thickness Orthotropic Plates Using Eigensensitivity Analysis," J. Thermoplastic Composites, Vol. 11, pp 185-197, March 1998.

An approximate closed-form expression is presented which can be used to compute the fundamental frequency of orthotropic laminates of variable thickness. The quadratic expression is derived for a laminate with a general thickness variation in one direction, and explicit results are provided for a laminate with a linear variation. The desired expression is determined by casting the governing differential equation into discrete form using the Ritz method and expanding the discrete equations in a Maclaurin series about the off-diagonal elements of both the stiffness and mass matrices. Simply supported and clamped boundary conditions are analyzed using both beam shape functions and orthogonal polynomials. Results are compared with those obtained numerically using the Rayleigh-Ritz approach for several laminate tapers and plate aspect ratios R.

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

Modifications to near-wall turbulent boundary layer structure with increased three-dimensionality have been investigated through the use of hydrogen bubble wire flow visualization. Results indicate that three-dimensionality does not influence the strength or sign of near-wall streamwise vortices. Increased three-dimensionality does stabilize the near-wall structure resulting in less ejection type activity. The spanwise spacing between low-speed streaks also decreased slightly with increased cross-flow.

FLACK, K.A., Assistant Professor, Schwarz, W.R., and Driver, D.M. "Experimental Investigation of Three-Dimensional Flow Separation," Submitted *AIAA Journal*, September, 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.

FLACK, K.A. Assistant Professor, Volino, R.J., Assistant Professor, "A Series-Parallel Heat Exchanger Experiment," ASME National Heat Transfer Conference, Baltimore, MD, August 10-12, 1997. Submitted to *ASEE Journal of Engineering Education*, October, 1997.

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.

FLACK, K.A., Assistant Professor, Johnston, J.P. "Near-wall Flow in a Three-Dimensional Turbulent Boundary Layer on the Endwall of a Rectangular Bend," *Experiments in Fluids,* Vol 24, 2, pp. 175-184, 1998.

Turbulence measurements are reported on the three-dimensional turbulent boundary layer along the centerline of the flat endwall in a 30 degree bend. Profiles of mean velocities and Reynolds stresses were obtained down to $y^+ = 2$ for the mean flow and $y^+ = 8$ for the turbulent stresses. Mean velocity data collapsed well on a simple law-of-the-wall based on the magnitude of the resultant velocity. The turbulence intensity and turbulent shear stress magnitude both increased with increased three-dimensionality. The ratio of theses two quantities, the a_1 structure parameter, decreased in the central regions of the boundary layer and showed profile similarity for $y^+ < 50$. The shear stress vector angle lagged behind the velocity gradient vector angle in the outer region of the boundary layer, however there was an indication that the shear stress vector tends to lead the velocity gradient vector close to the wall.

FLACK, K.A., Assistant Professor, Pruitt, B., Callari, M.J. "Velocity Measurements in the Flow Around a Rotating End Mill," Proceedings of the ASME Fluids Engineering Division Summer Meeting, Washington, D.C., June 22-25, 1998.

Recent experiments using acoustic emission (AE) signal monitoring to detect end mill and work piece interaction has shown high signal levels prior to material removal. A detectable increase in the AE signal is present for separation distances of 25 - 65 mm. A portion of this premature signal is due to elastic contact of the tool and work piece. In addition, it is hypothesized that the AE sensor is detecting the flow induced noise from the squeeze film similar to that of a slider bearing, between the end mill tooth and the work piece. Categorization of this signal could lead to in-process monitoring of edge detection and provide feedback on tool position with respect to the work piece prior to material removal. In order to better understand this manufacturing problem, the flow around a rotating end mill was investigated using a one-component laser Doppler anemometer system. Measurements of the tangential component of velocity were obtained. Phase and time averaged velocity profiles highlight the differences between the flow around a rotating end mill and the flow in a slider bearing of similar dimensions.

GRANGER, R.A., Professor and Watson, Kennard, "The Hydrodynamic Effect of a Satellite Transmitter on a Juvenile Green Sea Turtle., accepted for publication in J. bioengineering.

Tests were performed to measure the hydrodynamic effect of a satellite transmitter backpack on a juvenile green sea turtle (Chelonia mydas). A full-scale turtle

model was constructed from a 25-lb specimen with a 19-in carapace length, and a backpack model was constructed from a Telonics ST-6 transmitter (1.0 lb). The turtle model was tested in a wind tunnel with and without the backpack, which was mounted on the forward, topmost part of the carapace. Drag, lift and pitch moment were measured for several speeds and flow angles, and the data were scaled for application to the marine environment. For small flow angles representative of straight-line swimming, the backpack increased drag by 26-30 %, reduced lift by less than 10%, and increased the pitch moment by 22-39%. Based on the drag data, it is estimated that the backpack will reduce swim speed by 10-12%, assuming that the turtle expends the same energy with the unit attached. The results suggest the need to reassess the 5% "rule," which states that a transmitter should not exceed roughly 5% of the animal's body mass. For use in sea turtle telemetry, a drag-based criterion may be more appropriate, as drag is the principal force governing swim speed. Design guidelines are included to minimize the adverse forces and moments caused by the backpack. Additional tests are proposed to obtain data for a streamliined device and for other turtle species which have been the subject of telemetry investigations..

Quarterly Journal of Mechanics and Applied Mathematics.

GRANGER, R.A., Professor, "On The de Sitter-Schwarzschild Universe Having Massless Fields," accepted for publication to Physica D.

Teukolsky linearized the field equations on the Kerr metric for the case of massless scalar, neutrino, electromagnetic and gravitational perturbations, separating the variables and combined the four massless fields into a single general equation. Later, Chandraskekhar et al transformed Teukolsky's equation into the familiar one-dimensional barrier penetration problem of quantum mechanics.

In the present study, we start with the de-Sitter-Schwarzschild metric following the method developed by Penrose to obtain spin coefficients which are used to perturb the geometry with massless fields using the Teukolsky method. Like Teukolsky, the field equations are linearized, found to be separable, resulting in radial parts of the four spins which can be combined into one general radial equation. The radial equation is reduced to the well known one-dimensional wave equation form and finally we examine asymptotic forms of the relevant potential solutions for different spins. Our results show the potentials are real, (recall they are complex for the Kerr metric). We feel the present analysis is not valid in the de Sitter universe under which there are no mass terms. It may be valid in the Schwarzschild case, however, analytic solutions are not easy to obtain. We hope an analytic form might be possible for the reflection coefficient, in some limiting case.

JOYCE, J.A., Professor and LINK, R., Assistant Professor, "Application of Two Parameter Elastic-Plastic Fracture Mechanics to Analysis of Structures," Engineering Fractrure Mechanics, v57, n 4, 431-446, 1998.

J-integral resistance curves are developed for single edge bend [SE(B)] specimens ofo HY80 over a range of crack length ratios from 0.13 to 0.83. The wide range of constraint present over this range of crack length ratios results in J-integral resistance curves with nearly constant initiation toughnesses as measured by Jic, but with widely varying J-R curve slopes beyond Jic. A nearly linear relationship is shown to exist between the slope of the material J-resistance curve after 1 mm of crack extension and the Q parameter introduced by O'Dowd and Shih (Family of crack-tip fields characterized by a triaxiality parameter: Part I - Structure of fields. Journal of Mechanics and Physics of Solids, 1991, 39(8), 989-1015) to quantify elastic-plastic constraint. The constancy of Jic and the linear dependence of the tearing resistance on Q is used to develop an interpolation scheme to evaluate the J-integral resistance curve applicable to a specific structural application when the Q parameter can be estimated for the flaw geometry and loading present in the application. Published by Elsevier Science Ltd.

JOYCE, J.A., Professor and LINK, R.E., Assistant Professor, "Ductile-to-Brittle Transition Characterization Using Surface Crack Specimens Loaded in Combined tension and Bending," Fatigue and Fracture Mechanics: 28th Volume, 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, Jc, 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 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.

JOYCE J.A., Professor and LINK, R.E., Assistant Professor, "Fracture Behavior of Surface Crack Tension Specimen in the Ductile-to Brittle Transition Region," *Fatigue and Fracture Mechanics: 29th Volume, ASTM STP 1332*, T.L. Panontin and S.D. Sheppard, Eds., American Society for Testing and Materials, accepted for publication in 1998.

LINK, R.E., Assistant Professor and Graham, S.M., "Dynamic Fracture Initiation Toughness of ASTM A533, Gr. B Steel Plate," *Fatigue and Fracture Mechanics: 29th Volume, ASTM STP 1332*, T.L. Panontin and S.D. Sheppard, Eds., American Society for Testing and Materials, accepted for publication in 1998.

The dynamic fracture toughness of an ASTM A533, Grade B steel plate was determined at several temperatures in the ductile-brittle transition region. Crack-tip loading rates ranged from approximately 10^3 to 10^5 Mpa m^(½)s. The fracture toughness was shown to decrease with increased loading rate. The dynamic fracture toughness was compared with results from previous investigations and it was shown that the decrease in toughness due to increased loading rate at the highest test temperature was not as severe as reported in previous investigations. It was also shown that the reference temperature, T(0), was a better index of the fracture toughness vs. temperature relationship than the nil-ductility temperature, RT(NDT) for this material.

MINER, S. M., Associate Professor, "CFD Analysis of an Axial Flow Pump Impeller Using a Coarse Grid," published in the Proceedings of the Third Pumping Machinery Symposium, 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 - 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 =0.12, head coefficient =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.

MINER, S. M., Associate Professor, "3-D Viscous Flow Analysis of a Mixed Flow Pump Impeller," to be published in the proceedings of the Seventh International Symposium on Transport Phenomena and Dynamics of Rotating Machinery, Honolulu, Hawaii, February, 1998.

This paper presents the results of a study using a

coarse grid to analyze the flow in the impeller of a mixed 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 - turbulence model is used. The mesh for this study uses 26,000 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 1185 rpm, flow coefficient =0.116, head coefficient =0.094, and specific speed 2.01 (5475 US). Results for the model include circumferentially averaged results at the leading and trailing edges of the impeller, and analysis of the flow field within the impeller passage. Circumferentially averaged results include axial and tangential velocities, static pressure, and total pressure. Within the impeller passage the static pressure and velocity results are presented on surfaces from the leading edge to the trailing edge, the hub to the shroud, and the pressure surface to the suction surface. Results of this study are consistent with the expected flow characteristics of mixed flow impellers, indicating that small CFD models can be used to evaluate impeller performance in the design environment.

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

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

MORAN, A. L., Associate Professor, "Undergraduate Laboratory - Materials Properties and Selection" with S. Kwiatek, Journal of Materials Education, Fall 1997.

MORAN, A. L., Associate Professor, "Advances in Intelligent Manufacturing," Proceedings of the National Academy of Engineering Frontiers of Engineering Symposium, NAE, Washington DC, 1998.

MORAN, P. J. Professor, (co-author) "Passivity and Breakdown of Carbon Steels in Organic Solvent Mixtures of Propylene Carbonate and Dimethoxyethane," .in "Passivity and Its Breakdown," page 432, Janik-Czachor, V. Macagno, P. Marcus, and M. Seo, Eds., The Electrochemical Society, Pennington, NJ (1998).

The passivity and breakdown of 1018 carbon steel in propylene carbonate and dimethoxyethane mixtures with 0.5 molar lithium hexafluoroarsenate supporting electrolyte were examined via several electrochemical and surface methods. Compatibility and the interrelationships of the passivation mechanisms found in pure PC (solvent adsorption, slat film formation) and pure DME (solvent adsorption, cation intermediate adsorption, electropolymerized film) solutions alone were identified in PC-DME mixtures with lithium hexafluoroarsenate with PC concentration ranging from 10 to 90 mole percent. The paper discusses the compatibilities and interrelationships determined.

MORAN, P. J., Professor, (co-author) "Detection and Monitoring of Crevice Corrosion Inside Pipe Flanges," Proceedings of the 1997 U.S. Tri-Service Conference on Corrosion Volume I, CDNSWC, Bethesda, MD (1998).

The development of a novel approach for detection and monitoring of crevice corrosion in pipe flanges is discussed. The o-ring sensor places the electrodes for an electrochemical impedance measurement inside the o-ring within the flange, thus allowing direct ionic contact with the crevice site. Results from piping loop studies have demonstrated the feasibility of this method for remote sensing of crevice corrosion in seawater piping networks fabricated from nickel Alloy 625 and Type 316 stainless steel. The o-ring sensor appears to be compatible with engineering considerations for the piping networks.

RATCLIFFE, C.P., Assistant Professor and BAGARIA, W.J., Professor, "A Vibration Technique Locating Delamination in a Composite Beam," AIAA Journal, Vol. 36, No. 6, pp. 1074-1077, 1998.

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, C.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, 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, C.P., Assistant Professor, "Locating Damage in Beams Using Experimental Broadband Vibration Data," *American Society of Mechanical Engineers,* NCA-V??, In press, 1998.

This paper develops a method for locating structural damage using experimental broadband data. The method uses measured frequency response functions to obtain displacement as a function of frequency. The displacement functions are processed to yield a damage index, displayed on a plot of position versus frequency. The method can be applied when there is no a priori knowledge about the undamaged structure. The method can be automated. This paper details the theory of the broadband method, and the results of an experimental demonstration in which a steel beam was damaged with a narrow slot. It is shown that this method is highly sensitive, and can locate a very small amount of damage. For example, the slot was correctly located when there was only a 0.8% reduction in thickness. Traditionally, damage causes a change in natural frequencies, but at this small level of damage the frequency changes were within experimental error.

RATCLIFFE, C.P., Assistant Professor and BARTON, O., Jr., Assistant Professor, "Modal Analysis of a Thick Sandwich Plate: a Comparison Between Theory And Experiment." *The Society for Experimental Mechanics, International Modal Analysis Conference IMAC-XV,* V1, pp. 71-75, Orlando, 1997.

Composite structures, beam, plates, and shells, are commonplace in many sectors of the automotive and aircraft industries. Use of such structures 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 six feet. This plate is a scale model of a new design for a ship's deck. In service, it is the fundamental mode that is normally most problematic for a ship's deck. Results are presented

from an experimental modal analysis with the plate suspended on rubber bungee cords.

RATCLIFFE, C.P., Assistant Professor and HOERST, B.C., "Damage Detection in Beams Using Laplacian Operators on Experimental Modal Data." *The Society for Experimental Mechanics, International Modal Analysis Conference IMAC-XV,* V2, pp. 1305-1311, Orlando, 1997.

The effect of damage on the dynamic properties of structures such as beams and plates has previously been studied. Most of the work considers the variation of natural frequencies, although some also considers the change in mode shape. However, little work considers using mode shape data for locating damage. This paper presents a technique for identifying and pinpointing structural damage in a beam. The procedure operates solely on mode shape data from the damaged structure, and does not require a priori knowledge of the undamaged structure. When damage is relatively severe, a finite difference approximation of Laplace's differential operator to the mode shape successfully identifies the location of the damage. When damage is less severe, it is shown that further processing of the Laplacian significantly increase the sensitivity of the procedure, and in some cases enables the location of less than 0.5% damage to be found. The procedure is best suited to the mode shape obtained from the fundamental natural frequency. The procedure is demonstrated using a finite element model of a beam. Experimental verification includes the location of crack damage in a steel beam, and a delamination in a glass reinforced plastic beam.

RATCLIFFE, C.P., Assistant Professor, "The 3:4:5 Coincidence of an Optimized Moment of Inertia Classroom Demonstration," *American Journal of Physics,* V65 N10, pp. 1015-1016, 1997.

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.

Wu, Chih, Professor, "Heat transfer effect on the specific cooling load of refrigerators," Applied Thermal Engineering, v17, #1, (1997), 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, "Finite analysis of a geothermal heat engine driven air conditioning systems," Energy Conversion and Management, v38, #3, (1997), 263-266.

A geothermally powered, low temperature Rankine cycle used to operate a conventional mechanical compression air conditioning cycle 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 predication of the performance that does the Carnot theoretical heat engine and air conditioning unit.

Wu, Chih, Professor, "Optimization of solar absorption refrigerator," Applied Thermal Engineering, v17, #2, (1997), 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), 277-282.

This paper derives the relations between optimal efficiency and power output of Carnot engines with heat transfer laws of $q \propto (T^{-1})$ and $q \propto (T)^n$. The bounds of efficiency at maximum power output are also given. The results, which are different from those based on Newton's law $q \propto T$, 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), 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, "Optimal coefficient of performance and heating load relationship of a three-heat-reservoir endoreversible heat pump," Energy Conversion and management, v38, #8, (1997), 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), 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 effectivenesses 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, vol. 38, no. 14, pp 1439-1444, 1997.

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, "The influence of internal heat leak on the power vs efficiency characteristics of heat engines,"Energy Conversion and Management, vol.38, no.14, pp 1501-1508, 1997.

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,"Heat pump performance with internal heat leak," International Journal of Ambient Energy, vol.18, no.3, pp 129-134, 1997.

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, "Finite time thermodynamic performance of an isentropic closed regenerated Brayton refrigeration cycle," International Journal of Energy, Environment and Economics, v4, #2, (1997), 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, " Performance analysis of an irreversible Brayton cycle via method of finite-time thermodynamics," Journal of the Institute of Energy, v70, #482, (1997), 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, "Optimal performance coefficient and cooling load relationship of a three-heat-reservoir endoreversible refrigerator," International Journal of Power and Energy Systems, vol.17, no.3, pp206-208, 1997.

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, "Power performance of a naval shipboard gas turbines," International Journal of Power and Energy Systems, v17, #2, pp 107-110, 1997.

Over the last three decades, aero-derivative gas turbines have become established naval ship propulsion engines. As the area of shipboard application of the gas turbine is extended, the thermodynamic cycle of the gas turbine becomes more sophisticated. Work and output power optimization of the shipboard gas turbine cycle are analyzed with a finite-time thermodynamic approach in this paper. The results provide a basis for designing a real shipboard gas turbine power plant and for a performance comparison with existing Brayton engines.

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

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, "Maximum power of a combined cycle isothermal chemical engine," Applied Thermal Engineering, v17, #7, pp 629-637, 1997.

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 the chemical engine.

Wu, Chih, Professor, "Steady flow combined refrigeration cycle performance with heat leak," Applied Thermal Engineering, v17, #7, pp 639-645, 1997.

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, "Using articulate virtual laboratories in teaching energy conversion at the U.S. Naval Academy," Journal of Educational Technology Systems, Vol.26, #2, pp 127-136, 1997.

The Mechanical Engineering Department at the U.S. 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 an advanced energy conversion course (EM443) for Mechanical Engineering students. The use of the CyclePad software enhances lectures and aids students in visualization and design.

Wu, Chih, Professor, "Performance of real regenerated air heat pumps," Proceedings of High

Technology in the Power Industry Conference, pp 386-392, Orlando, Florida, 27-30 October 1997.

This paper analyzes the performance of a real air heat pump plant via methods of finite-time thermodynamics. The analytical relations between heating load and pressure ratio, and between coefficient of performance (COP) and pressure ratio of real closed regenerated air Brayton heat pump cycles coupled to constant- and variable-temperature heat reservoirs are dderived. In the analysis, the irreversibilities include heat transfer irreversible losses in the hot- and cold-side of the heat exchangers and the regenerator, and the non-isentropic expansion and compression losses in the compressor and the expander. The optimal performance characteristics of the cycle is obtained by optimizing the distribution of heat conductances or heat transfer surface areas among the two heat exchangers and the regenerator, and the matching of the working fluid and the heat reservoirs. Detailed numerical examples are given to demostrate the influence of various losses on the cycle performance characteristics.

Wu, Chih, Professor, "Intelligent computer aided instruction in power and energy systems," Proceedings of High Technology in the Power Industry Conference, pp 490-494, Orlando, Florida, 27-30 October 1997.

The Mechanical Engineering Department at the U.S. 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 is incorporated in an advanced energy conversion course and two thermodynamic courses in teaching power and energy systems for mechanical engineering students. The use of CyclePad software enhances lectures and aids students in visualization and design.

Wu, Chih, Professor, "Performance of a class of irreversible heat engines," Proceedings of 1997 International Heat Powered Cycles Conference, pp 416-427, Nottingham, UK, 15-17 September 1997.

The effect of heat resistance and heat leakage on the optimal performance of heat engines is investigated in this paper based on a generalized heat transfer law. The relation between optimal power and efficiency for steady-state flow irreversible heat engine is derived.

Wu, Chih, Professor,"Heat pump performance with internal heat leak," International Journal of Ambient Energy, v18, n3, pp 129-134, 1997.

Influence of internal heat leak 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 a more reasonable prediction in the performance of an actual heat pump.

Wu, Chih, Professor,"The equivalent cycles of an n-stage irreversible combined refrigeration system," International Journal of Ambient Energy, v18, n4, pp 197-204, 1997.

An irreversible cycle model is used to investigate the performance of an n-stage combined refrigeration system affected by the irreversibility of finite-rate heat transfer and the internal dissipation of the working fluid. Some reasonable parameters are introduced so that the optimal performance of the irreversible combined refrigeration system may be directly derived by an equivalent simplified cycle model. The optimal relation between the coefficient of performance and the specific cooling load of the system is obtained. The optimal combined conditions between two adjacent irreversible cycles in the system, i.e., 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 system, are determined. The results obtained here are general and useful. They may be used to discuss the optimal performance of an arbitrary stage irreversible and endoreversible combined refrigeration system. Moreover, it is pointed out that the optimal performance of an arbitrary stage irreversible and endoreversible combined heat pump system may also be derived from the cycle model.

Wu, Chih, Professor,"Exergeo-economic performance bound and optimisation criteria for heat engines," International Journal of Ambient Energy, v18, n4, pp 216-218, 1997.

Finite-time thermodynamics and exergeoeconomics are combined to form a new analysis method called finite-time exergeoeconomics in this paper. The optimal thermal efficiency and profit rate holographic spectrum for the heat engine is derived. The derivation is used to obtain the efficiency bound at maximum profit rate and the optimisation criteria of the heat engine cycles. The results provide a solid theoretical basis for design and evaluation of practice heat engines.

Wu, Chih, Professor, "Optimal collector temperature for solar driven heat pump systems," Energy Conversion and Management, v.39, n.½, pp 143-147, 1998.

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, "Influence of internal heat leak on the performance of refrigerators," Energy Conversion and Management, v.39, n.½, pp 45-50, 1998.

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

Wu, Chih, Professor, "Optimization of specific rate of heat pumping in combined heat pump cycles," Energy Conversion and Management, v.39, n.½, pp 113-116, 1998.

The optimization problem of a combined heat pump cycle made of two endoreversible Carnot heat pump cycles in series without intermediate reservoirs is investigated using finite-time thermodynamics. The fundamental relation between heating quantity and coefficient of performance of the combined cycle is derived. Relations are also derived between the specific rate of heat pumping, the average rate of heat pumping per unit of total heat transfer surface area and the COP for reciprocating and stable flow models of combined cycles. The results obtained from this paper may be extended to an endoreversible, combined heat pump cycle formed by more than two endoreversible Carnot heat pump cycles.

Wu, Chih, Professor, "Cooling load versus COP characteristics for an irreversible air refrigeration cycle," Energy Conversion and Management, v.39, n.½, pp 117-125, 1998.

The effect of heat resistance on the performance of an air refrigeration cycle is analyzed with a finite time heat transfer analysis. The present work extends the recent studies on refrigerator performance by incorporating nonisentropic compression and expansion. Relations between cooling load and pressure ratio and between COP and pressure ratio for the air refrigerator in which the irreversibilities of heat resistance losses in the hot- and cold-side heat exchangers and nonisentropic losses in the compression and expansion processes are derived. The results show that there exists a maximum value of COP and that the cooling load has a parabolic dependence on COP, unlike the monotonically decreasing behaviour in the case of an endoreversible air refrigerator.

Wu, Chih, Professor, "Optimal collector temperature for solar driven heat pump systems," Energy Conversion and Management, v.39, n.½, pp 143-147, 1998.

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, "Intelligent computer aided optimization on specific power of an OTEC Rankine power plant," Applied Thermal Engineering, v18, n5, pp 295-300, 1998.

Specific power of a heat engine is chosen to be the objective function in the design of an OTEC Rankine power plant. An intelligent computer aided instruction computer software, CyclePad, with refrigerant-12 as the working fluid operating between a warm ocean water heat source and a cold ocean water sink is used in the design process. Through manipulation of the boiler pressure and condenser pressure, the specific power of the OTEC is calculated and an upper bound is determined. This bound can direct the design of current and future OTEC heat engines to provide beneficial applications in industry.

Wu, Chih, Professor, "Optimal expansion of a heated working fluid with phenomenological heat transfer," Energy Conversion and Management, v.39, n.3/4, pp 149-156, 1998.The optimal motion of a piston fitted with a cylinder containing an ideal gas is examined. The gas is heated at a given rate f(t) and coupled to a heat bath. The optimal path which maximizes the expansion work is obtained. Several applications of the optimal path are also given.

Wu, Chih, Professor, "Efficiency of an Atkinson engine at maximum power density," Energy Conversion and Management, v.39, n.3/4, pp 337-342, 1998.

The power density is maximized for an Atkinson cycle in this paper. The results showed that the efficiency at maximum power density is always greater that that at maximum power, and the design parameters at maximum power density lead to smaller and more efficiency Atkinson engines with larger pressure ratios.

Wu, Chih, Professor, "Optimization of steady flow heat pumps," Energy Conversion and Management, v.39, n.5/6, pp 445-454, 1998.

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

Wu, Chih, Professor, "Using articulate vittual laboratories in teaching energy conversion at the U.S. Naval Academy," Journal of Educational Technology Systems, v26, n2, pp 127-136, 1998.

The Mechanical Engineering Department at the U.S. 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 is incorporated in an advanced energy conversion course for Mechanical Engineering students. The use of the CyclePad software enhances lectures and aided students in visualization and design.

Wu, Chih, Professor, "Effect of heat transfer law on finite time exergeoeconomic performance of a Carnot heat pump cycle," Energy Conversion and Management, v.39, n.7, pp 579-588, 1998.

The operation of a Carnot heat pump is viewed as a production process with exergy as its output. The short run economic optimization of the endoreversible heat pump is performed in this paper. The profit of the heat pump is taken as the optimization objective

function. Using the method of finite time exergoeconomic analysis, which emphasizes the compromise optimization between economics and the utilization factor of energy for finite time thermodynamic cycles, this paper derives the relation between optimal profit and COP of an endoreversible Carnot heat pump based on a relatively general heat transfer law. The COP bound at the maximum profit is also obtained. The result obtained involve those for three common heat transfer laws.

Wu, Chih, Professor, "Heat transfer effects on the net work output ans efficiency characteristic for an air-standard Otto cycle," Energy Conversion and Management, v.39, n.7, pp 643-648, 1998.

Finite-time thermodynamic analysis of an air standard Otto cycle is performed in this paper. The relation between net work output and efficiency of the cycle is derived. The maximum network output and the corresponding efficiency bound of the cycle with heat transfer considerations are also found. Detailed examples are given. The results obtained herein provides a guide to the performance evaluation and improvement for practical Otto engines.

Wu, Chih, Professor, "Optimum performance of reversible Stirling engine with imperfect regeneration," Energy Conversion and Management, v.39, n.8, pp727-732, 1998.

An optimal performance analysis is performed for a Stirling engine with heat transfer and imperfect regeneration irreversibilities. The relationship between the net power output and thermal efficiency of the engine is derived. Detailed numerical examples are given. The results obtained in this paper provide guidance to performance evaluation and design improvement for Stirling engines.

Wu, Chih, Professor, "Performance and optimization criteria for forward and reverse quantum Stirling cycles," Energy Conversion and Management, v.39, n.8, pp 733-740, 1998.

The optimal performance for forward and reverse quantum Stirling cycles is studied in this paper. The finite time thermodynamic performance bound and optimization criteria for these cycles are derived. The optimal relations between the performance parameters for quantum Stirling engines, refrigerators and heat pumps are obtained.

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, v18, n1, pp 16-20, 1998.

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 ($_1$, $_2$, 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, v18, n1, pp 2-15, 1998.

The design of an axial flow compressor stage at subsonic Mach numbers has been formulated as a nonlinear multiobjective mathematical programming problem with the obiective 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 .

Wu, Chih, Professor, "Optimum performance parameters for a quantum Carnot heat pump with spin ½," Energy Conversion and Management, v39, n11, pp 1161-1167, 1998.

The purpose of this paper is to study the optimal performance for an endoreversible Carnot heat pump with a working fluid system consisting of many spin ½ fermi. The relationship between the optimal heating load and the coefficient of performance (COP) for the quantum Carnot heat pump is derived.

The optimum parameters are obtained at a maximum heating load point and at a maximum ecological function point, respectively.

Wu, Chih, Professor, "Intelligent computer aided design on optimization of specific power output of a finite time Rankine cycle using CyclePad," Journal of computer Application in Engineering Education, v6, n1, pp 9-13, 1998.

The specific output of a shipboard nuclear propulsion system is analyzed. The plant consists of a Rankine cycle coupled to coolant from a nuclear reactor and ocean water by heat transfer. The specific power is optimized by using thermodynamic software called CyclePad and computer graphics.

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, "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, "Performance characteristic of isothermal endoreversible chemical engines," Energy Conversion and Management, paper accepted for publication.

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, "Performance characteristic of an endoreversible Stirling refrigerator,"International Journal of Power and Energy Systems, in press

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, "Effect of heat resistance on the performance of closed gas turbine regenerative cycles," International Journal of Power and Energy Systems, in press.

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.

Presentations

BARTON, Oscar Jr., "Eigensensitivity Methods in Composite Structural Mechanics," Meeting of USNA Chapter of Sigma Xi, March 4, 1998.

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

FLACK, Karen A, Assistant Professor and VOLINO, R.J., Assistant Professor, "Experimental Capabilities in the USNA Fluids Laboratory," NRl - Computational Physics and Fluid Dynamics Division, March 5, 1998.

GILLERLAIN, Joseph D., JR., Professor and ZSELECZKY, J. T., "Force and Moment Measurements on a Low Length-to-Beam Submarine Model," ASME Fluids Engineering Division Summer Meeting, Vancover, British Columbia, Session on Hydrodynamic and Submerged Configurations, June 26, 1997.

GRANGER, Robert A., Professor, "Life on Mars," Book Signing and Lecture at Barnes and Noble, Annapolis, MD, January 30, 1998.

GRANGER, Robert A., Professor, "Fluid Dynamics of the Universe," Rotary Club Dinner Lecture, Laurel, MD, April 1, 1998.

GRANGER, Robert A., Professor, "Life on Mars," Book Signing and Lecture, Barnes & Noble, Ellicot City, MD, April 18, 1998.

JOYCE, James A., Professor, "Fracture Behavior of Surface Crack Tension Specimens in the Ductile-Brittle Transition Region," 29th National Fatigue and Fracture Symposium, ASTM, Stanford University, June 23-26, 1997.

JOYCE, James A., Professor, "K/J Size Requirements Consistency and Adequacy," presented at Imperial College, Exhibition Road, London, U.K., June 16, 1997.

JOYCE, James A., Professor, "High Rate Round Robin Testing," presented to Task Group E08.08.02 at ASTM Committee Week, San Diego, CA, November 11, 1997.

JOYCE, James A., Professor, "Additions to ASTM E1829," presented to Task Group E08.08.02 at ASTM Committee Week, San Diego, CA, November 11, 197.

JOYCE, James A., Professor, "Fracture Toughness Testing of Plate HSST 14," ASME Section XI Task Group on Master Curbe, Reno, Nevada, December 8, 1997.

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

MINER, Steven M., Associate Professor, "Fundamentals of Fluid Mechanics," Computational Fluid Dynamics Using Finite Elements Short Course, University of Maryland, November 1997.

MINER, Steven M., Associate Professor, "3-D Viscous Flow Analysis of a Mixed Flow Pump Impeller," to be presented at the Seventh International Symposium on Transport Phenomena and Dynamics of Rotating Machinery, Honolulu, Hawaii, February 1998.

MORAN, Angela L., Associate Professor, SAXTON, P.C., HARPER, M, and LINDLER, K., "Materials Selection for TPV Emitter," IECEC Conference, Honolulu, HI, July 1997.

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

MORAN, Patrick J., Professor, "Passivity and Breakdown of Carbon Steels in Organic Solvent Mixtures of Propylene Carbonate and Dimethoxyethane, Electroochemical Society Meeting, Paris, France, September, 1997.

MORAN, Patrick J., "Detection and Monitoring of Crevice Corrosion Inside Pipe Flanges, U. S. Tri-Service Conference on Corrosion, Wrightsville Beach, NC, November 1997.

PUZINAUSKAS, Paul V., Assistant Professor, "Engine Combustion Analysis Demonstration, " Advanced Engine Technology Conference, Superflow Corporation, Colorado Springs, CO, November 18-19, 1997.

VOLINO, Ralph J., Assistant Professor and SMITH, G. B., "An Experimental Investigation of the Thermal Plumes in a Thick Layer Cooled from Above," ASME IMECE, Dallas, TX, November 16-21, 1997.

VOLINO, Ralph J., Assistant Professor, "Wavelet Analysis of Transitional Flow Data Under High Free-Stream Turbulence Conditions," ASME International Gas Turbine Congress and Exposition, Stockholm, Sweden, June 1-5, 1998.

VOLINO, Ralph J., Assistant Professor and Flack, Karen A., Assistant Professor, "Presentation of Research Capabilities and Interests in Fluid Mechanics and Heat Transfer at the U. S. Naval Academy," presented to the Propulsion and Power Engineering Division, Naval Air Warfare Center, Patuxent River, MD, January 15, 1998.

DEPARTMENT OF

Naval Architecture, Ocean And Marine Engineering

Professor Roger H. 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 1997-1998. 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. Naval Architecture topics included the study and experimental testing of composite material hull panels - including ultimate strength and failure characteristics, the design and fabrication of a fish propulsion dynamometer, the towed seakeeping behavior of USS CONSTITUTION, the design of a planing boat dynamometer for combination pitch, roll, heave dynamic instability testing, and an experimental study of porpoising of modern planing craft. Ocean engineering topics included studies of wave groups and wave breaking in irregular seaways, wind and flood loading factors on fixed structures, the strength of bonded composite joints, the flow criticality of GRP sandwich panels, the technique of fiber steering for composite aircraft structure, the thermal protection of divers and deep diving systems, the pollutant dispersion and water wave kinematics in the vicinity of submerged barriers, the engineering aspects of ship navigation channel design and maintenance, the drag and speed of diver propulsion vehicles, the influence of submerged barriers on breaking wave characteristics, breakwater design, the added mass and damping of multiply moored ships, and the interaction of waves with vertical barriers. Marine engineering topics included studies of the performance of environmentally acceptable refrigerants, emission reduction of naval power plants, the performance effects of gas and liquid additives to the working fluid of gas turbines, the continued study of thermophotovoltaic (TPV) direct energy conversion systems, the study of multiple source light transmission from a fiber optic cable, the development of a portable neutron detector for arms control/non-proliferation applications, the study of radiation effects on RAM devices, the study of particulate emissions from combusting solid waste, heat pipe design, photon and neutron responses of LiF thermoluminescent detectors, hazardous waste remediation, reliability-centered maintenance procedures, and neural network applications to econometric problem solution.

Research funding was made available from many sources including department operating funds, the Trident Scholar Program, as well as contracts and grants from the Office of Naval Research; the Dahlgren, Panama City, Carderock and Annapolis offices of the Naval Surface Warfare Center; the National Science Foundation; the Department of Energy; the Naval Sea Systems Command; the Naval Dosimetry Center; the U.S. Army Corps of Engineers, the American Society of Civil Engineers; the Naval Academy Research Council; the Knowles Atomic

Power Laboratory; the Naval Research Laboratory; the Defense Special Weapons Agency; and the Society of Naval Architects and Marine Engineering.

Sponsored Research

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

Researcher: Dr. Martin R. Cerza

Sponsor: Naval Surface Warfare

An International agreement in 1992 called the Montreal Protocol has set the stage for the phasing out of Ozone harmful refrigerants, CFC's (Chlorofluorocarbon) 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. This means that phenomena associated with the thermal performance of refrigeration facilities, namely, boiling and condensation heat transfer will have to be examined with regards to the new HFC refrigerants. In addition, in order to make the new equipment lighter and more compact, enhanced heat transfer surfaces are also being developed. 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 ethylene glycol cooling loop has been completed and is operational. Work is proceeding with the computer integrated measurement diagnostic systems and the first refrigerant replacements are expected to be tested early fall of 1998.

The Development of a Multiple Source Light Transmitter from a Single Fiber Optic Cable

Researcher: Dr. Martin R. Cerza

Sponsor: NADC Pax River/ONR

The purpose of this investigation is to study the feasibility of developing a multiple source light emitter from a single multimode fiber optic cable. In the technology of non-destructive evaluation (NDE) a single fiber optic cable is used in conjunction with a light source, to transmit a beam of light to a particular location in a structural member, such as an aircraft wing, in order to aid in the evaluation of the stress of that member. Several evaluation techniques may be employed to determine the stress: interferometry, Bragg grating frequency diagnosis to name a couple. The problem is that the fiber optic cable can only be run to one location. In this investigation, the fiber optic cable is to have its cladding removed via an HF etching process at various locations along its length. The purpose is to allow light to escape the cable at various points along the cable length, since the difference in the index of refraction between the cladding and the core is what keeps the light totally internally reflected. With the cladding removed, multiple light transmission sources can be achieved so that a single cable can transmit a

diagnostic light beam at many locations in the stressed member. To date, this process appears to be working, although the HF etching process needs further refinement in order to be exact.

Thermodynamic Mixing of Real Gasses and Gas/Liquid Mixtures and the Effect on Enthalpy and Entropy as Applied to Gas Turbines

Researcher: Dr. Martin R. Cerza

Sponsor: Office of Naval Research

The purpose of this the ongoing investigation to evaluate the ability 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. The investigation will be theoretical and will answer several posed questions pertaining to the mixing of real gases and gas/liquid systems. Conclusions will be drawn in order to determine whether or not further experimental or theoretical investigations are warranted. This year, analysis was extended to include Gas Turbine Engines. Due to the relatively low pressures of gas turbine engines, there is no appreciable effect of compressibility on enthalpy departure from the ideal gas formulation.

Wave Groups and Wave Breaking in Random Seas

Researcher: Professor Thomas H. Dawson

Sponsor: Office of Naval Research

Wave groups in random deep-water waves are being studied experimentally using the Naval Academy's 380 foot towing tank. Results to date have been compared with theoretical work that accounts for nonlinear effects on crest amplitudes. Recent work has been concerned with investigation of wave-group statistics derived from Markov theory for wave runs. Most recent work has been concerned with the effects of breaking waves on group statistics. The work is continuing under ONR sponsorship.

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

Researchers: Professor Martin E. Nelson (PI) and Associate Professor Mark J. Harper

Sponsor: Naval Research Laboratory

Eight sites at Kirtland Air Force Base (KAFB) have been intentionally contaminated with Th-232 compounds in order to provide realistic training scenarios for Defense Department personnel. In response to the Comprehensive Environmental Response, Compensation, and Liability Act

(CERCLA), KAFB has initiated an Installation Remediation Program (IRP) for complete environmental restoration. Before remediation can commence it is necessary to fully characterize the contaminated soil, with particular emphasis on geophysical analysis and relationships between soil grain size and radionuclear content. Following this analysis various remediation methods will be proposed.

Advanced Concepts for Naval Nuclear Propulsion Plants

Researcher: Associate Professor Mark J. Harper

Sponsor: Knolls Atomic Power Laboratory (KAPL)

Various designs of thermophotovoltaic direct energy conversion devices were evaluated and tested. Some innovative energy conversion methodologies using heat pipes for transport of heat were studied. Research continues on an advanced energy delivery system that is capable of supplying power for submersibles of various sizes, from small unmanned vehicles to full-size submarines. Particular attention is paid to integration of advanced propulsion schemes with the vision outlined by the Joint Chiefs of Staff ("Joint Vision 2010") and the Department of the Navy ("Forward. . .From the Sea) documents, as well as other high level guidance from the Defense Department, including that specified in the Defense Science Board's special task force, "The Future of the Submarine.

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

Researcher: Associate Professor Mark J. Harper (PI) and Professor Keith W. Lindler

Sponsor: Department of Energy (via KAPL)

The United States Naval Academy is tasked with the design and fabrication of a combustor/emitter which is compatible with a DOE furnished thermophotovoltaic (TPV) power module.

The current effort is to use the combustion gases from a T-58 gas turbine as the energy source for the TPV emitter. Tests have been conducted with the T-58 gas turbine to determine the best location to remove combustion gases to power the TPV module. The USNA team has designed and constructed an emitter module to be attached to the T-58 gas turbine and tested in the near future. Future work will focus on heat pipe design and testing for removal of waste heat from the TPV cells.

Development of Load Factors for Combined Wind and Flood Events

Researchers: Associate Professor David L. Kriebel and Professor Gregory J. White

Sponsor: American Society of Civil Engineers

In this project, load factors for coastal wind and flood loading on buildings are being derived 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 was completed in 1996-1997, while the second and third phases are now in progress.

Wave Interaction with Vertical Wave Barriers

Researcher: Associate Professor David L. Kriebel

Sponsor: National Science Foundation and Alaska Science and Technology Foundation

Laboratory tests were performed 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 U.S. Naval Academy, (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, a model wave barrier was constructed in the small wave/towing tank of the Hydromechanics Laboratory. This tank is 120 feet long, 8 feet wide, and 5 feet deep. The wave barrier model was tested with barrier depths (drafts) of 2, 2.5, 3, and 3.5 feet. For each barrier configuration, tests were conducted in regular waves using 21 combinations of wave height and period. Measurements were made of the incident, transmitted, and reflected wave heights, along with the water surface elevation on either side of the wall. Wave forces were measured near the top and bottom of the wall such that both the total wave force, as well as the wave-induced overturning moments could be resolved.

Results of wave force measurements are being presented at the 26thth International Conference on Coastal Engineering in Copenhagen, Denmark. Measured values of wave forces from both the USNA and the Oregon State tests are being compared to predictions based on an eigenfunction expansion theory.

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 is tasked with the design and fabrication of a combustor/emitter which is compatible with a DOE furnished thermophotovoltaic (TPV) power module.

The current effort is to use the combustion gases from a T-58 gas turbine as the energy source for the TPV emitter. Tests have been conducted with the T-58 gas turbine to determine the best location to remove combustion gases to power the TPV module. The USNA team has designed and constructed an emitter module to be attached to the T-58 gas turbine and tested in the near future. Future work will focus on heat pipe design and testing for removal of waste heat from the TPV cells.

Improved Navy Marine Bonded Composite Joint Concepts

Researcher: Assistant Professor Sarah E. Mouring

Sponsor: Naval Surface Warfare Center, Carderock Division

Results from recent programs indicate that typical Navy laminate materials 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 Navy composite bonded joint concepts. 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.

A number of concepts designed to improve both Mode I and interlaminar tensile strength performance is being evaluated using a subcomponent test. 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 that is not provided in coupon test, and too costly to evaluate in full-scale component tests.

The most promising concepts will be used in structural component validations tests. Preliminary component candidates include hat-stiffened panels, T-joints, or platform joints. The failure of all components is controlled to varying degrees by Mode I, interlaminar tension, and fillet material behavior. Analysis efforts identified in a previous program, indicate 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.

Analytical and experimental work is being performed on the subcomponent test. After this work is completed, component testing will begin.

Strength of Composite Joints Fabricated with an Alternative Joining Technique

Researcher: Midshipman 1/C Colby W. Sherwood, USN

Adviser: Assistant Professor Sarah E. Mouring

Sponsor: National Science Foundation

The use of composite material is growing more and more. In the marine environment, it is most often used for the construction of boat hulls up to 25 meters in length. Composites are also used in the construction of super structures, sonar domes, and pressure hulls. A drawback of composite structures is the cost of building. Joining members together accounts for much of this cost. The current method requires laying a bead of adhesive on the surface of one part, joining the two parts, and then using clamps to secure the joint until the adhesive cures. This is a labor and time intensive process. A cheaper and more efficient method needs to be found.

A new method of joining composite panels is under investigation. The process uses a combination of liquid adhesive and double sided foam tape. Pieces of tape are placed on the panel to form a channel. The second panel is then placed onto the tape. The tape "tacks" the two panels together holding them in place. Liquid adhesive is then injected into the channel. This method saves time and labor, thereby reducing overall cost. An experimental and analytical evaluation of this new method has been completed as part of this independent research project.

Structural Behavior of Composite Panels Stiffened with Preform Frames

Researcher: Assistant Professor Sarah E. Mouring

Sponsor: Naval Academy Research Council (FY97)

Composites materials, particularly glass reinforced plastic (GRP), dominate the small boat industry and offer many advantages over traditional materials for ship building. Navy ships have traditionally been constructed of 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 this are weight savings, stealth, and low maintenance. Presently, the disadvantages associated with composite material construction is cost. While open mold hand lay-up fabrication with GRP composites materials has proven to be cost effective for small boats, it is not the most economical fabrication method or materials for larger vessels. The cost of molds and high labor costs have prevented the use of GRP for producing larger vessels, except for specialty vessels such as the Coastal Mine Hunter (CMH). 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 new preform frame technology, PRISMA Preform Frames, has been developed recently which 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. They are installed typically 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, more information on the structural behavior of the preform frames using different geometries, materials, and fiber orientation. The question of proper fiber orientation of the GRP laminates will be considered in this research.

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. Biaxial (0,90), double bias (+45,-45), triaxial (+45,-45,0) and quadaxial (0,90,+45,-45) laminates are commonly used for frames. These laminates are analyzed for stiffness and strength, with particular attention to failure modes, to determine optimum laminates for in-plane loading conditions. Results from this numerical model will be compared to results from structural testing of a series

of composite panel in the USNA Ship Structures Laboratory. These comparisons will help quantify any modeling errors. All information gained will be used to develop an optimal framing system for a naval vessels.

The development of analytical models of the hat-stiffened panels have been completed; however, they need to be verified by experimental testing. The six composite panels were delivered to the Naval Academy in March 1997 and testing was completed during November 1997.

Flaw Criticality in Glass Reinforced Plastic (GRP) Sandwich Panels

Researcher: Assistant Professor Sarah E. Mouring

Sponsor: Naval Surface Warfare Center, Carderock Division

A study to quantify the defects of glass reinforced plastic (GRP) panels is being performed. Presently, these effects have not been quantified adequately in Navy ships. The use of composites in Navy ship design is expected to expand in the future. Therefore, this study would be beneficial to the Navy's interest. For this study, the Ship Structures Laboratory at the U.S. Naval Academy is being utilized to conduct the testing. A total of 42 panels is being tested under in-plane compressive forces using the Panel Test Fixture. Five panels are baseline panels and the other ones have structural defects such as disbonding of core and skin or impact damage. The panels are sandwich construction with balsa or foam cores with dimensions of 3 feet by 4 feet. Testing should be completed by September 1998. Strength and stiffness data are being collected which will allow a comparison between the baseline values and the values of the panels with defects. The goal is to evaluate the strength/stiffness retention after the defects have occurred. Analytical tools are being used to model the baseline and defect panels in order to predict their structural behavior. The comparison of the experimental data to the analytical data will be used to validate the analytical method. A final report will be written which will summarize the correlation of flaw type and severity with the strength/stiffness retention.

Behavior of Composite Joints Adhesively Bonded Using an Innovative Joining Method

Researcher: Assistant Professor Sarah E. Mouring

Sponsor: National Science Foundation (NSF)

Adhesive structural joints are formed typically by applying a bead of adhesive to one surface of a structural part or panel and placing a second structural part or panel onto the adhesive bead, compressing it to cover all or most of the joint surface. The joint is then secured usually by clamping until the adhesive has cured; this curing process can take many hours, often overnight. Structural adhesive tape (similar to double-sided carpet tape) are also used to make structural joints, however they are usually of much lower strength than the adhesive joint described above. Adhesive tape also can be used to secure a joint while a liquid adhesive cures. The proposed method is a different combination of liquid adhesive/adhesive tape technology, involving the use of adhesive tape to temporarily secure and to create a channel between structural parts to be joined. The liquid adhesive is then pumped into the channel to form a permanent bond. This allows multi-part structures to be "tacked" together quickly, checked for accuracy, and then permanently bonded later by injecting the adhesive. The method eliminates adhesive drips and spills, provides a more consistent bond-line, and uses less adhesive (typically an expensive commodity). It also significantly reduces the amount of labor involved in bonding the parts. This research is to develop and evaluate this new joining method.

The research plan involves both experimental and analytical research. As part of the development and evaluation of the proposed joining method, analytical procedures are being developed to model several different joint configurations. These models are being used to optimize joint designs. Experimental tests are being preformed to validate the analytical models. In the next year, analytical and experimental research will be performed on the current joining method used in Civil Engineering, and compared to the results of the proposed method. Also, guidelines on testing joints bonded using the new method will be suggested.

Fiber Steering for Lightweight Affordable Composite Structures

Researchers: Assistant Professor Sarah E. Mouring, Assistant Professor Oscar Barton, Associate Professor Gabriel Karpouzian, and Associate Professor Michael Mackney

Sponsor: Office of Naval Research (ONR)

The objective of the program is to develop an integrated design for manufacturing/fiber steering capability for fiber placement that will achieve optimum structural efficiency while producing affordable primary aircraft structure. In phase one, the capability will be validated through manufacturing trials on demonstration panels. The faculty members listed above have been awarded funding recently. In the Summer of 1998, technical support will be provided for several aspects of mechanical behavior and testing of composite structures containing non-unidirectional fibers. The research effort will be organized into two main focus groups; theoretical methods and experimental methods. The theoretical study will include performing a literature survey, investigating current models, and investigating current failure models. The experimental study will include an assessment of proposed experimental methodology, performing coupon specimen testing, and investigating empirically-based modeling. At the completion of this phase, an implementation plan will be developed to utilize this capability in full-scale components.

Prototype Planning Boat Rig

Researcher: Professor Bruce C. Nehrling

Sponsor: Naval Sea Systems Command

The dynamic stability of a planning boat at high speeds is an issue of considerable concern to the designers and operators of these boats. Model tests designed to systematically investigate transient and oscillatory instabilities are an ideal way to determine dynamic instability trends and relationships. Two major phenomenon to investigate are porpoising and corkscrewing. Porpoising results in dynamic pitch-heave oscillations while corkscrewing manifests itself as dynamic pitch-roll-yaw oscillations. To conduct these types of tests a multi-axis rig is required to link the model to the towing carriage. The dynamometers in this rig need to be able to measure drag forces, heave displacements, and pitch, roll, and yaw angles. In addition, since planning boat models are usually small, that portion of the rig which is supported by the model must be light in weight. Finally, the rig needs to be rugged enough to physically restrain the model from destructive motions after the inception of either porpoising or corkscrewing and at the end of a high-speed test.

An appropriate planning boat rig was designed, analyzed and fabricated. The machine work and fabrication was done by Mr. J. Meyers of the Technical Support Division. This rig augments the resources of the Hydromechanics Laboratory and will enable experiments to be conducted on the dynamic instabilities of planning boats.

Characterization of the INWS Site at Kirtland AFB

Researchers: Professor Martin E. Nelson, Associate Professor Mark J. Harper

Sponsor: Naval Research Laboratory

This project involves performing site characterization at four formerly utilized sites by the Interservice Nuclear Weapons School (INWS). The sites were contaminated with thorium, in order to provide training to DoD personnel who would then be available respond to a potential nuclear emergency. The project involves performing geophysical, chemical, as well as soil sample collection and analysis at the four sites. Following sample collection, radionuclide analysis was performed by gamma spectroscopy. In addition, the collected soil samples were sieved in order to determine, if there is a higher concentration of the contaminant in a given particle size. A chemical analysis was also performed in order to determine if various non-radioactive contaminants are present, and hence if a mixed waste problem exists at the sites. The project will continue through the upcoming intersessional period in order to develop recommendations to Kirtland AFB personnel concerning potential future remediation actions that may be required to properly restore the sites. It is expected that a final report will be issued in September, 1998.

Two abstracts have been submitted for presentations at technical conferences on the results obtained to date. The first abstract, which is entitled "Characterization of Thorium in Soil at the INWS" , has been submitted to the 1998 annual Health Physics Society meeting in July, 1998 in Minneapolis, Minnesota. The second abstract, which is entitled "Environmental Remediation research", has been submitted to the 1998 Symposium on Radiation Measurements and Applications in May, 1998 in Michigan.

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

Researcher: LT Marshall G. Millett, USN

Adviser: Professor Martin E. Nelson

Sponsor: Defense Special Weapons Agency

This project involves designing an improved neutron detector, which will have a higher efficiency and lower weight than the detector(s) currently used for arms control purposes. The project involves four major tasks. First, computer modeling has been performed on a gas filled proportional counter and a fast neutron source. The modeling was accomplished through the use of a Monte Carlo computer code, MCNP-4A. Second, experiments were performed with a suitable gas filled detector in order to validate the results of the model. From the results of these first two tasks, a prototype detector was designed and constructed. Finally, experiments were performed that established the operating characteristics of the prototype detector.

In order to minimize the weight of the detector, composite materials were used in constructing the detector carrying box. This resulted in a substantial decrease in system weight. NSWC, Carderock Division-Annapolis Detachment was used for the material selection and construction of the composite box.

A final version of the report has been reviewed by DSWA and the Center for Verification Research. The report was accepted for publication as a DSWA in December, 1997. A journal article has been submitted in March, 1998 to Nuclear Instruments

and Methods, which is entitled "Weight and Counting Optimization in a Moderated Neutron Detection System."

Evaluation of Experimental Phase Change Material (PCM) Liners in a Hot Water Diving Suit

Researcher: Professor M. L. Nuckols and Ensign Cara Grupe, USN

Sponsor: Naval Surface Warfare Center, Dahlgren Division

Saturation diving operations require the use of hot water suits for diver thermal protection. In the event of losing the hot water supply, the diver can rapidly chill and become hypothermic. The thermal stress is compounded when the diver is in a current, since the thermal barrier of the water immediately surrounding the diver is removed. In addition, when the hot water source does not provide a consistent water temperature, the hot and cold fluctuations cause "cold spots" which can be distracting and affect the diver's overall work performance. In the previous year, thermally protective suit liners were developed and laboratory tested at USNA which could be worn by divers to enhance their thermal protection for at least twenty minutes following an accidental interruption in the flow of hot water to their suits. The purpose of this continuing effort is to experimentally evaluate the performance of these liners in deep diving operations at the Navy Experimental Diving Unit in Panama City, FL. Shallow water testing completed during July 1997 is being followed by testing at depths up to 850 feet in June 1998.

Reliability Centered Maintenance

Researcher: Associate Professor Kenneth L. Tuttle

Sponsor: Naval Sea Systems Command, Surface Ship Maintenance Office (NAVSEA 915)

The purpose of this research is to provide a Maintenance Engineering Laboratory at the U.S. Naval Academy for instruction of the Midshipmen in modern maintenance engineering concepts. The objectives of this research are:

1. To develop instructional capabilities in maintenance engineering.
2. To introduce RCM, Reliability Centered Maintenance, to Naval Officers.
3. To conduct long range planning for introducing maintenance engineering into the curriculum.

The Maintenance Engineering Laboratory portion of the Diesel Engine-Room Laboratory has been upgraded to MCAS, Machinery Condition Assessment System, from the DEMA, Diesel Engine Monitoring and Analysis System, is currently slated to be upgraded to ICAS, the Integrated Condition Assessment System. 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 1Hz 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 (formerly DEMA) 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. The Maintenance Engineering Laboratory is used by all non-engineering students and all Marine, Ocean and Naval Architecture Engineering students at the Naval Academy. During the past nine years, more than seven thousand new naval officers or future naval officers have been introduced to the concepts of modern maintenance practices in this U.S. Naval Academy, Maintenance Engineering Laboratory.

Environmental Text

Researcher: Associate Professor Kenneth L. Tuttle

Sponsor: Society of Naval Architects and Marine Engineers

As Chairman of the Environmental Panel, am editor and producing a SNAME Reference Text: The Principles of Environmental Design and Operation of Ships. Society of Naval Architects and Marine Engineers, New York. Planning of the text has progressed and two members have been appointed to the Environmental Panel from the U.S. 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 as well as the technology available to treat those environmental problems and the regulations pertaining to marine pollution. The effort has been extended to include participation by the ASNE Environmental Division and ASNE has provided two members for the SNAME Environmental Panel to help plan the text.

Investigation and Integration of Technical, Operational and Economic Issues Affecting Navigation Channel Design and Maintenance

Researchers: Assistant Professor Jennifer K. Waters, Associate Professor David L. Kriebel and Associate Professor Robert H. Mayer

Sponsor: Institute for Water Resources (IWR) / Army Corps of Engineers

This research is in support of the Institute for Water Resources (IWR) work unit #33123: "Impacts of Navigation Trends on Channel Usage and Design." The goal of IWR's study is to improve the design and maintenance of navigation channels in order to achieve economic efficiency, reliability, and safety of shipping operations. Specifically, the study aims to investigate how changes occurring in the international shipping industry may impact the Army Corps of Engineers' design and maintenance of its channels. The study is also concerned with how navigation trends on channel usage may contribute to safety, piloting, and maintenance problems.

A critical element in the work unit is an updated review of both domestic and international practices for the design and maintenance of navigation channels. Existing design practices used within the Corps of Engineers are summarized in the Engineer Manual (EM) 1110-2-1613 published in 1983. Given the

rapidly changing vessel characteristics of the international shipping fleet, an update of the Corps' design practices may be warranted to ensure U.S. competitiveness in the international shipping industry into the next century. A key first-step in updating these practices is to complete an extensive review of current and future vessel design trends in conjunction with advances in navigation channel design during the past 15 years in both the U.S. and abroad.

Another critical element of the work unit is an investigation into how channels are actually being maintained and utilized, *after* the design process has been completed. This part of the study must incorporate an analysis of channel accident data, with specifics of vessel navigation and dredging operations. This effort is important since it is well-recognized that navigation channels are not necessarily maintained or utilized as they were originally designed.

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)

The USNA Ship Structures Laboratory, under the direction of Dr. White, will conduct six structural tests on pre-fabricated steel stiffened panels provided by the USCG. The test series will consist of two panels will continuously welded longitudinal stiffeners; two panels with intermittent welds on the longitudinal stiffeners; and two panels with scalloped stiffeners with intermittent welds. Each test specimen will have inplane loads applied. Sufficient strain and deflection measurements will be taken so that the mode of failure and load at failure for each series can be identified. The results from the three series are to be compared in the final report. (This investigation completed testing in August of 1997, final report presented to USCG in October 1997).

Marine GRP Sandwich Panel In-Plane and Out-of-Plane Testing

Researcher: Professor Gregory J. White

Sponsor: The Johns Hopkins Applied Physics Laboratory (JHUAPL)

Dr. White will conduct two series of structural tests on Glass Reinforced Sandwich Panels (GRP) provided by APL. The panels will be tested, according to the plan outlined below, in the Grillage Test Fixture at the U.S. Naval Academy Ship Structures Laboratory. In all tests the short (loaded) edges of the panel will have fixed-end boundary conditions and the long edges will have simply-supported boundary conditions.

Test Series 1

This series will consist of 12 panels;

Six 72-inch by 36-inch flat panels, three with segmented balsa cores and GRP face sheets and three with foam cores and GRP face sheets,

Six 48-in by 36-inch flat panels again three with segmented balsa cores and GRP face sheets and three with foam cores and GRP face sheets.

All twelve flat panels will be tested under inplane loads to determine the elastic buckling load, and then will continue to be loaded until destruction.

Test Series 2

This series will consist of 8 panels;

Four 72-inch by 36-inch flat panels, three with segmented balsa cores and GRP face sheets and three with foam cores and GRP face sheets,

Four 48-in by 36-inch flat panels again three with segmented balsa cores and GRP face sheets and three with foam cores and GRP face sheets.

All eight flat panels will be tested under uniform lateral until destruction.

Effect of Mechanical and Manufacturing Defects on the Ultimate Strength Marine Composite Panels

Researchers: Professor Gregory J. White & Associate Professor Sarah E. Mouring

Naval Surface Warfare Center – Carderock Division (Code 6552)

Test mechanical response of twenty-one 3' x 4' composite sandwich panels with embedded defects (9 with skin-to-core disbonds, 12 with impact damage) in the USNA Ship Structures Laboratory grillage test fixture to determine the effects of defects on panel structural integrity under compressive end loading. This work is in support of ongoing efforts by the Survivability, Structures, & Materials Directorate, Structures and Composites Department, Marine Composites Branch, Mechanics Section of NSWC-CD.

INDEPENDENT RESEARCH

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

Researcher: Professor Martin E. Nelson and J. Ziegler (IBM)

The purpose of this research was to determine the SER cross sections of modern DRAM memory chips with respect to different types of radiation found at aircraft altitudes. The initial study considered the effect of 14.3 MeV neutrons as well as pions. A paper was accepted for publication in the IEEE journal of solid state circuits in February, 1988, which is entitled "Cosmic Ray Soft Error Rates of 16 Mb DRAM memory chips."

During the past year, the initial work has been extended to consider the thermal neutron response of commercial 16 Mb memory chips with BSG or PBSG. The study first experimentally approximated this effect by irradiating a surface silicon barrier detector (SSB) with neutrons from two different sources available at the USNA. Later several commercial chips were irradiated using the thermal column off the NIST reactor in Gaithersburg, Maryland. The data show that commercial chips have a wide range of sensitivity to thermal neutrons. More irradiations are planned to better understand this effect.

A proposal has been submitted to the Department of Energy (DOE)to fund this research. The title of the proposal is "Development of a Single Event Upset Detector for Neutron Measurements." Award grant notification is planned for August, 1998.

Comparison of Neural Networks to Econometric Solution Techniques

Researchers: Eight Midshipmen enrolled in FE485, Fall, 1988

Advisers: Professor Martin E. Nelson, Suzanne McCoskey, LT. Dan Doney, USN

Research is being conducted on comparing neural network solution techniques with econometric methods

for application to economic problems. The research will be conducted by midshipman who enroll in FE485 next semester and be extended into the spring semester by having those midshipman write their senior paper on their results of the analysis. Currently the three participating faculty are preparing the lecture materials on neural networks and econometrics so that the midshipman will be able to perform the research. It is expected that applications of this research will be to such diverse topics as financial markets, trade, urban economics, or other macroeconomic problems, which have not previously been investigated with neural networks.

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. Written input has been submitted to the EPA in attempt to convince the U.S. not to regulate ship exhaust emissions and especially not navy ships as they burn low sulfur fuel already and most have engines that produce low oxides of nitrogen. Results of this research have been presented to SNAME, the Society of Naval Architects and Marine Engineers. One paper is included in a book titled, "Ship Design and Operation in Harmony with the Environment," a SNAME Publication. A second paper has been published in the Proceedings of the Maritime Environmental Symposium '95 by the American Society of Naval Engineers, ASNE. Efforts have been initiated with ONR to fund the Naval Academy as the Environmental Research Center for the US Navy. The plan is to include funding for all faculty interested in environmental research and an Environmental Chair to coordinate and administer the program. Currently a solicited paper is in progress for the SNAME transactions and the symposium at the annual conference. This paper is the result of a joint effort that has been developed between SNAME and ASNE.

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. This research has been investigating the possibility of incineration to destroy shipboard trash rather than dumping at sea. There is world-wide support for burning to destroy shipboard combustible wastes. Most of the combustible solid wastes generated on navy ships is on ships having 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 publishing 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 state experiments as well as steady state experiments. One paper was presented to and published in the Proceedings of The Thirteenth International Conference on Solid Waste Technology and Management. Substantial prior publications exist on

the subject of solid fuels, combustion and gasification of solid fuels and combustion generated emissions by this author.

RESEARCH COURSE PROJECTS

An Investigation into the Effect of Augmentation Gas Injection on the Combustion Effluents and Fuel Efficiency of a Gas Turbine

Researcher: Midshipman 1/C Paul C. Campbell, USN

Adviser: Professor Martin R. Cerza

Sponsor: NAOME Department

The purpose of this investigation is to look for ways to reduce the nitrous oxide (NO_x) and carbon monoxide (CO) formation in gas turbine exhaust gas byproducts by injecting an augmentation gas into the compressor of a gas turbine. This in effect is simulating an Exhaust Gas Recirculation (EGR) system when the augmentation gas is Carbon Dioxide. Other gases to be injected include Argon, Nitrogen and Helium (varying spread in molecular weights). A state of the art exhaust gas analyzation system has been procured to measure the concentrations in the exhaust gas products for varying types of synthetic atmospheres. Also being investigated are the effects of the augmentation gas injection on fuel efficiency. Varying concentrations of augmentation gases should effect the adiabatic flame temperature of the combustion process. This should influence both the formation of pollutants and fuel efficiency.

The Prediction of Porpoising Inception for Modern Planing Craft

Midshipman Tullio Celano III, USN, Trident Scholar

Faculty Adviser: Professor R. H. Compton

Planing craft are high-speed marine vehicles that derive most of their support from hydrodynamic pressures acting on their relatively flat, wide bottom surfaces. While the concept of planing was recognized in the late nineteenth century, the first practical application of the concept can be traced to the development of seaplane hulls during the beginning of the twentieth century. As powerplants became light and powerful enough to propel a small to medium size boat past is "hump speed," defined by the generated wave patterns, into the planing speed regime, the dawn of a whole new facet of marine transportation began. While the planing hull introduced the ability to operate at high speeds across the surface of the water, it can easily fall victim to dynamic instabilities, which have manifested themselves in both vertical and transverse responses. In mild cases, these instabilities can be a mere annoyance, but in the most extreme cases, have led to catastrophic structural failure, capsizing and serious personal injury. One of the most common instabilities, known as "porpoising," is a vertical plane, coupled oscillation in pitch and heave which occurs in calm water, and can be divergent in magnitude. Porpoising inception and the craft parameters that influence it are the subjects of the research described in this report.

Fish Propulsion: Design and Fabrication of a Dynamometer

to Measure Forces on Oscillating Fins

Researcher: Midshipman 1/C. C. Ian Hoag, USN

Adviser: Professor Roger H. Compton

Renewed interest in the mechanics of fish propulsion for improved performance by competitive swimmers and for investigating the potential of improved vehicle propulsion, have identified a lack of hard data. To acquire quantitative hydromechanical data on thrust, drag, and efficiency of a translating and rotating hydrofoil (like a fish's tail), a study of available sources and methods was followed by the design and fabrication of a prototype device which induces the compound motion and allows forces, displacements (linear and angular), and velocities to be measured. The device is intended for use in the U.S. Naval Academy's Hydromechanics Laboratory.

Evaluation and Design of Heat Pipes for High Temperature Applications

Researcher: Midshipman First Class Scot G. Hughes, USN

Advisers: Associate Professor Mark J. Harper and Professor Keith W. Lindler

The theory, design, and feasibility of using heat pipes for high temperature applications was investigated. Heat pipes can provide a constant temperature heat source that can power numerous energy conversion devices such as a thermophotovoltaic (TPV) generator.

A heat pipe provides a means of efficiently transmitting thermal energy from a heat source to a heat sink. All heat pipes are enclosed in a shell material which must be capable of withstanding the required operating temperatures. The working fluid in the heat pipe evaporates at the point where the heat is applied. The vapor then travels to the heat sink where it releases energy and condenses back to a liquid. Capillary action causes the liquid to flow through a screen wick material back to the evaporator to complete the cycle. This phase change allows the heat pipe to operate at a uniform temperature as is required for TPV generators. For high temperature applications, the working fluid must have a high boiling point. Liquid metals, such as potassium, sodium, lithium, and silver have all been successfully used as working fluids in high temperature heat pipes.

A spreadsheet was developed to demonstrate the fundamentals of heat pipe design. The spreadsheet allows the user to vary the heat pipe working fluid, operating temperature, diameter, and other properties that affect performance. The spreadsheet was used to design a heat pipe that could be used to provide heat to the emitter of a TPV generator operating at 2200°F.

FIELD TEST COMPARISON OF THE ONDAC AND INF DETECTOR

Researcher: Midshipman 1/C Keith M. Roxo, USN

Adviser: Professor Martin E. Nelson

Sponsor: Defense Special Weapons Agency (DSWA)

Los Alamos National lab (LANL) SARA program

This research project involves investigating the field response of the INF detector and the USNA designed ONDAC detector to four unique fission neutron sources at Los Alamos National Laboratory. In these tests, the responses of both instruments was compared with and without the presence of a moderator. The ONDAC was also exposed to gamma radiation sources to test its gamma sensitivity. Additionally, the two detectors were compared in the area of weight and cost. The test results showed that the ONDAC detector is potentially a viable replacement for the INF detector for use in START applications. The ONDAC detector was found to lighter in weight and cheaper in cost than the INF detector, thereby verifying earlier predictions made by the USNA. Additional recommendations are provided to improve the ONDAC's gamma insensitivity and field readiness.

Draft report completed July 23, 1997 and forwarded to LANL and DSWA for review and comments. In addition, report peer reviewed by Center for Verification research. Result of review process was approval in March, 1998 to issue final report with various format revisions under DSWA auspices. Revised report expected to be forwarded to DSWA by June, 1998.

OPTIMIZATION OF THE PHOTON RESPONSE FOR A LiF TLD

Researcher: Midshipman 1/C Robert C. Carnell, USN, 97-98 Trident Scholar

Adviser: Professor Martin E. Nelson

Sponsor: Naval Dosimetry Center

In this project filter materials and thicknesses in the USN TLD card holder were optimized in order to maximize discrimination between incident photon energies and hence give an improved dosimetric response. First, a model was created to calculate the energy deposited within the TLD for five different photon beams. These calculations were correlated to within 20% of experimental data. Second, an improved model was developed by employing the MCNP-4B radiation transport program. This model accounted for the exact photon spectrum as well as relevant parts of the experimental set-up. With this improved, the previous experimental data was correlated to within 9% except for one of the beams. Third, prediction were made about the expected response of other photon beams that would be available at an experimental facility at Brooks AFB in Texas. Fourth, new experimental data was collected at this facility and compared with the model predictions. Strong agreement was obtained between this new experimental data and the model predictions.

Presentation of the project is planned at the Trident scholar seminar at the USNA in April, 1998. Trident scholar report is to be issued in May, 1998

An abstract has been submitted to the 1998 Health Physics Society for presentation at the July, 1998 annual meeting, which is to be held in Minneapolis, Minnesota. The presentation will be given MIDN. Rob Carnell and is entitled "Optimization of Photon response for a LiF TLD""

Investigation of Neutron Response of the Copper-Doped Lithium Fluoride Thermoluminescent Detector

Researcher: Midshipman 2/C Aaron R. Kline (summer intern at NDC), USN

Adviser: Professor Martin E. Nelson

Sponsor: Naval Dosimetry Center (NDC) and Naval Environmental Health

This project has involved characterizing the neutron response of the copper-doped Lithium Fluoride (LiF) detector. The detector is known to have has a significantly greater neutron response than the manganese-doped LiF detector, which is in current use by the USN. The project will involve two phases. First, the detector will be irradiated with different neutron sources in order to determine its response to different energy neutron sources. Second, the measurement of delivered dose will be determined by both experimental tests and theoretical calculations. The experimental tests will use two instruments: the AN/PDR-70 neutron remmeter as well as the TEPC detector. The neutron facilities at both the NIST and the USNA will be used for these tests. The theoretical calculations will be developed by modeling the radiation transport using the MCNP-4B Monte Carlo code. It is planned to continue the research during the upcoming academic year as part of an EN495-EN496 research project.

Methods For Minimizing Variations in Drag and Speed for Diver Propulsion Vehicles

Researcher: Midshipman 1/C Lynn R. Fodrea, USN

Adviser: Prof M. L. Nuckols

Sponsor: Naval Surface Warfare Center, Coastal Systems Station,

Panama City, FL

Naval Special Warfare operations use diver propulsion vehicles for long excursions. These vehicles have limited power and therefore the efficiency of their design is very important. This project focused on determining the most efficient positioning of a diver on the diver propulsion vehicle and investigated the benefits of fairings and diver restraints to reduce the drag on these vehicles. The results of this experimental investigation showed that significant reductions in drag could be achieved, and variations in drag between different diver subjects could be minimized by providing an appropriate fairing over the diver's backpack and by controlling the positioning of the diver.

A Thermal Capacitor for a Deep Diving System

Researcher: Midshipman 1/C Steven P. Pfirman, USN

Adviser Professor M. L. Nuckols

Sponsor: Naval Surface Warfare Center, Coastal Systems Station, Panama City, FL

The goal of this research project is to develop a passive heat capacitor mechanism inside the heat exchanger of a helmet used in saturation diving systems which will allow divers to reach a safe refuge in their personnel transfer capsule (i.e., diving bell) in the event of a heating system failure. Under normal deep diving operations, divers receive a heliox breathing mixture from their personnel transfer capsule. During the gas delivery process, the breathing gas loses a significant amount of heat. In order to prevent life-threatening, cold-induced asthma which would result by breathing cold, dense helium-rich mixtures, the gas must be rewarmed to at least 60°F prior to being inhaled by the diver. A thermal capacitor is being designed and tested

to satisfy this gas warming function as a backup in the event of failure of the existing gas heating systems. While several options exist for the design, a phase change material looks most promising. Major consideration is being given to design this backup capability without sacrificing the performance of the existing primary gas heating system.

Design of a Submerged Barrier to Induce Breaking Waves with High Plunge Distance

Researcher: Midshipman 1/C Stephen C. Fortmann, USN

Adviser: Assistant Professor Jennifer K. Waters

Submerged offshore bars and reefs change wave breaking characteristics. These features may change the general type characteristic of a breaking wave (e.g. spilling or plunging) and may also change specific dimensional characteristics of the breaker wave such as breaker height. For plunging waves breaking over a bar, the horizontal distance from the initiation of the breaker to the point where the crest strikes the trough surface (known as "plunge distance") is typically significantly reduced. This research project involved a background study of the wave kinematics behind this phenomenon as well as the design, construction and testing of a novel, modular, reef-like structure which would initiate plunging waves while preserving a large plunge distance. At this point, the tests have been completed, but the data is still being analyzed

Water Wave Kinematics and Pollutant Dispersion Near a Partial Boundary

Researcher: Midshipman 1/C Daniel Moll, USN

Adviser: Asst Prof. Jennifer K. Waters

The purpose of this study was to examine the dispersion patterns of a simulated pollutant around a submerged structure that resembles a coral reef. The testing was conducted in the 120-foot wave tank in the U.S. Naval Academy Hydromechanics Laboratory. The study was conducted by injecting a fluorescent dye into the water near a simulated reef; sending regular waves toward the structure and collecting water samples at varying depths and longitudinal locations along the centerline of the tank after a known elapsed time. Samples were taken from the wave impact side of the structure, immediately above the structure, and from the lee side of the structure. Concentrations of the injected dye were then measured using a fluorometer. The dispersion patterns were examined by comparing the relative concentrations of the dye at each measurement location.

The data from these tests indicates that pollutant dispersion characteristics near a structure such as a coral reef are disrupted when compared to similar dispersion patterns in the absence of a reef structure. Specifically, in these tests the dye tended to concentrate in pockets on both the wave impact side as well as on the lee side of the structure. This phenomenon is most likely a result of the altered wave kinematics due to the presence of the structure. Further tests investigating these effects have been planned.

Review of Chesapeake Bay Headland Breakwater Design

Researcher: Midshipman 1/C Marc F. Williams, USN

Adviser: Assoc. Prof. David L. Kriebel

In order to better understand the principles behind breakwater systems, an in depth literature study was conducted focusing especially on performance of systems constructed in the Chesapeake Bay. Also, interviews with practicing engineers as well as visits to the Maryland Department of Natural Resources were performed in order to obtain practical application ideas. Through these actions, a better understanding of the disparity was gained. In order to attempt to correct the disparity, data, including aerial photographs, engineering drawings, and sites dimensions of locations in the Chesapeake Bay was analyzed.

The numerical analysis portion of this project involved comparing the many variables of a breakwater system. These include Breakwater Length (L), Gap width (G), and Embayment Depth (M). Descriptive statistical analysis as well as linear regression was performed on the ratios of these parameters to determine the mathematical relationships that could be used to provide future design guidance. In addition, shoreline plan-forms behind breakwaters were studied and graphical procedure was used to find the Focal Point (F). This process coupled with statistics and linear regression produced a mathematical relationship for the Focal Point (F). Once all the variables had been defined either numerically or geometrically, guidelines were set for the construction of a headland breakwater system. A spreadsheet based system was developed to assistant designers in laying out a generic breakwater system. In using this spreadsheet and considering wave conditions and other important site variables, the accuracy of predicting the performance of breakwater systems will be greatly increased.

Added Mass and Damping Characteristics of Multiple Moored Ships

Researcher: Midshipman 1/C E. Bradley Hipp, USN

Midshipman 1/C Sarah E. Rollings, USN

Adviser: Associate Professor David L. Kriebel

This project conducted for the Naval Facilities Engineering Service Center (NFESC), provides basic information to aid in the design of safe moorings for nests of ships. A "nest" of ships is considered a group of two or more ships moored together in a common mooring system. There is a great deal known about ships underway in deep water; however, very little is known about the behavior of moored ships in relatively shallow water. Furthermore, while moorings of individual ships are designed to withstand a set of loads generated by wind, waves, and current loads acting upon the vessel, the nature of the loads on nests of ships is generally unknown.

Currently, NFESC uses a computer program, AQWA, that can analyze the effects of wind speed, currents, and waves to predict the dynamic motions of moored ships. In order to apply AQWA to predict the dynamic motions of a nest of ships, NFESC needs to input the added mass and damping coefficients for all ships in the group to make reliable calculations. This is especially true in the sway or side-to-side motion.

The goal of this project is to determine the added mass and damping characteristics of multiple ships in the sway direction in shallow water. Small-scale laboratory tests were used to determine these parameters. The tests were conducted in the Hydrodynamics Laboratory at the U.S. Naval Academy. Existing models of a YP (Yard Patrol Craft) were used. Tests were performed using one ship, and nests of two through five ships. Three different mooring stiffnesses and four different ship draft to water depth ratios were tested. These ratios were selected to simulate the likely range of conditions of nested ships moored in shallow water. In particular, the natural period of motion of ships in the laboratory was selected to represent a realistic range of full scale natural periods. The data from testing was analyzed using Corel Quattro Pro spreadsheets to determine the added mass and damping coefficient for each test. Changing the parameters of stiffness, draft to depth ratio, and number of ships allowed for analysis of parallel relationships and trends to be spotted.

PUBLICATIONS

AUGUST, Robert A. Jr., Gary W. Phillips, Mark J. Harper, Martin E. Nelson, Steven Gann, "Environmental Remediation Research, *Proceedings of the Ninth Symposium on Radiation Measurements and Applications*, paper no. 1DX3, The University of Michigan, Ann Arbor, Michigan, May 11-14, 1998.

We initiated a pilot program at Kirtland AFB, New Mexico to study new methods of environmental characterization and restoration of sites contaminated with mixed wastes. The initial program studied four sites whose primary contaminant was radioactive thorium. Geophysical, nuclear, and chemical analyses were performed during the initial phase, with the program currently expanding to include biochemical studies. The entire program was conducted on-site to eliminate public health concerns about hazardous waste movement and to provide a more efficient way to take and process characterization samples. The program is especially focused on improving remediation alternatives, and the initial study showed a correlation between radiation content and soil grain size that has spurred an effort to exploit this effect for remediation.

AUGUST, Robert A., Martin E. Nelson, and Mark J. Harper, "Characterization of Thorium in Soil at the Interservice Nuclear Weapons School Sites," *Health Physics Society's 43rd Annual Meeting*, Minneapolis, MN, July 12-14, 1998. Accepted April 1998.

An assessment has been performed on the radionuclide concentration in soil at four inactive INWS sites which are located within Kirtland AFB in New Mexico. A preliminary radiation survey with an ionization chamber yielded the locations of highest potential contamination. Then samples were collected at 6-inch depth intervals from the surface in order to develop a contamination vs. Depth profile. The samples were analyzed both chemically and for radionuclides. The radionuclide analysis was performed on site using a HpGe gamma spectroscopy system and showed the presence of predominantly ^{232}Th. Those samples with the highest radioactivity concentration were then dried and sieved and then separated into individual samples of differing grain sizes for further radionuclide analysis. The results showed a definite activity correlation with grain size with a strong excess activity found in the 250-850 μm range. The thorium depth profiles showed in most cases that the concentration had dropped to background levels by a depth of 2 feet. However, in a few cases this was not the case, and sampling down to 5 feet was required before the levels were at or near background. Finally, a risk analysis was performed in order to assess potential remediation needs by calculating the expected mrem y^{-1} based on the collected sample's ^{232}Th pCi g^{-1} and using the EPA risk coefficients. Assuming that the current EPA dose equivalent remediation criterion of 15 mrem y^{-1} in soil is adopted, the analysis indicates that little or none of the soil would need to be removed or treated.

AUGUST, Robert A., Jr., Gary W. Phillips, Mark J. Harper, Martin E. Nelson, Stephen Gann, "A Mixed Waste Characterization in Soil," accepted for publication in *Nuclear Instruments and Methods in Physics Research A*, May 1998.

A pilot program has been initiated at Kirtland AFB, New Mexico to study new methods of environmental characterization and restoration of sites contaminated with potential mixed wastes. The initial program studied four sites whose primary radioactive contaminant was thorium. Geophysical, nuclear, and chemical analyses were performed during the initial phase, with the program currently expanding to include biochemical studies. The entire program was conducted on-site to eliminate public health concerns about hazardous waste movement and to provide a more efficient way to collect and process characterization samples. Chemical analyses showed no significant chemical contamination by metals, semi-volatile organic compounds, and total petroleum hydrocarbons by EPA standards and thus indicated that the soil would not have to be treated as mixed waste. Radioactivity analysis showed a ^{232}Th activity that ranged from background levels to over 1000 pCi/gram. Additionally, using dry sieving, a correlation was found between sample radiation content and soil grain size. It is planned to exploit this effect later in the program when site remediation strategies are developed.

CERZA, Martin R., S. B. MEMORY, Paul MARTO, "The Effect of Pool Circulation on the Natural

Convection and Pool Boiling Heat Transfer of R113 from a Bank of Heated Cylindrical Tubes," submitted for publication in the ASME Journal of Heat Transfer.

This paper focuses on the influence of pool circulation on the natural convection and pool boiling of R113 from a vertical array of heated horizontal tubes. The array was made up of three electrically heated smooth copper tubes, each with an outside diameter of 15.9 mm and a pitch of 66 mm. The array was situated centrally between two vertical walls with a minimum wall to tube OD spacing of 22 mm. The top tube, which coincided with the top of the vertical walls, was 10 cm below the pool surface. Four auxiliary heaters were placed well outside the vertical walls to keep the pool at saturation conditions. Each tube in the array was fitted with a 1kW cartridge heater (which provided a heat flux per tube in the range of 1-100 kW/m^2) and six wall thermocouples which gave an accurate determination of the average wall temperature. Tests were conducted with both increasing and decreasing heat fluxes and data was collected in both the natural convection and nucleate boiling regions.

CERZA, Martin R., Associate Professor, "The Effect of Water of Varying Salinities on the Dissolution of Carbon Dioxide from Bubbles Rising in a Water Column," submitted for publication in the Journal of the American Institute of Chemical Engineering (J. AIChE).

This investigation presents an experimental study of the carbon dioxide absorption process for gas bubbles comprised of both carbon dioxide and carbon dioxide and oxygen into both fresh water and sea water. The parameters investigated include the partial pressure of the carbon dioxide, the volumetric flow rate of the gases and the salinity of the sea water. The method of investigation was to determine the absorption of carbon dioxide into the water by measuring the change in the pH of the ambient water. A six foot plexiglass tower was used to hold the water column which the gas bubbles were percolated. The pH change of the water was measured at both the inlet and outlet of the tower. Three series of data were taken. The first two involved percolating first, pure CO_2 at various flow rates, and then an O_2 and CO_2 mixture through fresh water. The last series of test involved determining the absorption rate of CO_2 in waters of various salinities. These sea water tests showed that CO_2 was more readily absorbed in the saltier waters.

CERZA, Martin R., Associate Professor, "The Effect of a Time Dependent Pressure Field on a Bubble Rising in a Column of Liquid," submitted to the ASME Journal of Fluids Engineering.

A pseudo-steady convective model for bubble diffusional growth or collapse as the bubble is rising in a time dependent pressure field has been developed. The bubble model neglects the effect of added mass, history and interfacial momentum terms. Criteria are developed to show when these terms do affect the bubble motion. The pressure fields investigated are a simple hydrostatic pressure field, and a hydrostatic field with an oscillating reference pressure.

COMPTON, Roger H., Professor, (co-author with Mr. Howard CHATTERTON), "USS CONSTITUTION (IX-21): Then and Now," Chesapeake Section of The Society of Naval Architects and Marine Engineers, 16 December 1997.

In July 1997 the frigate USS CONSTITUTION sailed for the first time in 116 years on the occasion of her 200th anniversary. Model testing in wind and waves and performance under tow were investigated using a 1/25 scale model of the ship in the U.S. Naval Academy's 380 foot towing tank. Such testing was necessary since CONSTITUTION satisfies effectively none of the stability criteria imposed by the U.S. Navy today. The fabrication and testing of the fully rigged model are described.

DAWSON, Thomas H., Professor, "On Markov Theory and Wave Groups," Journal of Offshore Mechanics and Arctic Engineering, Vol. 120 (1998), 56-58.

The Longuet-Higgins connection between Markov description of runs of high waves and the truncated frequency spectrum of a given sea is developed in a simplified, experimentally based manner using combined results from envelope and Markov theories. A high-frequency truncation limit is proposed as $2w_p - 0.5w_o$, where w_p denotes peak spectral frequency and w_o denotes mean frequency. Results are shown to apply to measurements from laboratory and computer simulations of standard Bretschneider and Jonswap seas.

DAWSON, Thomas H., Professor, "Statistics for Wave Crests in Heavy Seas," Proceedings Third International Conference on Ocean Wave Measurement and Analysis, American Society of Civil Engineers, New York (1998).

Statistics for wave crests in heavy seas are described for Bretschneider and Jonswap sea states using scale measurements from laboratory simulations. Attention is directed toward the relative number of high waves expected at a fixed location and the average manner in which these waves come along. The Rayleigh probability law and Markov theory are used to provide a theoretical basis for predictions. Nonlinear effects are included using a Stokes correction. Results from computer simulations are used for comparison purposes.

ERICKSON, Timothy A., Midn 1/C, Keith W. LINDLER, Professor, Mark J. HARPER, Associate Professor, "Design and Construction of a Thermophotovoltaic Energy Conversion System Using Combustion Gases from a T-58 Gas Turbine," Proceedings of the 32nd Intersociety Energy Conversion Engineering Conference, Honolulu, Hawaii, July 1997, pp. 1101-1106.

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

The combustion gas was tapped from the T-58's combustor through one of the two ignitor ports and extracted through a silicon carbide matrix ceramic composite tube into a similarly constructed ceramic composite radiant emitter. The ceramic radiant emitter is heated by the combustion gas via convection, and then serves the TPV generator by radiating the heat outwards where it can be absorbed by thermophotovoltaic cells and converted directly into electricity. The gas turbine and generator module are monitored by a data acquisition system that performs both data collection and control functions. This paper details the design of the TPV generator. It also gives results of initial tests with the gas turbine.

HAWLEY, J. Gary, Peter F. WIGGINS, Pierre G. VINING, Keith W. LINDLER, "Thermodynamics of Marine Engineering Systems," Second Edition, Kendall Hunt, 1998.

This textbook provides students with a practical understanding of the thermodynamics and heat transfer in the design and operation of marine power systems. After developing the basic principles, the book uses a building block approach to analyze various types of marine propulsion systems, including auxiliary equipment.

KRAPIVIN, Vladimir F., Vladimir A. CHEREPENIN, Gary W. PHILLIPS, Robert A. AUGUST, Andrey Yu PAUTKIN, Mark J. HARPER, and Francis Y. TSANG, "An Application of Modeling Technology to the Study of Radionuclear Pollutants and Heavy Metals Dynamics in the Angara-Yenisey River System," *Ecological Modeling*, accepted for publication, March 1998.

This paper 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 was accomplished in the summer of 1995. Using the results of the pollution measurements taken during this expedition, it becomes 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. The influence of soil-plant formations are considered. The model is designed for interactive use in the mode of a computer experiment. The results of the model calculations and of the expedition are given.

KRIEBEL, David L., Associate Professor, "Swash Zone Profile Changes Over Short Time Scales," Proceedings of Coastal Dynamics '97 Conference, Plymouth, England, June 1997.

Results are presented for changes in sand bed elevations occurring across the swash zone over short time scales corresponding to individual swash events. This work is based on large-scale wave tank measurements made during the SUPERTANK Laboratory Data Collection Project where wave records were obtained across the swash zone using wave gages that were partially buried in the sand beach. As a result, these gages could document the wet sand surface following one swash event and preceding the next swash event.

KRIEBEL, David L., Associate Professor, "Use of Transient Waves in Wave Barrier Model Testing," Proceedings of 3rd International Symposium on Ocean Wave Measurement and Analysis, Virginia Beach, VA, Nov 1997.

This paper presents results of laboratory model tests on a vertical wave barrier using transient waves generated from a standard wave spectrum. With these transient waves, a typical model test can be conducted in less than one minute and can yield complete spectral information for wave transmission, wave reflection, and wave forces on the barrier. Results of these short transient wave tests are shown to compare favorably to results of more laborious tests using regular waves. Other advantages of transient waves are then discussed.

KRIEBEL, David L., Associate Professor, "Nonlinear Wave Interaction with a Vertical Circular Cylinder: Wave Forces," Ocean Engineering, Vol. 25, No. 7, 1998, pp. 597-606.

Second-order wave forces on a large diameter vertical circular cylinder, computed according to a semi-analytic nonlinear diffraction theory, are compared to results of 22 laboratory experiments with regular waves. In general, predicted forces agree quite well with measured forces. In most tests, both measured and predicted maximum forces exceeded linear theory by 5 to 15 percent. In a few cases, however, the measured forces were less than those predicted by linear theory in contrast to the second-order predictions. It is shown that these results are related to the phasing of various linear and nonlinear wave force components, and are consistent with those obtained by other investigators.

KRIEBEL, David L., Associate Professor, (co-author), "Wave Kinematics for Simulated Shallow Water Storm Waves - Analysis and Experiments," Ocean Engineering, Vol. 24, No. 9, pp. 835-865, 1997.

Computation of wave kinematics at or near offshore structures is a vitally important consideration in the design of offshore structures. Design waves often include breaking and near-breaking storm waves in the presence of currents. It is important to predict the kinematics of these steep waves. Experiments were carried out in a wave tank with simulated steep waves with and without in-line current in which the wave profiles and the corresponding kinematics were simultaneously measured. The simulated waves represent shallow-water Gulf of Mexico storm waves. Many of these waves broke at or near the measuring instruments. Irregular stream-function theory was used to compute the wave kinematics and was found to generally predict the measured wave-current kinematics well. The differences found between the two are noted. Some of the noteworthy features of the breaking waves are also discussed.

KRIEBEL, David L., Associate Professor, E. P. BEREK, S. K. CHAKRABARTI, and Jennifer K. WATERS, Assistant Professor ,

"Wave-Current Loading on a Shallow Water Caisson: An Evaluation of the API Recommended Practice," Journal of Waterway, Port, Coastal & Ocean Engineering, 1998, in press.

Results of laboratory model tests are used to assess the accuracy of the American Petroleum Institute (API) recommended procedure for predicting wave-current loading on a shallow water production caisson in extreme random waves. Model tests were conducted using a 1-to-20 scale model of a 36-inch diameter caisson in a 50-foot water depth. Tests were conducted in extreme random waves, many of which were breaking, both with and without in-line currents. The experimental results for wave-current kinematics, wave forces, and overturning moments were then compared to predictions based on the API procedure using Stream Function wave theory. Based on analysis of 132 extreme random waves, it was found that the in-line fluid velocities predicted just below the wave trough level were 6% larger than measured values on average. Predicted in-line wave forces and moments were also somewhat biased and were, on average, 10% and 15% larger than measured values, respectively. Despite the

small bias toward over-prediction, the variability between measured and predicted values was quite large and for many waves, measured loads exceeded predicted by 20% to 50% or more. Measured wave loads included dynamic amplification of 5% to 10% due to ringing of the structure following the impact of extreme breaking waves.

KRIEBEL, David L., Associate Professor, (co-author), "Forces on a Single Pile Caisson in Breaking Waves and Current," Applied Ocean Research, volume ?, 1998, pp. ?...?

The effect of breaking and steep non-breaking waves on a vertical pile such as found in the Gulf of Mexico shallow water environment was studied in a wave tank testing. The waves generated were both regular and irregular. The irregular waves were of Bretschneider type. In some tests current was combined in the direction of waves. Specially steep waves in the recorded wave profile were chosen for the analysis of wave forces. It was observed that the forces on the caisson at the wave frequency due to breaking waves were no higher in general than those in nonbreaking steep waves. The drag coefficients in waves alone were much higher than those in a combined wave-current field. The wave-current drag coefficients approached those found in the steady current alone.

LINDLER, Keith W., Professor, Mark J. HARPER, Associate Professor, "Combustor/Emitter Design Tool for a Thermophotovoltaic Energy Converter," *Energy Conversion and Management*, Vol 39, No. 5/6, pp. 391-398, March/April 1998.

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 U. S. 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 a 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 (2200°F). This paper describes the computer spreadsheet model that was written as a tool to be used for the design of the high temperature emitter.

LINDLER, Keith W., Professor, "Use of Multi-Stage Cascades to Improve Performance of Thermoelectric Heat Pumps," *Energy Conversion and Management*, Paper accepted for publication, Oct 1997. (To be published in 1998.)

A thermoelectric heat pump is a miniature solid state device used to pump small amounts of heat. Potential uses range from the cooling of electronic components to dorm size refrigerators. An ongoing study at the U.S. Naval Academy proposes to use a miniature thermoelectric heat pump to maintain a neutron dosimeter at near constant temperatures in order to obtain more accurate readings. Unfortunately, the coefficient of performance of the heat pump decreases rapidly with increasing temperature difference. The current study investigates the potential improvement in heat pump performance that can be obtained by cascading two or more heat pumps in series operation.

MAYER, Robert H., Associate Professor, "Wetland Applications in Capstone Design," USNA Technical Report EW14-97, United States Naval Academy, Annapolis, MD, Aug. 1997.

Natural wetlands are found throughout the world in many forms: as inland salt flats in arid regions; as bogs and tundra in cooler, humid regions; as riparian forests and backwater swamps along rivers and streams. In coastal environs, tidal salt and freshwater marshes and mangrove swamps are typical.

Because wetlands often possess characteristics of both terrestrial and aquatic environments, they offer unique habitats for a variety of wildlife and, biologically, are extremely productive. Wetlands are also known to improve water quality, reduce (the potential for) flooding, and control erosion, among other (shoreline) amenities. Even so, drainage and filling of wetlands, principally for agricultural use, were common practice until the early 1980's. Fortunately, increased public awareness of wetland functions and values led to the "no net loss of wetlands" policies of the Bush and Clinton Administrations. Today, engineers will find it useful and often necessary to include wetlands restoration and conservation among project objectives.

Accordingly, instruction in wetlands function awareness and design procedures has been introduced in the ocean engineering curriculum at the U.S. Naval Academy. Also, capstone design projects have been initiated which include wetlands restoration or creation as a desired design objective. Among the recent design projects are the construction of a saltwater marsh; the restoration of a natural sand spit/island complex, and the protection and environmental enhancement of an eroding shoreline. This paper provides a brief review of wetlands design technology and discusses the capstone tasking and design results of the midshipmen design team(s). It is intended that the paper provide others a convenient means to initiate instruction in this relatively-new coastal design methodology.

MILLETT, Marshall G., LT, USN, Martin E. NELSON, Professor, G. PERTMER, "Weight and Counting Efficiency Optimization in a Moderated Neutron Detector," Nuclear Instruments and Methods, paper submitted march, 1998.

This paper describes a technique in which a polyethylene moderated neutron detector was designed in order have the optimum combination of maximum counting efficiency and minimum weight. The moderator weight efficiency concepts was developed as the basis for comparisons of different moderators and geometries. The MCNP neutron transport code was used to evaluate moderator efficiencies for these different systems. Moderator considered included light water, heavy water, graphite, and polyethylene. The geometries considered included both pancake and cylindrical shapes. The optimized system was then fabricated and experimentally tests against the system in use in the INF treaty between Russia and the US. The test results confirmed the theoretical predictions on the improved moderator weight efficiency of the optimized detector over the current INF deployed system.

MOURING, Sarah E., Assistant Professor, "Advanced Composites for the 21st Century," National Science Foundation (NSF) Civil and Mechanical Systems Proceedings, Arlington, VA, September 1997.

There has been an increase in the use of composite materials during the past few decades, especially in the aerospace and automotive industries. Properties of composites have many advantages including high strength, light weight, and resistance to corrosion, and can be manufactured in various shapes and sizes. However, there are many U.S. industries that are lagging behind in the use of composites including the Civil Engineering and Ship Building industries. The author has concentrated her research work in these emerging areas of composite construction. She is the cofounder and chair of the Advanced Composites Research Center (ACRC) at the U.S. Naval Academy (USNA). The center is a multi-discipline team of members in Ocean Engineering, Mechanical Engineering, and Aerospace Engineering. Her initial research in the area of advanced composites at the Naval Academy was a feasibility study on the development of advanced composite hull panels for large surface ships (NSF-sponsored, NSF9522768). It was concluded from the study that composite-construction hulls were feasible using state-of-the-art technology and new materials for lengths up to 400 feet. However, several areas of major concern were determined. These areas are the current focus of the author's research, and include the following topics: Composite Joint Design, Construction Techniques, and Flaw Criticality.

MOURING, Sarah E., Assistant Professor, "Structural Behavior of Composite Panels Stiffened with Preform Frames," Marine Applications of Composite Materials '98 Proceedings, Melbourne, FL, March 1998, M1-M10.

The U.S. Navy is incorporating composite materials into the fleet due to the advantages of composite construction. These advantages include the reduction in total life costs, corrosion resistance, high strength- and stiffness-to-weight ratios, and improved stealth. One disadvantage is the higher material costs of composites compared to steel and other conventional materials. Therefore, new higher quality materials with lower costs and new fabrication methods need to be developed before composite materials will be fully accepted for the construction of large ships. A new composite preform framing technology shows promise in the reduction of fabrication costs for large ship construction. There already has been significant cost savings using this framing technology in the construction of small recreational boats and large yachts. This framing technology involves casting a dry glass fiber-reinforced plastic (GRP) fabric into shape in a closed mold with a foam core. One unresolved issue using this framing technology is the orientation of the fiber for the frames. This paper summarizes experimental results of testing of composite panels

stiffened with preform frames under in-plane uniaxial compressive loads. Biaxial (0,90), quadaxial (0,90,+45,-45), and triaxial (+45,-45,0) laminates were used in the frames.

MOURING, Sarah E., Assistant Professor, "Behavior of Composite Joints Adhesively Bonded using an Innovative Joining Method," U.S.-Pacific Rim Workshop on Composite Materials for Ship and Offshore Structures Proceedings, Honolulu, HI, April 1998.

Composite structural elements are becoming a popular choice for many marine applications. An inherent benefit of composite materials is the ability to tailor the mechanical properties to suit the application. A major point of interest when designing composite structures is the method of joining. Composite structural elements are joined using two different methods: bonding and bolting. Adhesive bonding has a number of advantages over bolting and is the preferred method of joining for marine applications. Adhesive structural joints typically are formed using a three-step process beginning with the application of an adhesive bead on the surface of one structural part, next joining the structural parts, and finally clamping to insure an adequate bond. Clamping may, in some instances, be required overnight. This is a labor-intensive procedure which may result in high labor costs. Therefore, there is a need to develop an improved joining method for marine applications.

A new joining technique using a combination of liquid adhesive/adhesive tape technology is now being considered as an alternative to current joining techniques. In short, adhesive tape is used to temporarily "tack" structural parts together and to create a channel between the structural parts in which liquid adhesive can be injected at some future time. The resulting bond lines are more consistent than bond lines formed using current bonding practices. Tape thickness determines the bond line thickness while spacing between tape strips determines the bond line width. A benefit of this method is that it can be applied to a variety of structural configurations. Moreover, quality control is possible both before and after application of the liquid adhesive. Overall, this method has the potential to be a more cost-effective, less labor-intensive joining method while providing good structural bonds. This paper describes the ongoing development and evaluation of the new joining method. Experimental and analytical studies are discussed.

NEWNAN, Donald G. and Jerome LAVELLE, Engineering Economic Analysis, 7th Edition, Engineering Press, San Jose, CA, 1998. Professor Johnson prepared spreadsheet supplements to 9 chapters plus a new chapter on advanced spreadsheet topics for this edition. He was listed as a co-author for the 5th edition.

NUCKOLS, M. L., Professor, J. C. CLARKE, C. E. GRUPE, ENS, USN, "Maintaining Safe Oxygen Levels in Semi-Closed Underwater Breathing Apparatus," Intl J. of Life Support and Biosphere Science, Vol 4, 1997, pp 87-95.

Semi-closed circuit, underwater breathing apparatus (UBAs) are far more conserving of limited gas supplies than either steady-flow, open circuit or demand, open circuit systems. Semi-closed systems re-circulate most of the diver's breathing gases, while injecting only a small percentage of the total circuit flow with a fresh make-up supply. The fresh, injected gas supply delivers the necessary make-up to compensate for the oxygen that the diver consumes during each pass through the lungs. This gas conserving feature makes the utility for semi-closed UBAs for long duration, deep diving applications more practical than either of the open circuit designs. However, while more gas conservative, these systems maintain variable oxygen levels during a dive which can fluctuate widely with changes in the diver's activity level, depth of the dive, make-up gas composition, or variations in the total circuit volume. It is essential that the oxygen levels in the circuit always remain within physiologically safe limits; neither too low to avoid the onset of hypoxia, nor too high to risk oxygen toxicity. This paper presents an analytical assessment of the oxygen levels in semi-closed UBAs. This model allows the designers of semi-closed circuits to predict the effects of UBA circuit volumes, make-up gas compositions, injection rates for the make-up gas, diver depths and initial circuit oxygen levels on the time dependent levels of oxygen in these circuits. By using this analytical tool, judicious selection of these design variables can result in the most efficient utilization of the fresh gas supply carried by the diver, and ensure the safe operation of these UBA designs.

NUCKOLS, M. L., Professor, C. E. GRUPE, Midn 1/C, "The Use of Phase Change Materials To Enhance Diver Thermal Protection," Proc 14th U.S.-Japan Diving Physiology Panel, Panama City, FL, 16-17 Sept 1997

An overview of the design, analysis and testing of a recent development in diving suit technology is presented which incorporates the use of phase change materials inside a thermal liner to provide stored latent heat during cold water diving. This liner provides thermal protection for divers' wetsuits, drysuits, and hot water suits while causing minimal restrictions to diver mobility. The liner, which contains approximately 6 pounds of bulk octadecane or eicosane, has been shown to provide up to 30 minutes of emergency backup heating in the event of an interruption of warm water supply when hot water diving suits are used. Up to 2 ½ hours of supplemental heating are predicted with the liner when used as a supplemental heat source for divers wearing passively-insulated drysuits to prolong acceptable durations in near freezing water. The thermal liner is also being investigated to give an emergency "come home" capability in case of power failure within drysuits supplied with an electrically-heated undergarment. As an added benefit, these liners have been shown to protect divers from thermal "shorts" normally encountered when a diver's suit is compressed by surface contacts or in high water currents.

NUCKOLS, M. L., Professor, J. RUDOLPH,

R. J. HUGHES, "Thermal Analysis of a Firefighters' Breathing Gas Cooler,"

J. International Society for Respiratory Protection, Spring 1997, pp9-24.

A breathing gas cooler design is described 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. Two basic heat exchanger designs are evaluated for their thermal performances. 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, in the configuration of an air-to-liquid (or solid) heat exchanger, were designed to be worn comfortably by 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 was found adequate to reduce 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 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 was shown to be 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 was found to provide sufficient heat storage capacity to operate the breathing gas cooler for a 30 minute duration.

SAXTON, P.C., Midn, Angela L. MORAN, Associate Professor, Mark J. HARPER, Associate Professor, K. W. LINDLER, Professor, A Material Selection and Design of a High Temperature Thermophotovoltaic Emitter, *Proceedings of the 32nd Intersociety Energy Conversion Engineering Conference*, Honolulu, Hawaii, July 1997, pp. 1107-1112.

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 TPV 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.

TUTTLE, Kenneth L., Associate Professor, "Combustion Generated Particulate Emissions," Thirteenth International Conference on Solid Waste Technology and Management, Philadelphia, Nov 1997. pp. 4C, 17-24.

Substantial data have been taken that demonstrate the effect of combustion parameters on combustion generated particulate emissions from wood wastes burning on grates. These results apply in a relative sense to any solid fuel that is burned on a grate, including coal, industrial solid wastes, shipboard solid wastes and municipal solid wastes.(4,5, 10) This paper presents results documenting the effects of one of the most important variables found to affect combustion generated particulate emissions, the distribution of

combustion air. In a combustor using a grate, the air used for combustion may be admitted to the firebox entirely as overfire air as in a recovery boiler or on the other extreme, entirely as underfire air as in an updraft gasifier. Wood wastes and other solid wastes are burned in combustors using grates with air ranging from the one extreme, all of the air admitted through the grate, to nearer the other extreme with most of the air admitted above the fuel pile.(4,5,10) These data show the effect on particulate emissions of reducing the proportion of the combustion air that is admitted underfire, through the grate, and increasing the proportion that is admitted overfire, above the fuel pile.

WATERS, Jennifer K., Assistant Professor,"Environmental Protection," Chapter in *Principles of Small Craft Design*, Society of Naval Architects and Marine Engineers, 1998, in progress.

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 smaller craft design. This chapter is therefore the first comprehensive environmental protection reference for smaller craft. Topics include water pollution, air pollution, noise pollution, as well as domestic & foreign legislative and regulatory bodies.

ZIEGLER, J. F., Midn 1/C, Martin E. NELSON, Professor, J. D. SHELL, R. J. PETERSON, C. J. GELDERLOOS, H. P. MUHLFELD, C. J. MONTROSE, "Cosmic Ray Soft Error Rates of 16 Mb DRAM Memory Chips," IEEE Journal of Solid State Circuits , vol. 33, no. 2, vol 33, pp 246-252, February, 1998.

A new study is presented on the effects of high energy neutrons, protons, and pions on modern memory chips. The paper shows that an observed factor of 1000 can be found in the SER in three types of modern memory chip designs currently commercially available modern 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 as to the system electronic and their effects on the observed SER.

ZOULIAS, J. G., Midn 1/C, M. L. NUCKOLS, Professor, "Innovative Concepts in Diver Thermal Protection," Proceedings of ASME International Mechanical Engineering Congress & Exposition, Dallas, TX, 16-21 Nov 1997, pp225-233.

Passive methods of protecting a diver from cold exposures are constantly being sought as alternatives to active heating systems. All passive thermal protection techniques share one common advantage over their active heating counterparts; that is, no requirement for 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. Innovative passive protection techniques, including the use of phase change materials (PCM's) and insulating liquids were explored in this research. Laboratory testing of conceptual insulating concepts were conducted. The objective of this research has been to provide the diving community with improvements in thermal protection for long duration, cold water missions.

PRESENTATIONS

AUGUST, Robert A. Jr., Gary W. PHILLIPS, Mark J. HARPER, Martin E. NELSON, Steven Gann, "Environmental Remediation Research," *Ninth Symposium on Radiation Measurements and Applications*, The University of Michigan, Ann Arbor, Michigan, May 11-14, 1998.

NAVAL ARCHITECTURE, OCEAN AND MARINE ENGINEERING

AUGUST, Robert A., Martin E. NELSON, Mark J. HARPER, "Characterization of Thorium in Soil at the Interservice Nuclear Weapons School Sites," *Health Physics Society's 43rd Annual Meeting*, Minneapolis, MN, July 12-14, 1998. Accepted for presentation, April 1998.

COMPTON, Roger H., Professor, "USS CONSTITUTION (IX-21): Then and Now," Webb Institute, Glen Cove, NY, Dec 8, 1997, Chesapeake Section of the Society of Naval Architects and Marine Engineers, Dec 16, 1997.

DAWSON, Thomas H., Professor, "Statistics for Wave Crests in Heavy Seas," Third International Conference on Ocean Wave Measurement and Analysis (WAVES 97), Virginia Beach, 3 Nov 1997.

ERICKSON, Timothy A., Keith W. LINDLER, Professor, Mark J. HARPER, Associate Professor, "A Design and Construction of a Thermophotovoltaic Energy Conversion System Using Combustion Gases from a T-58 Gas Turbine, *The 32nd Intersociety Energy Conversion Engineering Conference*, Honolulu, Hawaii, July 1997, pp. 1107-1112.

KRIEBEL, David L., Associate Professor, "Use of Transient Waves in Wave Barrier Model Testing," 3rd International Symposium on Ocean Wave Measurement and Analysis, Virginia Beach, VA, Nov 10, 1997.

KRIEBEL, David L., Associate Professor, "Swash Zone Profile Changes Over Short Time Scales," Coastal Dynamics '97 Conference, Plymouth, England, June 24, 1997.

MAYER, Robert H., Associate Professor, "Capstone Design of Constructed Wetlands in Ocean Engineering Education," prepared for presentation at the 1997 ASEE Annual Conference, Milwaukee, WI, June 1997 . . . Note: member participation in division activities, including technical sessions, has been extremely low; since I was serving as session moderator, my formal presentation of "Capstone Design . . ." was postponed in favor of an open discussion on Faculty & Industry support of Ocean and Marine Engineering Education within ASEE.

MOURING, Sarah E., Assistant Professor, "Advanced Composites for the 21st Century", National Science Foundation (NSF) Civil and Mechanical Systems Workshop, Arlington, VA, (Invited Speaker), September 1997.

MOURING, Sarah E., Assistant Professor, Oscar BARTON, Assistant Professor, Gabriel KARPOUZIAN, Associate Professor, and Michael MACKNEY, Associate Professor, "Advanced Composites Research Center," Greatlakes Composites Consortium, Boeing Corp., St. Louis, MO, (Invited Speaker), September 1997.

MOURING, Sarah E., Assistant Professor,"Structural Behavior of Composite Panels Stiffened with Preform Frames," Marine Applications of Composite Materials '98, Melbourne, FL, March 1998.

MOURING, Sarah E., Assistant Professor, "Behavior of Composite Joints Adhesively Bonded using an Innovative Joining Method,"U.S.-Pacific Rim Workshop on Composite Materials for Ship and Offshore Structures, Honolulu, HI, April 1998.

NUCKOLS, M. L.,Professor, "The Use of Phase Change Materials To Enhance Diver Thermal Protection," 14th U.S.-Japan Diving Physiology Panel Meeting, Panama City, FL, 16-17 Sept 1997

NUCKOLS, M. L.,"Innovative Concepts in Diver Thermal Protection," 1997 International Mechanical Engineering Congress & Exposition, Dallas, TX, 16-21 Nov 1997.

NUCKOLS, M. L., Professor, "Maintaining Safe Oxygen Levels in Semi-Closed Underwater Breathing Apparatus," 3rd Intl Conference on Life Support and Biosphere Science, Orlando, FL, 11-15 Jan 1998.

NUCKOLS, M. L., Professor, "Living and Working Underwater," to Gifted and Talented Students at Severna Park Middle School, 12 December 1997.

SAXTON, P. C., Midn, Angela L. MORAN, Associate Professor, Mark J. HARPER, Associate

Professor, Keith W. LINDLER, Professor, "Material Selection and Design of a High Temperature Thermophotovoltaic Emitter," *The 32nd Intersociety Energy Conversion Engineering Conference*, Honolulu, Hawaii, July 1997.

SCHMIECHEN, Michael, and Bruce JOHNSON, Professor, "The History and Recent Developments in the International Towing Tank Conference ITTC Symbols and Terminology List," presented at the First International Symposium on Maritime Terminology, Brussels, Belgium, 15-16 May, 1998.

SHERWOOD, Colby, Midn, and Sarah E. MOURING, Assistant Professor, "Strength of Composite Joints Fabricated with an Alternative Joining Technique," U.S. Naval Academy, 1 May 1998.

TUTTLE, Kenneth L., Associate Professor, "Combustion Generated Particulate Emissions," Thirteenth International Conference on Solid Waste Technology and Management, Philadelphia, Nov 1997.

WHITE, Gregory J. - "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.

TECHNICAL REPORTS

CERZA, Martin R., Associate Professor, "The Development of a Multiple Source Light Transmitter from a Single Fiber Optic Cable," Division of Engineering and Weapons Report no. EW-01-98.

This report outlines the study to develop a multiple source light emitter from a single multimode fiber optic cable. In the technology of non-destructive evaluation (NDE) a single fiber optic cable is used in conjunction with a light source, to transmit a beam of light to a particular location in a structural member, such as an aircraft wing, in order to aid in the evaluation of the stress of that member. Several evaluation techniques may be employed to determine the stress: interferometry, Bragg grating frequency diagnosis to name a couple. The problem is that the fiber optic cable can only be run to one location. In this investigation, the fiber optic cable is to have its cladding removed via an HF etching process at various locations along its length. The purpose is to allow light to escape the cable at various points along the cable length, since the difference in the index of refraction between the cladding and the core is what keeps the light totally internally reflected. With the cladding removed, multiple light transmission sources can be achieved so that a single cable can transmit a diagnostic light beam at many locations in the stressed member. To date, this process appears to be working, although the HF etching process needs further refinement in order to be exact.

CERZA, Martin R., Associate Professor, "An Investigation into the Effect of Augmentation Gas Injection on the Combustion Effluents and Fuel Efficiency of a Gas Turbine," Division of Engineering and Weapons Report no. EW-02-98.

This report outlines the investigation to reduce the nitrous oxide (NO_x) and carbon monoxide (CO) formation in gas turbine exhaust gas byproducts by injecting an augmentation gas into the compressor of a gas turbine. This in effect is simulating an Exhaust Gas Recirculation (EGR) system when the augmentation gas is Carbon Dioxide. Other gases to be injected include Argon, Nitrogen and Helium (varying spread in molecular weights). A state of the art exhaust gas analyzation system has been procured to measure the concentrations in the exhaust gas products for varying types of synthetic atmospheres. Also being investigated are the effects of the augmentation gas injection on fuel efficiency. Varying concentrations of augmentation gases should effect the adiabatic flame temperature of the combustion process. This should influence both the formation of pollutants and fuel efficiency.

MOURING, Sarah E., Assistant Professor, Michael E. MCCORMICK, Professor, Johns Hopkins Univ., and

B. DONALD, Ensign, USN, "Investigation into Wave Energy Attenuation by Artificial Aquatic Vegetation," USNA Report EW-13-97, December 1997.

Hard stabilization techniques been used in the past for erosion control of shorelines with often poor results. One alternative to hard stabilization techniques is the use of natural or artificial aquatic vegetation to attenuate water waves. Both natural and aquatic vegetation allows water and sediment transport while provide an environmental habitat for aquatic species. Artificial aquatic vegetation has been proven to withstand much harsher environmental conditions compared to natural vegetation. However, little investigation into the use of artificial vegetation as an alternative method of shore protection has been performed. Recently, a preliminary study into the effects of artificial vegetation on the` attenuation of water waves was performed. Arrays of rigid submerged rods were used to represent aquatic vegetation. Results were analyzed and compared two array with different patterns: full pattern and staggered pattern. Both array patterns were shown to successfully reduce the amount of transmitted wave energy with the best results associated the full array pattern. Wave energy reflection was minimal for both array patterns. Nondimensional analyses were performed using wave steepness and Keulegan-Carpenter number. This report is a summary of the findings and review of current research in this area.

DEPARTMENT OF

Weapons and Systems Engineering

Professor T. E. Dwan
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 were two Trident Scholar in the Systems Engineering Department. They engaged in extensive research projects in lieu of several courses. Their research topics were the development of a tunable light source and the use of digital signal processing for acoustic analysis.

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. This work develops the software and procedures 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 the one 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

Researchers: Associate Professor George E. Piper and

Assistant Professor John M. Watkins

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 use of magnetic bearings for noise control in a large scale naval pump system. The major issues addressed in this work concern 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-membership estimation to the problems of system identification, 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.

Investigations into Distributed Aperture Surveillance Systems

Researcher: Associate Professor Carl E. Wick

Sponsor: Naval Air Warfare Center, Patuxent River, Maryland

Our conventional military and civilian optical surveillance systems are most often constructed with a single staring or scanning camera and lens system that provides instantaneous coverage over a relatively limited field of view. The camera/lens system may often be slewed in one or more directions to increase the surveillance area, but at the expense of potentially missing fast moving targets. Current technology can produce a multiple-camera visual or infrared surveillance system fitted with wide-angle lenses, which in total is capable of the simultaneous viewing of a hemisphere or more. Making sense of multiple images from multiple cameras, however, requires some new thinking in image processing architectures and algorithms. For example, the images from each camera must be processed to remove lens distortion, to remove camera artifacts, and to enhance other image properties. The combined images must be registered with reference to each other and the combined data must be stored in a computer in such a fashion that data can be easily extracted for multiple purposes: visual surveillance, early warning, situational assessment, etc.

This investigation will assist the Naval Air Warfare Center in an on-going distributed aperture surveillance project. The investigation areas will include algorithms for image enhancement and standardization, hardware memory architectures for storing multiple-camera image data, and hardware and software architectures for very high speed image processing. A prototype distributed system has been constructed in our laboratory spaces for the purposes of system study and verification.

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.

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.

Sonar-Integrated Control of Vision-Driven Robotic Systems

Researcher: Assistant Professor Bradley E. Bishop

This proposal focuses on the design of multiple, independent controllers and sensing algorithms for dynamic robotic manipulation using computer vision. The long term goal of this work is integration of sensing and control into a unified framework for flexible, autonomous robotic manipulation. To facilitate increased flexibility we will admit a family of system objectives defined with respect to the robot-environment

interaction and design a control and sensing methodology in accordance with the multiple objective framework.

Intuitively, it can be seen that purposive action and focused sensing are closely related, in that the environment is projected onto the objective space through the sensor mapping. Multiple sensing methodologies can be combined to generate primitives in a "sensing language" that can be utilized to achieve widely varying sensing objectives, such as object recognition, motion estimation, localized object tracking, etc. This sensing language interacts with control-based objectives in a qualitative manner, in that the output of the sensing system must match the requirements for a specific action objective.

Given a family of possibly unrelated objectives, a suite of control laws is defined. The individual controllers are designed to guarantee appropriate and efficient use of the system capabilities for each of the objectives. To achieve maximal performance, appropriate sensing algorithms must be coupled with the various classes of controllers. Selection of an objective will suggest suitable classes of controllers and sensing algorithms. Similarly, stability requirements may indicate specific classes of suitable controllers at a given instant, thereby limiting achievable objectives. Instantiation, and switching between specific controllers and sensing methodologies then require careful analysis of the complex interaction between sensing and control.

The aim of this research is to develop conceptual and mathematical tools for the integration of multiple sensing and control methodologies into a unified approach to sensor-driven robotics. The test bed that will be investigated is that of vision-driven dynamic robot systems, so called visual servo systems.

Fuzzy Model-Based Control: An LMI Approach

Researcher: Assistant Professor Kiriakos Kiriakidis

Based on previous results, this research suggests the development of less conservative and more tractable design tools for nonlinear systems. In addition to necessary stabilization requirements, the proposed research investigates compliance to performance specifications.

The advocated methodology applies to complex nonlinear systems, i.e., plants whose internal mechanics are not completely known or whose modeling via first principles is impractical. Fuzzy modeling, an approach based on input-output measurement, is the platform for analysis and synthesis of such systems. As a by-product, the new technique is suitable for any nonlinear system, not necessarily complex, which can be approximated by a fuzzy model.

Robust Controller Design for Linear, Time Varying Systems

Researcher: Assistant Professor Richard T. O'Brien

A robust controller design procedure for linear, time-varying systems is proposed. Controller design for linear, time-invariant systems has been studied extensively and typically, the design methods are based on classical frequency domain analysis. The extension of these techniques to time-varying systems is complicated because the frequency response of a time-varying system changes with time. As a result, the application of frequency domain analysis to the problem of controller design for time-varying systems has been limited.

In previous research a design procedure for time-varying systems using existing results on $H\infty$ optimal control results was developed. In this procedure, performance specifications are incorporated in the design process using localized-in-time frequency domain analysis. As part of this analysis, measures of the time-variation of a system for the purpose of identifying slowly varying systems was examined. For

this class of systems the frequency domain methods used with time-invariant systems can be applied to the design of controllers for time-varying systems.

For time-invariant systems, poles and zeros play important roles in controller design. For example, the connection between the location of poles and zeros of a single-input, single-output system and the achievable performance and robustness is classical. The relationship between these poles and zeros and a system's frequency response; and subsequently methods for incorporating this information in the design process will be investigated. The objectives of this project are to build a procedure and create a systematic approach to controller design for time-varying systems. The design of a steering controller for an automated vehicle will be used as a benchmark for comparing this new procedure with the procedure previously developed

Research Course Projects

Tests to Evaluate Low Frequency Characteristics/Performance

Researcher: Midshipman 1/C Horace R. Ashworth, USN

Adviser: Assistant Professor Svetlana Avramov-Zamurovic

This project seeks to learn about the Thermal Voltage Converter and its low frequency behavior. I will use the step response of the system and the DC transfer function measurements to generate frequency response predictions. And, after generating a new emf output, I will compare these predictions with the frequency response measurements and examine the error involved as well. Finally, a new output emf for different input voltages and frequencies to try and see what can be done in predicting the AC-DC difference in the frequency characteristics of the Thermal Voltage Converter.

Radio Direction Finding System

Researcher: Midshipman 1/C David S. Cox, USN

Adviser: Associate Professor Carl E. Wick

In a world that relies on radio signals to accomplish a wide variety of tasks, there exists a need to develop a system that can determine the direction from which a particular radio signal originates. Such a system would be useful for tracking down sources of malicious interference, electronic surveillance, and many other important tasks. I propose to create a radio direction finding system to accomplish this goal. A study will be conducted of the advantages of basing the system on a fixed or rotating antenna array, determining whether the goal can be achieved with one or multiple receivers and constructing the most feasible system.

Monitoring the Exhaust Gases of a Combustion System

Researcher: Midshipman 1/C Melissa Plean, USN

Adviser: Assistant Professor Kiriakos Kiriakidis

The purpose of this project is to monitor the exhaust gases of a combustion system. This project will be environmentally beneficial, since the exhaust gases we are testing go directly into our atmosphere. We will be strategically placing a sensor at various points in the combust or to achieve the best readings. Then, using an oscilloscope and computer programs, we will make this information more usable. Signal conditioning will play a large role in this project, translating the sensor's output readings into data we can easily manipulate, understand, compare.

Virtual Reality Investigations

Researcher: Midshipman 1/C Robert F. Reynolds, USN

Adviser: Associate Professor Carl E. Wick

The growing numbers of areas that are inaccessible to humans have forced engineers to develop ways to see and maneuver in the regions without actually being there. Virtual reality has been the first step in this process. A person can don equipment and feel like he is actually on the planet Mars without actually being there through the use of virtual reality. This project will seek to create a system that will not only allow you to feel like you are in a remote location, but will also allow you to manipulate a camera through the use of Virtual i-glasses! Personal Display System.

Optical Fiber Grating Tunable Light Source Centered at 683 nm

Researcher: Midshipman 1/C Ian J. Schillinger, USN

Adviser: Assistant Professor John M. Watkins and

Assistant Professor P. Battle, Physics Department

The project is to construct and characterize a tunable light source centered at a wavelength of 683 nm by coupling a laser diode with an optical fiber containing a reflective diffraction grating. This source, once constructed and characterized will be used to seed a Raman Amplifier and for applications in spectroscopic research. The optical fiber grating will isolate light of a specific wavelength and return it to the diode for amplification. The wavelength selected will be a function of the longitudinal strain applied to the fiber since the fiber is flexible and since the internal reflective behavior is determined by the spatial orientation of the grating surfaces. This in combination with the natural mode selectivity of a laser diode should combine to produce a very precise output. In addition, the compound feedback nature of this process should insulate it from the effects of optical noise. Where time permits, a mathematical model of the sight source will be developed, which will relate the output of the device to parameters such as longitudinal strain on the optical fiber.

Noise Reduction in Submarine Propulsion Systems Through Use of Magnetic Bearings

Researcher: Midshipman 1/C John S. Wiggins, USN

Advisor: Associate Professor George E. Piper

Noise emissions are of prime concern in submarine design. The aim of this project is to use active sound control to achieve tonal reductions in the noise emissions of the motor and propeller assembly. Active sound control is the use of one sound wave - the "secondary" sound - to cancel out a "primary" sound wave. If the primary and secondary waves are of equal magnitude, but 180° out of phase, they will cancel each other out completely, eliminating any noise at that frequency. In the case of the submarine design, the normal operation of the motor and the movement of the propeller through the water generate the primary noise. The primary and secondary sound sources are close together relative to the wavelengths of low frequency sounds. Therefore, it is theoretically possible to achieve global noise control, or to reduce the sound level at all points in space.

This project will simulate a submarine propulsion system with an electric motor and fan blade operating in air. Tow magnetic bearings will support the drive shaft radially, while a third bearing will control the lateral position of the shaft. Magnetic bearings provide several advantages over conventional bearings; since the shaft is not in contact with the bearings there is little or no friction at the bearings; the bearings do not need to be lubricated. They require no regular maintenance and of special significance in this project, magnetic bearings can adjust the position of the shaft which they support. Since the bearings are electromagnets, a current or voltage control system can adjust the force produced by the bearings. By rapidly altering the force of the bearings, the control system can cause the shaft to vibrate with a particular frequency and magnitude. A digital control system is designed to perform this function using a microcomputer with a digital signal processing card. Several control algorithms including feedback control and adaptive feed forward using the least mean square algorithm are investigated. Performance of each algorithm is evaluated by measuring noise emissions with and without active control in an anechoic chamber.

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 1997-98:

Sumo Wrestler

Midshipmen 1/C Joseph P. Abbott,

Horace R. Ashworth and Eric D. Zito, USN

Adviser: Commander Bradford H. Baylor, USN

Sumo Wrestler

Midshipmen 1/C Ryan P. Ahler and

Edward F. Ward, USN

Adviser: Commander Bradford H. Baylor, USN

WEAPONS AND SYSTEMS ENGINEERING

Optimus Prime (Voice Activated, Transforming Robot)

Midshipmen 1/C Brett A. Allison,

Matthew J. Gilbreath and Thomas J. Kneale, USN

Adviser: Lieutenant Commander Christopher H. Jensen, USN

Systems Ball

Midshipmen 1/C Stephen W. Alridge and

Christian M. Sewell, USN

Adviser: Lieutenant Commander Earl F. Goodson, USN

Systems Ball

Midshipmen 1/C Peter J. Andrews and

Jesse H. Balboa, USN

Adviser: Lieutenant Thomas P. Bogan, USN

The Austin "Danger" Powers Pathfinder 9800

Midshipmen 1/C George A. Bancroft and

Greig T. Gehman, USN

Adviser: Lieutenant Thomas P. Bogan, USN

Master Blaster

Midshipmen 1/C Blaine S. Bitterman and

Joshua M. Kiihne, USN

Adviser: Commander John J. Viniotis, USN

Severn Eco Box

Midshipmen 1/C Justin J. Bliffen ,

Shanti Holmes-McGovern, Robert L. Radak and

Charles D. Spenceley, USN

Adviser: Lieutenant Commander David R. Gillingham, USN

Radar Defeater

Midshipmen 1.C Timothy C. Boehme and

Grant W. Flynn, USN

Adviser: Commander Peter A. Fyles, USN

WEAPONS AND SYSTEMS ENGINEERING

The Intelligent Room

Midshipmen 1/C Andre D. Bonakdar,
Donald W. Faul and Jacob R. Harriman, USN
Adviser: Lieutenant James H. Jennings, USN

Systems Ball

Midshipmen 1/C Michael R. Breen and
Brian M. Campbell, USN
Adviser: Lieutenant Commander Scott D. Bohman, USN

Eco-House

Midshipmen 1/C John Chau and
Vincent E. Yealdhall, USN
Adviser: Commander Bradley D. Taylor, USNR

Transmitter Locator

Midshipman 1/C David S. Cox, USN
Adviser: Lieutenant Commander David R. Gillingham, USN

C & G Tuning Machine

Midshipmen 1/C Christopher J. Curtiss and
Gene G. Severtson, USN
Adviser: Lieutenant Commander Earl F. Goodson, USN

Automated Parallel Parking

Midshipmen 1/C Matthew W. Dodge,
Jonathan B. Snavely and Bryan P. Taylor, USN
Adviser: Captain Denise A. Mattes, USMC

Systems Ball

Midshipmen 1/C James E. Dorff and
William J. Tull, USN
Adviser: Lieutenant Commander Scott D. Bohman, USN

Systems Ball

Midshipmen 1/C Blake I. Dorr,
Angelo D. Fontanaza and Douglas K. Meagher, USN
Adviser: Lieutenant Commander Michael E. Pas, USN

Central Cooling/Heating Unit for Multiple Rooms

Midshipmen 1/C Phillip A. Duba,
Jose A. Perez and Theodore Mac O. Quidem, USN
Adviser: Lieutenant Commander Christopher H. Jensen, USN

Gyro-Inertial Helmet for Remote Camera Control

Midshipmen 1/C David L. Edgerton and
Michael C. Lawler, USN
Adviser: Commander John F. McKernan, USN

The Micro Mouse

Midshipmen 1/C Shane J. Eisenbraun and
Christopher N. Hayter, USN
Adviser: Lieutenant Commander David R. Gillingham, USN

Weapon Vision for Acquisition and Targeting

Midshipmen 1/C Jed R. Espiritu and
Joseph A. Goodwin, USN
Adviser: Major William W. Arrasmith, USAF

Automated Windshield Visor

Midshipmen 1/C Charles E. Fisher and
Gerald J. Wilson, USN
Adviser: Lieutenant James H. Jennings, USN

The Amazing Golf Ball Finder Thing

Midshipmen 1/C James T. Fuller and
Jason E. Weed, USN
Adviser: Captain Denise A. Mattes, USMC

WEAPONS AND SYSTEMS ENGINEERING

Mobile Digital Satellite System

Midshipmen 1/C Torey F. Hinkson,
Mitchell S. McCallister and Eddie F. Whitley, USN
Adviser: Major William W. Arrasmith, USAF

Satellite Attitude Control Simulator

Midshipmen 1/C Jarod A. Kesselring,
Thomas E. Neal and Brendan J. Robinson, USN
Adviser: Commander John F. McKernan, USN

Thermal Camouflage

Midshipmen 1/C Michael J. Kinsella and
Robert F. Reynolds, USN
Adviser: Major Thomas L. Langlois, USMC

Automated Automobile Wheel Alignment System

Midshipmen 1/C Joseph B. Lambert,
Adel M. Maani and Christopher J. Warden, USN
Adviser: Commander John J. Viniotis, USN

Electronic Muffler

Midshipmen 1/C Brett M. Levander and
Samuel E. McGowan, USN
Adviser: Lieutenant Commander Steven F. Vincent, USNR

Systems Ball

Midshipmen 1/C Matthew J. Maloney and
Gabriel A. Mauldin, USN
Adviser: Commander Steven D. Kinney, USN

3-D Hull Mapping Using Lasers

Midshipmen 1/C Nathan S. Marvel and
Chad W. Seagren, USN
Adviser: Commander Peter A. Fyles, USN

Voice Activated Golf Bag

Midshipmen 1/C Jonathan A. Marvell and

Michael T. Puffer, USN

Adviser: Lieutenant Thomas P. Bogan, USN

Active Noise Control

Midshipmen 1/C Milton V. Mendieta and

Marlin Ratajczyk, USN

Adviser: Lieutenant Commander Steven F. Vincent, USNR

Radio-Controlled Traffic Sensor

Midshipmen 1/C Michael P. Murphy and

Kenneth E. Schwalbe, USN

Adviser: Commander Bradley D. Taylor, USNR

Analysis and Comparison of CO2 Exhaust as Related to Methane Fuel Consumption

Midshipman 1/C Melissa B. Plean, USN

Adviser: Major Thomas L. Langlois, USMC

Micro-Mouse

Midshipmen 1/C Kengh Poh and

Banjird Tongchiw, USN

Adviser: Lieutenant Commander Michael E. Pas, USN

A Coxswain Box that Keeps the Coach Informed

Midshipmen 1/C Jonathan L. Wright and

John R. Zurn, USN

Adviser: Commander Steven D. Kinney, USN

Publications

AVRAMOV-ZAMUROVIC, Svetlana, Assistant Professor and Horace R. Ashworth, Midshipman 1/C, "Student Independent Research Project: Evaluation of Thermal Voltage Converters Low-Frequency Error," *ASEE Conference Proceedings*, June 1998.

This paper describes a student independent research project. The project task was to evaluate the low frequency errors of Thermal Voltage Converters (TVCs). A method to evaluate the low frequency errors of TVCs has been developed. This method is based on measurements of the dc transfer function and time constant of the tested TVC. The error analysis is performed in the frequency domain. The first phase of the student project was to confirm the developed method by generating MATLAB simulation based on the publications. The project's second phase was to analyze the TVC errors in the time domain and compare the results.

AVRAMOV-ZAMUROVIC, Svetlana, Assistant Professor, N. M. Oldham, M. Parker, and B. Waltrip, "Low Frequency Characteristics of Thin-Film Multi-junction Thermal Voltage Converters," *IEEE Transactions of Instrumentation and Measurements*, Vol.47, No. 1, Feb 1998, pages 87-89.

Low frequency errors of thin-film 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 characteristic using a digitally synthesized source.

AVRAMOV-ZAMUROVIC, Svetlana, Assistant Professor, J. R. Kinard, T. E. Lipe and C. B. Childers, "Comparison of High Voltage Thermal Converter Scaling to Binary Inductive Voltage Divider", *CPEM98 Conference Proceedings*, (July 1998).

High-Voltage Thermal Converters (HVTCs) are used as standards of ac-dc difference and for the measurement and calibration of ac voltage up 1000 V and 1000 kHz. Their multiplying resistors can be compensated to yield small ac-dc differences by using adjustable internal shields; however, the ac-dc differences of HVTCs may vary as functions of warm-up time, applied frequency, and applied voltage. Voltage coefficients between 100 V and 1000V can be quite significant compared to calibration uncertainties, and can be major sources of error in the buildup process used to characterize the HVTCs. Formal and informal international comparisons of HVTCs have revealed variations among the participating laboratories. The present work was undertaken to compare the scaling accuracy of HVTCs to the completely independent principle of a binary inductive divider.

BISHOP, Bradley E., Assistant Professor and Mark W. Spong, Research Professor, "Adaptive Calibration and Control of 2D Monocular Visual Servo Systems," *Proceedings of the 9th IFAC Symposium on Robot Control*, (August 1997).

For a majority of visual servo systems, accurate camera-robot calibration is essential for precision tasks, such as tracking time-varying end-effector trajectories in the image plane. This paper presents details of control-theoretic approaches to calibration of monocular visual servo systems in the case of a planar robot with workspace perpendicular to the optical axis of the imaging system. As on-line adaptive calibration and control scheme is developed along with an associated stability and convergence theorem. A redundancy-based refinement of this scheme is proposed.

BISHOP, Bradley E., Assistant Professor and Mark W. Spong, Research Professor, "Control of Redundant Manipulators Using Logic-Based Switching," *1998 IEEE Conference on Decision and Control*, (March 1998).

This is a study of the control of redundant planar robotic manipulators using a switched (or hybrid) control scheme, focusing on manipulators with a degree of redundancy of one. Emphasis is on effectiveness of switched control systems with respect to stabilization and performance enhancement for this class of manipulators. A simulation study of logic-based switching control of a 3 DOF planar manipulator under end-effector trajectory tracking and demonstrate the capabilities of this scheme.

BISHOP, Bradley E., Assistant Professor and Mark W. Spong, Research Professor, "Development of a Three Degree-of-Freedom Air Hockey Robot," *Video Proceedings of the 1998 IEEE International Conference on Robotics and Automation*, (May 1998).

Development of a three degree of freedom air hockey robot in the Coordinated Science Laboratory at the University of Illinois at Urbana-Champaign. This system serves as a test bed for the study of real-time visual servoing, nonlinear control of redundant robots, intelligent and hybrid control theory and machine learning. The challenges we face in visual servo control arise due to the high-seed motion of the puck on the table and the highly uncertain environment dynamics which make accurate real-time motion prediction from camera images difficult. Our control architecture utilizes supervisory control and switching among a set of nonlinear controllers, each designed for a specific task, such as blocking or striking the puck. The supervisor uses a confidence measure based on the reliability of the estimated puck trajectory to determine, at each interval, which controller to switch into the closed loop.

BISHOP, Bradley E., Assistant Professor and Mark W. Spong, Research Professor, "Toward 3D Uncalibrated Monocular Visual Servo," *Proceedings of the 1998 IEEE International Conference on Robotics and Automation*, (May 1998).

This work is an initial step toward combining control theory with computer vision for the case of uncalibrated monocular (or single-camera) three-dimensional manipulation. We investigate an achievable control goal using a novel image measure and derive a sampled-data control system that results in quick convergence of the end-effector trajectory to a depth-invariant velocity subspace in the camera coordinate frame. We also discuss how this uncalibrated behavior can be used to perform on-line calibration.

KIRIAKIDIS, Kiriakos, Assistant Professor, "Dynamic Output Feedback of Gas Furnaces via Fuzzy Modeling," *Proceedings of the Sixth IEEE Conference on Control Applications*, (October 1997).

This paper presents the design of a dynamic output feedback controller, which is based on fuzzy modeling, for the regulation of complex plants. The method develops separate procedures to design a converging state estimator and a stabilizing controller. The results are demonstrated on the fuzzy model of a gas furnace process.

KIRIAKIDIS, Kiriakos, Assistant Professor, "Observer-based Control of a Gas Furnace via Fuzzy Modeling," *Proceedings of the ASME Dynamic Systems and Control Division, International Mechanical Engineering Congress and Exposition*, (November 1997).

The paper addresses the control problem of complex plants, using state space realization derived from Takagi-Sugeno fuzzy models. In particular, a state feedback controller, based on the observed state, is proposed for the regulation of gas furnaces. The method comprises procedures to design a converging observer and a stabilizing controller. It is shown that if the observer and controller gains satisfy an additional sufficient condition the observer-based closed loop is stable. Simulation studies on the fuzzy model of the gas furnace process verify the result.

KIRIAKIDIS, Kiriakos, Assistant Professor, "Nonlinear Control System Design via Fuzzy Modeling and LMIs," *International Journal of Control*, 1999, Vol. 72, No. 7/8, 676-685.

Fuzzy modeling and model based control offer alternative solutions to analysis and synthesis problems associated with many systems that exhibit complex nonlinear behavior. A prominent advantage of these approaches has been their ability to work without resorting to first principles or engaging elaborate controllers whose performance in a changing environment will deteriorate inevitably. The present paper facilitates further advances in the field through the development of a framework that embraces the vast majority of the existing fuzzy model based control techniques and provides novel means to design nonlinear control systems for a variety of applications. The proposed design methodology exploits the distinctive property of the fuzzy model as the convex hull of linear system matrices. Using this quasi--linear model structure, the robust stabilization of nonlinear systems, against modeling error and parametric uncertainty, based on static state or dynamic output feedback is formulated and solved as a Linear Matrix Inequality (LMI) problem.

KIRIAKIDIS, Kiriakos, Assistant Professor, "Fuzzy Model Control of Nonlinear Plants Using LMIs," *Proceedings of the World Automation Congress*, (May 1998).

At present, there exists several methodologies that provide Takagi-Sugeno fuzzy models for nonlinear plants. The main advantage of fuzzy modeling, compared with modeling via first principles, lies within the ability of the method to approximate nonlinear behavior directly from I/O data. From the design point of view, the mathematical form of fuzzy models, which distinguishes them from other non-conventional models, such as neural networks, is a unique asset. Indeed, their quasi-linear aggregative structure enables the use of Linear Matrix Inequalities (LMIs) for control system synthesis. Herein, we present a systematic approach that exploits this added advantage.

O'BRIEN, Jr., Richard T., Assistant Professor, "Time-Varying Modeling of Vehicle Dynamics for Automated Steering Control," *Proceedings of IASTED International Conference on Modeling and Simulation*, (1998).

This paper addresses the modeling of the lateral dynamics of a highway vehicle for the purpose of designing and evaluating automated steering controllers. Linear and nonlinear models are presented describing the lateral motion of the vehicle traveling at a known time varying speed. The nonlinear model contains only those parameters relevant to the lateral motion of the vehicle and has been validated using a comprehensive vehicle model. The linear model is developed for use in a controller design procedure to linear, time-varying systems. Numerical simulations of both models are presented.

O'BRIEN, Jr., Richard T., Assistant Professor. "On Stabilizing Solutions to the Riccati Differential Equation," *Proceedings of 13th IEEE Symposium on Systems Theory*, (1998).

Sufficient conditions are presented for the existence of a stabilizing solution to a Riccati differential equation using the mostion of a pole set for a time-varying state equation previously defined by the author. The results presented in this paper supplement the work of Ravi, et al. and generalize the methods used in the investigation of stabilizing solutions to the algebraic Riccati equation. Furthermore, this stabilizing solution is used to compute a particular left coprime factorization of a time-varying system not addressed by Ravi, et al.

WATKINS, John M., Assistant Professor, George E. Piper, Associate Professor, E. Eugene Mitchell, Professor and Kevin J. Wedeward, Assistant Professor, "Computer Animation of Dynamic Systems in the Classroom," *ASEE Computers in Education Journal*, Vol. VIII, No. 1, pp. 7-13, 1998.

Today's students are exposed to multimedia in all aspects of their lives, from MTV to World Wide Web. They have become accustomed to receiving information in this manner. Multimedia is also finding its way in to computer simulation. Computer simulation is also being used to enhance students understanding of dynamic systems. Incorporating animation with simulation not only increases the student's understanding, it captures their attention and increases their motivation. Animation bridges the gap between abstract mathematical equations and the physical behavior of the system.

In the past , computer simulation and animation required the use of conventional programming languages such as FORTRAN, PASCAL, or C. While this approach allows for effective dynamic simulation, it is easy for the user to get sidetracked with programming issues and lose sight of the original problem. Animation, in particular, requires a specialized knowledge of the computer platform. With today's windowing environment, there are an increasing number of commercially available programs that allow the user to easily develop simulations of general dynamic systems. These programs include MATLAB, Matrix-X, Control-C, and VisSim. computer simulation programs encourage students to explore complex and realistic systems. The interactive environment and graphic capability of these programs provides instant feedback to the students. In addition to dynamic simulation capabilities, many of these programs allow the user to incorporate animation into the simulation.

Animation is being incorporated into the systems engineering courses at the U.S. Naval Academy to help teach system dynamics and control. The systems Engineering curriculum at the U.S. Naval Academy focuses mainly on linear systems theory, feedback control, and mechatronics. It is a four year, undergraduate, ABET-accredited, engineering program. Throughout the curriculum students learn how to model, simulate, and design various types of control systems. The computer software the students use to analyze, simulate, and implement their designs are

MATLAB, VisSim, and the C-programming language. These tools were selected based on their relevance to industrial practices, cost, and availability to the student. Methods of animation in VisSim and MATLAB as well as three examples used in the curriculum are presented.

WIGGINS, John S., Midshipman 1/C, George E. Piper, Assistant Professor, "Active Noise Control of Rotating Machinery Using Magnetic Bearings," Proceedings of the IASTED/ISMM International Conference on Modeling and Simulation, (1998).

This paper investigates magnetic bearings as an actuator for noise control of rotating machinery. The apparatus used consists of a DC motor connected to a fan blade by a short, rigid shaft supported radially and axially by magnetic bearings. The bearings provide position control of the shaft, and thus the fan blade as well. This position control can be used to vibrate the fan blade as an effective speaker for producing the secondary sound in an active sound control scheme. Due to the proximity of this secondary noise source to the primary noise sources, the motor and fan blade, good control of low frequency noise can be theoretically achieved at all points in space. For this project, the objective was tonal noise control at frequencies corresponding to blade rate and shaft rate, as indicated by tachometer feedback. Noise control algorithms such as the least mean squares algorithm were implemented on a dedicated digital signal processor, with out output translated into position commands for the magnetic bearing controller. Reduction in the emissions of certain tones from a motor and fan assembly operating in an open environment were investigated. This paper presents the problem formulation, active noise control design, and experimental results. This work has application to rotating machinery and marine propulsion systems.

WATKINS, John M., Assistant Professor, George E. Piper, Assistant Professor, Kevin J. Wedeward, Assistant Professor and E. Eugene Mitchell, Professor, "Computer Animation: A Visualization Tool for Dynamic System Simulations," *Proceedings of the 1997 ASEE Annual Conference, Milwaukee, WI,* (June 1997).

This paper describes how animation is being utilized to teach system dynamics and control in the Systems Engineering Department at the U.S. Naval Academy. Included is a description of how animation has been incorporated into the classroom using the computer software tools, VisSim and MATLAB. The animation capabilities of these software tools are demonstrated with several classroom exercises.

WATKINS, John M., Assistant Professor, "Observer Design for Feedback Linearization Control of a Magnetic Levitation System," *Proceedings of the IASTED International Conference on Modeling and Simulation*, (May 1998).

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. When a nonlinear system is required to function over a wide operating region, feedback linearization is often considered because the control is global in nature. However, feedback linearization assumes that all the states of the system are available for measurement. IN practice, this condition is not met. In this paper, we will demonstrate how linear observer design methodology can be applied to a system that is feedback linearizable, a magnetic suspension system. Simulation results will show very little difference in performance between the system using feedback linearization with full access to the states and the system using feedback linearization with partial access to the states and this novel observer design, provided, that the errors in the initial conditions of the observer are small.

Presentations

AVRAMOV-ZAMUROVIC, Svetlana, Assistant Professor, "Student Independent Research Project: Evaluation of Thermal Voltage Converters Low-Frequency Errors," ASEE, Seattle, Washington, June 1998.

BISHOP, Bradley E., Assistant Professor and Mark W. Spong, Researcher Professor, "Adaptive Calibration and Control of 2 D Monocular Visual Servo Systems," IFAC Symposium on Robot Control, Nantes, France, August 1997.

BISHOP, Bradley E., Assistant Professor and Mark W. Spong, Research Professor, "Toward 3D Uncalibrated Monocular Visual Servo," 1998 IEEE International Conference on Robotics and Automation, Leuven, Belgium, May 1998.

BISHOP, Bradley E., Assistant Professor, "Intelligent Control of an Air Hockey Playing Robot," 36th IEEE Conference on Decision and Control: Workshop on Control Using Logic and Switching, San Diego, California, 8 December 1997.

BISHOP, Bradley E., Assistant Professor, "Intelligent Control of an Air Hockey Playing Robot," United States Naval Academy Branch of Sigma Xi, Annapolis, Maryland, February 1998.

BISHOP, Bradley E., Assistant Professor, "Vision-Based Objective Selection for Robust Ballistic Manipulation," 1998 IEEE International Conference on Robotics and Automation: Workshop on Robust Vision for Vision-Based Control of Motion, Leuven, Belgium, 24 May 1998.

KIRIAKIDIS, Kiriakos, Assistant Professor, "Fuzzy Model Control of Nonlinear Plants Using LMIs," World Automation Congress, Anchorage, Alaska, May 1998.

KIRIAKIDIS, Kiriakos, Assistant Professor, "Observer-based Control of a Gas Furnace via Fuzzy Modeling," International Mechanical Engineering Congress and Exposition, Dallas, Texas, November 1997.

KIRIAKIDIS, Kiriakos, Assistant Professor, "Dynamic Output Feedback of Gas Furnaces via Fuzzy Modeling," Sixth IEEE Conference on Control Applications, Hartford, Connecticut, October 1997.

O'BRIEN, Jr., Richard T., Assistant Professor, "On Stabilizing Solutions to the Riccati Differential Equation," The 13th IEEE Symposium on Systems theory, Morgantown, West Virginia, 9 March 1998.

O'BRIEN, Jr., Richard T., Assistant Professor, "Time-Varying Modeling of Vehicle Dynamics for Automated Steering Control," The IASTED International Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 13 May 1998.

PIPER, George E., Associate Professor, and John M. WATKINS, Assistant Professor, "Computer Animation: A Visualization Tool for Dynamic Systems Simulations," 1997 ASEE Annual Conference, Milwaukee, WI, June 1997.

PIPER, George, E., Assistant Professor, Glen Bell, Research Engineer, "Multi-Channel Control of Fluid-borne Noise in a Magnetic Bearing Pump System," Naval Symposium on Electric Machines, Newport, RI, July 1997.

PIPER, George E., Associate Professor, John M. WATKINS, Assistant Professor, David C. Baumann, Assistant Professor, Glen Bell, Research Engineer, Seminar on Magnetic Bearings, Naval Surface Warfare Center, Annapolis, Maryland, July 1997.

WATKINS, John M., Assistant Professor, "Observer Design for Feedback Linearization Control of a Magnetic Levitation System," IASTED International Conference on Modeling and Simulation, Pittsburgh,

Pennsylvania, May 1998.

WATKINS, John M., Assistant Professor, "Parameter Set Estimation: Theory and Application," Applied Mathematics Seminar, U.S. Naval Academy, May 1998.

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 1997-98. Seven different faculty members made some 17 presentations at professional conferences, seminars, and other venues. There were nine publications.

Associate Professor Karen Thierfelder, again the Department nominee for the USNA Research Excellence Award, had a particularly productive year. Dr. Thierfelder and her associates at the World Bank, the U.S. Department of Agriculture, and the International Food Policy Research Institute worked actively on nine different projects relating to the application of computable general equilibrium models to international trade issues. Assistant Professor Suzanne K. McCoskey, in her first year at the Academy, published two papers and had two additional papers accepted for publication. Professors Roger D. Little and Rae Jean B. Goodman teamed to do policy oriented research on military culture. Professor Bowman continued to pursue his work on the impact of education on the career success of military officers. Professor Darryl E. Getter presented several papers relating to his work on consumer credit. Visiting Professor Adrian P. Kendry, the third holder of the William J. Crowe Chair of the Economics of the Defense Industrial Base continued on leave from the University of the West of England for a second year. 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 third and final year in the position in 1998-99.

Each of the 91 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 David J. Hopkins for his paper, "Population Migration: An Analysis of the Impact of Population Demographics and Amenities on City Growth," written under the direction of Assistant Professor McCoskey.

Sponsored Research

Information and Credit Rationing: Recent Evidence from the 1992 Survey of Consumer Finances

Researcher: Assistant Professor Darryl E. Getter

Sponsor: Naval Academy Research Council (O&M,N)

This research examines how different kinds of information affects the probability of being rejected for credit. In a world of perfect certainty in which lenders only rely upon economic characteristics, the probability of rejection would not change when demographic characteristics are included. If demographic characteristics do play a major role in who gets credit, then market failure exists, suggesting in turn that policy initiatives such as the Community Reinvestment Act are more likely to increase rather than to reduce

efficiency in the consumer credit market. This study uses information from the 1992 Survey of Consumer Finances compiled by the Federal Reserve Board. A standard risk-scoring credit model was used to examine the relationship between information and credit availability. A credit market with only economic characteristics was estimated first, then additional credit market models including various kinds of demographic information were estimated and compared with the original formulation. Three major findings emerge from the empirical work. First, credit history, followed by cash flow, are the most important economic characteristics in determining whether a credit request is rejected. Second, the relationship between outstanding debt and credit denial is inconclusive. Finally, when demographic information such as race, age and home ownership status is introduced, the probability of credit rejection changes. The latter finding suggests that consumer credit markets are imperfect, with market failure attributable either to discrimination or to uncertainty. The work is on-going. A presentation has been made.

Technology, Trade and Factor Returns

Researcher: Associate Professor Karen E. Thierfelder

Sponsor: Naval Academy Research Council (O&M,N)

The Heckscher-Ohlin-Samuelson (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 in 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. This paper extends 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. It is shown 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. A paper has been completed and has been submitted for journal review.

Independent Research

Graduate Education and Human Capital Development in a Hierarchical Organization

Researcher: Professor William R. Bowman

Human capital theory postulates a relationship between education and worker productivity. However, most empirical research testing the theory analyzes the relationship between education and earnings, assuming

that earnings reflect marginal productivity. In addition, empirical studies suffer from data problems. Data bases used are sometimes confined to single plants of large firms, or analyze the earnings of graduates of a particular university across a myriad of employers. Further, most studies approximate productivity by annual earnings or earnings growth over a fixed period, omitting workers who leave the firm during the period. These shortcomings and others are addressed in this study using military data which directly relates educational background to worker productivity as measured by across-grade promotions and individual performance evaluations. All observations have at least a college education and work in a highly structured internal labor market. Findings show that once self-selection bias is included in the models, graduate education has little significant impact on worker performance or promotion opportunities. Without such controls, graduate education is significantly related to productivity measures. The paper has been completed and submitted for journal review.

A Study of the Returns to Postsecondary Education

Researcher: Professor J. Eric Fredland

The purpose of this work is to synthesize professional research on the interface between postsecondary education (i.e. two and four-year college) and the labor market. The work consists of two parts: 1) an analysis of the match between the skills acquired in postsecondary education and those required by different occupations and 2) an analysis of the economic returns to postsecondary education. A first draft of the synthesis has been written. The final product will be a report published by the Department of Education.

Do Lenders Evaluate Applicants Differently?

Researcher: Assistant Professor Darryl E. Getter

This study investigates whether lenders evaluate credit applicants differently and if the evaluation process is impartial. This study uses information on credit rejections from the 1995 Survey of Consumer Finances compiled by the Federal Reserve Board. In this paper, credit rejection models and probabilities of credit rejection are computed for the following households: white, non-white, under forty years of age, and forty years of age or older. The analysis presents three noteworthy findings. First, lenders do evaluate households with different demographic characteristics differently. Second, both non-white households and households in which the family head is under forty face higher probabilities of rejection for credit than white households and households in which the family head is forty or older. Third, when the under forty households were fitted to the parameters or lending criteria of the over forty households, the probability of rejection changed very little from its original value. However, this was not the case when the same experiment was done with whites and non-whites. The results suggest that demographic knowledge about age may help young households get access to credit, while demographic information about race may act as a barrier to credit. The paper has been completed. A conference presentation has been made and the paper is under journal review.

New Evidence on Consumer Credit Availability

Researcher: Assistant Professor Darryl E. Getter

This paper investigates whether it has become easier to get credit over the past decade, which groups have the most difficulty getting credit, and whether greater credit use translates into greater credit risk for lenders. Data are drawn from the 1995 Survey of Consumer Finances compiled by the Federal Reserve Board. The results show that it has not necessarily become easier to obtain credit over the last decade. Rejection rates have been fairly stable, and there has been little change in credit accessibility for households that have low amounts of wealth. As a result, the rise in consumer indebtedness must be attributed to an increase in debt use by households that have traditionally enjoyed relatively easy credit access. However a larger percentage of high wealth households are reporting delinquencies. The delinquency rates for borrowers with high incomes have declines, while the delinquency rates for borrowers with high wealth have risen. The paper has been completed. A conference presentation has been made and the paper is under journal review.

Three New Ideas for Teaching Money and Banking

Researcher: Assistant Professor Darryl E. Getter

This paper offers three suggestions for refocusing the content of the traditional undergraduate money and banking course to emphasize policy questions and policy decisions that ultimately affect financial markets and institutions. These changes have generated enthusiasm among students at the Naval Academy. The paper has been completed and presented at a teaching conference.

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 first class economics majors on the Major Field Achievement Test for the 1989-1991 period. The experimental setup was to divide the class into separate classrooms matching the academic quality of the two rooms by QPR rank. As students entered the "incentive" room, they were given a memorandum informing them that there were monetary prizes for the top three performers by four QPR groupings. The students in the other room received the same memorandum as they exited 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 will be completed during the 1998 intersessional period.

Cooperation and the Transatlantic Defense Industrial Base

Researcher: Professor Adrian P. Kendry

The objectives of this project center upon understanding and explaining the inefficiency currently inherent in the industrial reorganization of both the US and European defense industrial base. The research shows that this inefficiency has serious implications for the structure and organization of the NATO defense industrial base. Industrial consolidation within each continent will not, of itself, eliminate excess capacity. Design and Acquisition tournaments emphasizing joint equipment requirements, output commonality and integrated management are pivotal in promoting co-ordinated behavior between governments and firms. The project utilizes the game-theoretic methods to analyze the strategic behavior of governments and firms in determining both the quantity and distribution of competition and cooperation in international weapons

acquisition. The conclusions are of some importance to the current debate over the optimal size and structure of the US defense industrial base and also illuminate the discussion concerning the re-organization of the European defense industrial base. Preliminary results were presented at a conference in July 1997 and at a seminar at West Point in May 1998. It is anticipated that the research will be completed in the early part of Fall 1998 and submitted to an appropriate journal in the field.

Symbiosis or Schism? The Military-Civil Nexus and the Reorganization of the Atlantic Aerospace Industry

Researcher: Professor Adrian P. Kendry

The reshaping of the American and European aerospace industries has been epitomized by the merger between Boeing and McDonnell-Douglas, the bitterly disputed proposed merger between Lockheed Martin and Northrop Grumman and the continuing debate over the reorganization of Airbus Industrie. The primary purpose of this project is to examine and interpret the impact of this metamorphosis of the aerospace industry on the organization, production, technology and management of military and civil aircraft programs. A secondary purpose is to assess and explain the consequences of the emerging military-civil nexus upon the horizontally and vertically integrated organization of suppliers at all levels within the supply chain. The objectives of the research are to reveal the benefits and costs to firms and government of dual use production, technology and management in aerospace programs. In addition, the search for economic complementarities in design, technology, production and organization will be shown to have important consequences for industrial concentration and competition within the aerospace industry. The project draws upon the growing literature focusing upon the economics of modern manufacturing and, in particular, the work of Milgrom and Roberts, to provide the analytical underpinning to the project. Utilizing a variety of case studies, the research program will attempt to derive a number of general results that will illustrate the benefits and costs of the military-civil nexus in aerospace production. Preliminary results were presented at a conference in September, 1997. It is anticipated that the research will be concluded by February 1999 and will be submitted for publication.

A Tale of Three Currencies: International Economic Policy and the Launch of the Euro

Researcher: Professor Adrian P. Kendry

In January 1999 the European Single Currency, the Euro, will be launched. For some, this will represent, perhaps begrudgingly, the apotheosis of the Monnet-Schumann post-war vision of European integration. For others, the Euro is the stepping-stone to, ultimately, European economic and political integration. However, for a further large constituency, the Euro will symbolize the nadir of European economic cooperation, a contrived and Maastricht-imposed embodiment of an Optimal Currency Area when the conditions for such an arrangement are almost completely absent. However, the Euro is a reality and already is exercising an important influence over international currency and capital markets. The purpose of this research program is to examine the implications of the Euro for international economic policy coordination, in general, and, in particular, for the relationship between the Dollar, the Euro and Sterling (the Pound representing the European "Outsider" currencies). The objectives of the research are to predict the short- and medium-term impact of the Euro on exchange rates, goods, capital and labor markets within the Euro countries, the USA and the UK. The analysis will seek to clarify the complicated arrangements surrounding the parity determination of the Euro and the locking-in of national currencies. In addition, the research will consider the wider implications of the Euro for European security and stability and the transatlantic relationship. The research draws heavily upon primary and secondary literature dealing with the Euro and analytical material

linked to the economics of optimal currency areas and international economic policy coordination. The research agenda has resulted in two presented papers. It is anticipated that further papers will be submitted for publication during the summer and early Fall of 1998.

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 is known to be male, the diversity of jobs and compensations schemes offered by employers to that primary earner poses complications and may bias empirical modeling of secondary earnings. Many of these problems 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.

Enculturation and Commissioning Source

Researchers: Professor Roger D. Little and Professor Rae Jean B. Goodman

This work attempts to determine whether academies, ROTC or OCS officer procurement programs provide the services with officers with different career expectations. These expectations include variables for time on active duty, ultimate rank, likelihood of attaining flag/general rank, likelihood of promotion to next rank, and likelihood of joining the reserves. The statistical analysis is in its final stages and a conference paper is scheduled for presentation in the summer of 1998.

A Monte Carlo Comparison of Tests for Cointegration in Panel Data

Researcher: Assistant Professor Suzanne K. McCoskey

This project surveys recent developments in the literature of cointegration in panel data and provides a

Monte Carlo comparison on various tests proposed for cointegration in panel data. In particular, tests for two different panel data models, varying intercepts with varying slopes and varying intercepts with common slopes are presented from the literature with a total of seven tests being simulated. In all cases results on empirical size and size-adjusted power are given. Tests for cointegration have become increasingly important in economics as the literature on cointegration provides a powerful link between economic theory and econometric techniques. In particular, cointegrated relationships among variables can immediately be interpreted as long-run relationships between these variables. The tests for which information is provided on size and power represent the first group of tests which extend the cointegration literature from a strict time series approach to panel data. The work on this project is nearly completed. Two presentations have resulted thus far.

How Does Your Output Grow? A Panel Data Investigation of the Relationship Between Urbanization and Growth

Researcher: Assistant Professor Suzanne K. McCoskey (with C. Kao, Syracuse University)

Urban economists have long sought to explain the relationship between urbanization levels and output. In this research project, the authors provide a fresh approach to this traditional question using non-stationary panel data econometric tools. With these tools it should be possible to distinguish between short run relationships of urbanization and growth, and more compelling long run relationships. The data set consists of 52 countries — 30 from among developing countries and 22 developed countries — over the years 1965-1989. To date, long run relationships between urbanization, capital per worker, and output per worker have not been discovered. These results, while discouraging, do highlight the difficulty for the applied econometrician of working with cointegration tests. Unlike results from stationary regression analysis, the results from cointegration testing does not provide any further insights to how a better model might be chosen to explain such a long relationship — i.e. t-statistics and standard errors cannot be recovered. The work is on-going, and has resulted in one presentation.

Early Economic Writings on the Marital Status of Women

Researcher: Assistant Professor Suzanne K. McCoskey

It is a popular misconception in economics that Becker was the first economist to discuss the intersection of gender, marital status and economic status. This research seeks to rediscover 19th and earlier 20th century writings by American and British women on this topic. Writings are examined for (a) attitudes on marriage and how marriage affects female economic status; and (b) policy proposals to improve the reality of marriage and money for both men and women. A considerable literature has been found to exist. This body of work precedes Becker and foreshadows his work and subsequent writing by other economists. Of particular interest is the diversity of policy proposals made by these earlier writers. Popular current proposals for dealing with, for example, unwed mothers, poverty, and compensation for work done at home represent only a subset of ideas discussed by these women. These texts are in fact more rich in philosophy and creativity in approaching such problems than such dialogues today.

Health Care Expenditures and GDP: Panel Data Unit Root Test Results

Researcher: Assistant Professor Suzanne K. McCoskey

(with T. Selden, Agency for Health Care Policy and Research)

This short paper presents unit root test results for time series on per capita national health care expenditures and gross domestic product in the Organization for Economic Cooperation and Development (OECD) countries. Unlike the country-by-country test used by Hansen and King, the test employed here exploits the panel nature of the OECD data. Using this approach, the null hypothesis that these series contain units roots is rejected. With rapid advances in time series econometrics, no single test is likely to be definitive; however, the results here help to mitigate concern that panel data analyses of national health expenditures are misspecified, a concern first presented in the work by Hansen and King. The paper has been accepted for publication by the *Journal of Health Economics.*

Estimation and Inference of a Cointegrated Regression in Panel Data: A Monte Carlo Study

Researcher: Assistant Professor Suzanne K. McCoskey

This paper studies the finite sample properties of the least-squares dummy variable (LSDV) estimator and t-statistic in a cointegrated regression with panel data. Through Monte Carlo studies it is found that both the LSDV estimator and the t-statistic have a small amount of bias, and the t-statistic diverges as the cross-sectional dimension increases. It is also found that the bias-corrected LSDV estimator and bias-corrected t-statistic do not reduce the magnitude of the bias problem. These results show that Least Squares is not a desirable method to use when estimating a cointegrated relationship in panel data. Although this result is well known in the time series case, the results here show that in spite of the additional cross-section dimension, Least Squares estimation is biased. Even though the bias may be known and corrected for, in small samples the performance of the bias-corrected statistics is weak. Therefore, for those researchers interested in estimating cointegrated relationships in a panel setting, more sophisticated methods should be found. The paper has been accepted for publication by the *American Journal of Mathematical and Management Sciences*.

Agricultural Policies in the Western Hemisphere

Researcher: Associate Professor Karen E. Thierfelder

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. The 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. The research is in its final stages; the data base has been compiled for Canada and the model has been expanded. The modeling of farm policies is on-going. One paper has been presented and another presentation is scheduled. A paper is to be published by the US Department of Agriculture in an edited volume. In addition, an expanded version of the paper is being prepared to submit for journal review.

The Marginal Cost of Public Funds in Developing Countries

Researcher: Associate Professor Karen E. Thierfelder

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. The research is in its final stages. The work has been presented at seminars. Journal submission is planned.

A Note on Taxes, Prices and Welfare in General Equilibrium Models

Researcher: Associate Professor Karen E. Thierfelder

Calculating the impact of changes in taxes has been a major theme of general equilibrium analysis in the field of public finance. In the empirical literature, commonly reported measures include changes in real wages, household income, Gross Domestic Product, absorption, and equivalent and/or compensating variation. There is a problem, however, in using measures of changes in factor returns when analyzing the impact of changes in taxes that operate in product and factor markets such as tariffs and indirect taxes, including the value-added tax. Even if the change is revenue neutral and welfare neutral, there will be changes in wages and prices that potentially confuse the welfare analysis. In particular, any change from a direct to an indirect tax will lead to a fall in real factor returns, and vice versa. The paper sorts out how a shift in tax structure will affect the real wage in a model which isolates the price, wage, revenue, and welfare effects. The paper starts from a simple general equilibrium model that includes traded and domestic goods, then analyzes the impact of changes in indirect taxes and tariffs on prices and wages. It demonstrates the pitfalls of using real factor returns as a welfare indicator when analyzing such changes. The research is in the preliminary stage. An abstract has been submitted for a conference presentation.

Publications

McCOSKEY, Suzanne K., Assistant Professor (with C. Kao) "A Residual-Based Test of the Null of Cointegration in Panel Data," Econometric Reviews, Vol 17, No. 1, 1998.

This paper proposes a residual-based Lagrange Multiplier test for the null hypothesis of cointegration in panel data. The test is analogous to the locally best unbiased invariant for a moving average unit root. The asymptotic distribution of the test is derived under the null hypothesis. Monte Carlo simulations are performed to study the size and power properties of the proposed test. Although much of the non-stationary time series econometrics has been criticized for having more to do with the specific properties of the data set rather than with underlying economic models, the recent developments in the cointegration literature have allowed for a concrete bridge between long run economic theory and time series methods. The test in this paper allows for the testing of the null of cointegration in a panel setting and should be of considerable interest to economists in a wide variety of fields.

McCOSKEY, Suzanne K., Assistant Professor "Health Care Expenditures and GDP: Panel Data Unit Root Test Results.

McCOSKEY, Suzanne K., Assistant Professor " Estimation and Inference of a Cointegrated Regression in Panel Data: A Monte Carlo Study.

MORRIS, Clair, E., Professor, review of Solomos Solomou, Themes in Macroeconomic History: The UK Economy, 1919-1939, Southern Economic Journal, Vol 64, No. 3, January 1988.

In this insightful study of the British economy in the period between the two great wars of this century, the author provides some reasonable explanations to many pestering questions that have troubled the minds of economic historians for decades. His use of theoretical economic models and extensive statistical data not previously tested enriches understanding of the United Kingdom's economic performance enormously. Episodic events, policy changes, and system shocks are all explored as possible fits to empirical evidence. The author is able to draw some strong and convincing conclusions from his study while at the same time raising some new questions and issues that will keep future researchers busy.

THIERFELDER, Karen E., Associate Professor, (with S. Devarajan and H. Ghanem) "Labor Market Regulations, Trade Liberalization and the Distribution of Income in Bangladesh," Journal of Policy Reform Vol 1, No. 1, 1998.

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.

THIERFELDER, Karen E., Associate Professor, (with M. Burfisher, D. Plunkett, and S. Robinson) "The Effects of NAFTA in a Changing Environment," in Gary W. Williams, Rita Rindermann de Schwentesius and Manuel G. Cruz (eds) NAFTA and Agriculture: Is the Experiment Working?, (Boulder, CO: Westview Press), 1998.

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.

THIERFELDER, Karen E., Associate Professor, (with M. Burfisher, and S. Robinson) "Agricultura, Comercieo y Tasas de Cambio en el MERCOSUR" in Lucio Reca and Ruben Echeverria (eds) Agricultura Medio Ambiente y Probeza Rural en America Latina (Washington DC: International Food Policy Research Institute and International Development Bank) 1997.

This paper reports on analysis of policy interactions in MERCOSUR, a proposed South American free trade area, focusing on agriculture, a sector with high trade shares in all the member countries. (Argentina, Brazil, Paraguay and Uruguay).The effects of implementing MERCOSUR are analyzed, identifying the potential resulting changes in production and trade within the region. The impact of full implementation of the agreement is studied without considering the phase in process. Next the effects of macroeconomic linkages in this freer trade environment are examined. Assuming MERCOSUR is in place, the effects of devaluation by the US are considered, comparing the effects of two alternative macroeconomic adjustment responses by Argentina — adjusting domestic price or foreign capital flows. Structural changes in Argentina and linkages through trade to Brazil are analyzed. Finally, the effects of a devaluation by Brazil are considered, again with alternate macroeconomic adjustment policies in Argentina.

THIERFELDER, Karen E., Associate Professor, (with M. Burfisher, and S. Robinson), "Linkage Effects from Processed Food Exports: A Comparison of Brazil, Mexico, and the United States" in Dennis Henderson, Jean Kinsey, Daniel Pick and Ian Sheldon (eds), Global Policies in Processed Food: Theoretical and Practical Issues, (Boulder, CO: Westview Press) 1997.

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.

THIERFELDER, Karen E., Associate Professor, (with M. Burfisher, and S. Robinson), "Migration, Prices and Wages in a North American Free Trade Agreement," in Roger Rose, Carolyn Tanner, and Margot Bellamy (eds) Issues in Agricultural Competitiveness: Markets and Policies, (Aldershot, Hampshire, UK and Brookfield VT: Ashgate Press) 1997.

This paper examines wage changes that can accompany trade liberalization between the United States and Mexico under the North American Free Trade Agreement. There are two forces at work: (1) indirect links between prices and wages as described in the Stolper-Samuelson theorem, and (2) direct effects of migration on labor supplies in the two countries. Much of the debate over potential wage changes reflects views about the links between output prices and factor prices as described in the Stolper-Samuelson theorem. However, one needs an empirical model with both price changes and migration to determine which wage effect dominates following trade liberalization. Using an 11-sector computable general equilibrium model which includes the United States, Mexico and the rest of the world, it is found that migration effects generally dominate Stolper-Samuelson effects on wages.

Unrefereed Publications/Technical Reports

KENDRY, Adrian P., William J. Crowe Professor, "The Role of Government in the Future of the Aerospace Industry: A Transatlantic Policy," Proceedings of the National Convention of Aerospace Regions Conference, (Coventry, UK: AIRLINE), 1998

The argument that governments can intervene strategically in industries dominated by several firms to generate trade benefits has hinged on the proposition that national (or multinational) industrial supports directed toward particular industries can reap economic gains in the form of extra market share and higher wages for skilled labor at the expense of rival national producers.

Although no conclusive evidence exists to support the

proposition that Aerospace is an example of such a strategic industry, the behavior of the US government has been consistent with the view that Aerospace is a highly important wealth and technology creating industry. This paper examines the historical and contemporary argument for US government support of the industry and explains the nature and scale of visible and invisible supports both internationally and domestically. The recent consolidation of the US aerospace industry has provoked concern over the impact of vertical integration on future bargaining between government and firms for industrial subsidies. The transatlantic tensions regarding the trade balance and offsets in aerospace goods is shown to reflect mispreceptions on both sides of the Atlantic as to the conditions for economically efficient and mutually productive sharing arrangements in military and commercial aerospace programs. The current preoccupation with growing consolidation in the US and continuing fragmentation in Europe • is an impediment to more efficient international teaming and common production. US and European governments must direct their energies toward enhancing cooperative arrangements in aerospace design and procurement and, through cooperation, underline the strategic benefits that flow from the aerospace industry.

McCOSKEY, Suzanne K., Assistant Professor, "What is an Econometrician?" Association for Women in Science Magazine, Vol 27, No. 1, Winter 1998.

This special edition of the magazine focuses on career opportunities for women in computing. In this article, the author outlines exactly what an econometrician does, the difference between theoretical and applied econometrics, the use of computer technology in econometrics, and future career opportunities for women interested in econometrics.

Presentations

Conference Presentations

BOWMAN, William R., Professor, "Minority Officers in the Surface Navy: Equal Promotion Opportunity?"Western Economic Association International Conference, Seattle, July 1997.

GETTER, Darryl E., Assistant Professor, "New Evidence on Consumer Credit Availability," Atlantic Economic Society Conference, Philadelphia, October, 1997.

GETTER, Darryl E., Assistant Professor, "Do Lenders Evaluate Applicants Differently?" Allied Social Sciences Associations, Chicago, January, 1998.

GETTER. Darryl E., Assistant Professor, "Three New Ideas for Teaching Money and Banking," Robert Morris Teaching Conference, Pittsburgh, February, 1998.

KENDRY, Adrian P. William J. Crowe Professor, "Integration of the European Defence Industrial Base" Western Economic Association International Conference, Seattle, July 1997.

KENDRY, Adrian P. William J. Crowe Professor, "Between Cooperation and Confrontation: Europe's Aerospace Relationship with the USA," Aerospace 2000 Conference: Towards Global Partnerships, Bristol, UK, September 1997.

KENDRY, Adrian P. William J. Crowe Professor, "Defence/Civil Integration: the Global Reach of the American Aerospace Industry," Aerospace 2000 Conference: Towards Global Partnerships, Bristol, UK, September 1997.

KENDRY, Adrian P., William J. Crowe Professor, "A Tale of Three Currencies: The Best and Worst of Times in Transatlantic Economic Policy," American Society of Business and Behavioral Sciences Conference, Las Vegas, February 1998.

LITTLE, Roger D., and Rae Jean B. GOODMAN,

Professors, "Enculturation and Commissioning Source," Biennial International Conference of the Inter-University Seminar on Armed Forces and Society, Baltimore, October, 1997.

McCOSKEY, Suzanne K., Assistant Professor (co-author), "A Monte Carlo Comparison of Tests for Cointegration in Panel Data," 8th International Conference on Panel Data, Goteborg, Sweden, June 1998.

McCOSKEY, Suzanne K., Assistant Professor (co-author), "How Does Your Output Grow? A Panel Data Investigation of the Relationship Between Urbanization and Growth," 8th International Conference on Panel Data, Goteborg, Sweden, June 1998.

GOODMAN, Rae Jean B. Professor, "Enculturation and Commissioning Source" Economics Department Seminar, Davidson College, February 1998.

KENDRY, Adrian P., William J. Crowe Professor,"The Euro and Economic Policy Coordination: Kafkaesque, Dickensian, and Panglossian Scenarios," Department of Social Sciences, U.S. Military Academy, May 1998.

KENDRY, Adrian P., William J. Crowe Professor, "The Impact of the Asian Economic Crisis upon the Market for Aircraft and Aero-Engines," presentation to the Rolls Royce PLC Board, London, UK March 1998.

McCOSKEY, Suzanne K. "A Monte Carlo Comparison for Tests on the Null of Cointegration in Panel Data," Department of Accounting Research Seminar, Rutgers University, May 1998.

THIERFELDER, Karen E., Associate Professor, (co-author) "The Marginal Cost of Public Funds in Developing Countries" Macroeconomics Division Seminar Series, The World Bank, May 1998.

THIERFELDER, Karen E., Associate Professor, (co-author), "Farm Policy Reforms and Harmonization in the NAFTA," US Department of Agriculture, Economic Research Service Regional Integration Seminar Series, October, 1997.

DEPARTMENT OF

English

Professor Timothy D. O'Brien
Chair

During this academic year the English Department pursued an impressive range of research topics. These and previous areas of investigation resulted in the publication of books, scholarly articles, essays and reviews, as well as conference papers delivered at significant venues.

Eleven members of the department pursued research supported by the Naval Academy Research Council. The topics ranged from a ground breaking edition of Korean War literature, to an edition of the journal of Master Mate John Lawrence during his time onboard the *USS Yorktown* 1844-5, to an anthropological approach to the Old English poem *Beowulf*, to an analysis of the Eco-Arts Festival in the Cancer Alley section of New Orleans. Professors Nancy Mace and John Hill completed their work on projects supported by the National Endowment for the Humanities: Professor Mace's on a two volume book analyzing the eighteenth-century music trade and Professor Hill's on a book investigating kinship and violence in Anglo-Saxon poetry.

Members of the English Department also pursued a number of independent research and creative projects. Officers worked on such projects as a much needed critical edition of a seventeenth-century play by George Granville and the economic paradigms in Chaucer's *Canterbury Tales*; and professors pursued projects ranging from the traditional literary ones--critical discussions of short stories, novels and plays--to creative ones--novels and poetry--to the non-traditional ones such as a study of the American Justice Festival and a history of a local Annapolis community. Among the numerous publications by English department faculty were three books--Professor Fleming's "avant-garde" novel *Twilley;* Professor Madison's edition of Thomas Wentworth Higginson's *Army Life in a Black Regiment;* and Professor Drew's collection of midshipmen letters, *Letters from Annapolis: The Midshipmen Write Home*. Members of the department also produced seven refereed articles, as well as numerous book and dance reviews and pieces for literary encyclopedias.

Certainly a function of the Naval Academy's support of research in the humanities, this scholarly and creative activity and its fruition in publications and presentations also marks a faculty whose knowledge of the material it teaches midshipmen continues to grow and stay current. This lively expertise contributes to the Academy's mission of providing the finest education possible for midshipmen.

Sponsored Research

Waiting for Isolde: Wagner in *The Waste Land*

Researcher: Associate Professor Allyson Booth

Sponsor: Naval Academy Research Council(O&M,N)

This project is part of a larger one investigating the interconnections between T. S. Eliot's *The Waste Land* (1922) and its numerous source materials. It relates directly to the teaching of modernism and should eventually constitute part of the available literature on the subject of teaching *The Waste Land*–a poem in which an extremely small detail frequently provides a window onto a surprisingly large field of vision. Eliot's complicated and intimidating poem is too often billed as absurdly inaccessible. By becoming more familiar with the poem's source materials, the researcher will become more adept at situating it in a cultural context that was still reeling from World War I and more skillful at communicating that context to the students.

Harridans, Harpies, and Heroines: William Shakespeare's Beatrice and Her Contemporaries

Researcher: Associated Professor Anne Marie Drew

Sponsor: Naval Academy Research Council(O&M,N)

In William Shakespeare's comedy *Much Ado About Nothing*, Benedick eagerly volunteers to perform the "slightest errand" . . . "rather than hold three words' conference with this harpy." The harpy to whom he refers is Beatrice, his soon-to-be-wife. Beatrice, although neither harpy nor harridan, does learn to control her sharp tongue, as does Benedick. Not all of her dramatic contemporaries undergo the same loving transformation. The essential difference among Renaissance comedies and their depiction of women is not so much one of realism as it is a matter of "attitude and tone." Madeline Doren argues in *Endeavors of Art* that there are two sets of human motives in English comedy. There are "poetic longings for love and adventure" and there are the "grosser appetites for women, money, or power." Most comedies tend to gratify our judgments, as we see the grosser longing debunked and the poetic longings rewarded. Still, such gratification notwithstanding, the women in these Renaissance comedies are treated with an unevenness that matches the age's mix of misogyny and Mariolatry. This unevenness is most obvious in moving away from Shakespeare's comedies to a study of his contemporary playwrights. In Beatrice, Shakespeare creates a women, who although flawed, is capable of putting her faults to mending. Neither madonna nor whore, she is capable of improvement: a characteristic not universally shared by her Renaissance counterparts.

The Eco-Arts Festival

Researcher: Assistant Professor Anne M. Ellis

Sponsor: Naval Academy Research Council(O&M,N)

This project involves on-site documentation and evaluation of Junebug Theater's Environmental Justice Festival, "The Eco-Arts Festival" in the Cancer Alley section of new Orleans, LA. Interviews of participants will also complete the research.

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(O&M,N)

The project, begun with seed money from NARC in AY 1996-97, continues. Study of Harper's poetry and the historical sources for it led to a closer look at the poems by contemporary African American poets about Frederick Douglass and his legacy. An investigation of these works in conjunction with a reading (or re-reading) of some of Douglass's seminal works reveals a curious manifestation of the abolitionist's influence–his style seems to surface in the poems dedicated to him, almost as if the modern poets either subconsciously or deliberately adopted Douglass's imagery to enhance his legacy in their versions of that legacy. In other works, what was to be a close analysis of cultural influence has become a literary analysis of contrasting genres as well.

Twentieth-Century Japanese Literature

Researcher: Professor Bruce E. Fleming

Sponsor: Naval Academy Research Council(O&M,N)

The purpose of the project is to establish a grounding in Japanese literature with intensive study on two writers: First, Lady Murasaki, whose *The Tale of Genji* is Japan's most influential work. This more than thousand-page novel, the story of the amorous adventures of a physically and intellectually well-favored prince during the Heian period (around the 10th century CE), is a veritable chronicle of court life in Kyoto and a catalogue of the Japanese sensibility of "aware" (roughly, sympathy with the transitory and melancholy). Second is Natsume Soseki, the single most revered modern Japanese novelist. The goal of this study is to flesh out a definition of the modern period, placing Soseki in his context and attempting to achieve some sense of his background. Research focuses on other early twentieth-century novelists, and on cultural histories of the period, as well as on secondary literature regarding Soseki himself.

Master's Mate John C. Lawrence: A Journal

Researcher: Associate Professor C. Herbert Gilliland

Sponsor: Naval Academy Research Council(O&M,N)

This project completes an edition of the journal kept by Master's Mate John C. Lawrence aboard the sloop-of-war *USS Yorktown* during an 1844-45 cruise with the African Squadron. The task involves not merely textual editing, but the incorporation of a considerable mass of amplifying material gathered from other sources.

Anthropological Approaches to Old English Literature

Researcher: Professor John M. Hill

Sponsor: Naval Academy Research Council(O&M,N)

This project solicits a comprehensive gathering of original essays on anthropological approaches to all manner of Old English literature. It also involves an introductory overview of the anthropological and literary issues involved, as well as an individual contribution on the part of the researcher to the gathering. Nationally renowned scholars have been approached for essays on the following topics: evidence of totemism in the Germanic avunculate; the psychological use of oral story in Old English narrative; the cultural transformation of heroic story in Christian apologetics; the nature and ethical status of the feud; ethnic boundaries in dramatized, small group relationships; charms and oaths in their social contexts; and the politicized nature of seemingly traditional Anglo-Saxon warband roles in the major heroic poetry.

Stories and Poems of the Korean War

Researcher: Professor Philip K. Jason

Sponsor: Naval Academy Research CouncilO&M,N)

The project recovers a neglected and forgotten body of creative literature that reflects the imaginatively fashioned experiences of those who participated in, witnessed, and studied the Korean War. The selection and examination of these representations provides an understanding of the impact of that war on American culture, as well as the ways in which American culture shaped understandings of the war. The specific goal of the project is to develop an anthology of Korean War literature with appropriate contextualizing and critical apparatus. The problem is neglect and cultural amnesia. There is less acknowledgment, exploration, and understanding of the Korean War than any modern American historical event of similar magnitude. The phrase "forgotten war" is already a handy label, and there is a "forgotten" literature that needs to be made available and reassessed in order to correct the notion that there was little or no literary record of consequence. A "rough cut" of the surveyed literature has narrowed the range of possibilities to about twelve stories and fifty poems.

Resolution and Discernment in Victorian Literature

Researcher: Associate Professor Eileen Tess Johnston

Sponsor: Naval Academy Research Council(O&M,N)

Although literary historians and critics have written extensively about the ethical dimensions of Victorian literature and its philosophical interest in the will, they have paid little attention to the depiction of the processes of discernment and the formation of resolutions. This research demonstrates pervasive, yet heretofore undiscovered, patterns in Victorian novels, poetry and autobiographies. Addressing major works by authors such as Tennyson, Dickers, Charlotte Bronte, and George Eliot, this study identifies, explains, and analyzes their complex and varying use of a set of terms, concepts, images, and patterns of actions, rooted in the literature of various Christian spiritualities. Such study and analysis should enhance the understanding of Victorian literature and culture and of traditional and modern ways of addressing major life decisions.

The British Music Trade in the Late Eighteenth-Century

Researcher: Associate Professor Nancy A. Mace

Sponsor: National Endowment for the Humanities and 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. The researcher has developed a database of musicsellers and others named in the suits and transcribed many materials. The first of two books on the subject–dealing specifically with music copyright–is almost completed. Another book will examine the business practices, clients, and finances of late eighteenth-century music sellers.

Harrison, the Thompsons, and the Music Magazine: Defining the Nature of Music Copyright in the 1780's

Researcher: Associate Professor Nancy A. Mace

Sponsor: National Endowment for the Humanities and the Bibliographical Society of America

This project is a part of the larger study of eighteenth-century music sellers. In 1784 the booksellers James Harrison and Thomas Drury advertised a new periodical entitled the *Music Magazine*, designed primarily to sell popular musical compositions at half the prices charged by the London musicsellers. Faced with this challenge to their business, the music sellers used the courts to block publication of the periodical after its first issue appeared. Although one suit was unsuccessful, the music sellers Ann, Peter, and Samuel Thompson were able to gain an injunction from the court of Chancery preventing Harrison and Drury from printing the opera *Artaxerxes*, the copyright of which they owned. The court documents provide new information about the publishing history of the opera and discuss several important issues involving music copyright.

Hemingway's Sophisticated Artistry: The Short Fiction

Researcher: Professor Charles J. Nolan, Jr.

Sponsor: Naval Academy Research Council(O&M,N)

The researcher examines a series of Hemingway's stories with a particular focus on those that remain elusive despite the wealth of criticism written about them. Since the Hemingway manuscripts were opened to scholars about fifteen years ago, there has been an explosion of textually based work on the stories. A number of puzzling aspects have been resolved because the manuscripts and their variants have made clear just how Hemingway proceeded. Some readings of his stories have turned out to be inspired hunches; others have been shown to be highly questionable interpretations. The researcher will use both the manuscripts and the criticism to come to terms with particularly enigmatic texts.

Independent Research

The She-Gallants

Researcher: Lieutenant Commander Cara D. Akerley

This is a critical edition of *The She-Gallants*, a play by George Granville, first produced in London in 1696. Various editions of the play are being collated and the variations in text noted. A detailed introduction to the play and the time period is included with the work. This edition is a dissertation for the University of Maryland.

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 horse racing, 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 dualism 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. Interdisciplinary readings are largely completed on this project.

'He Do the Police in Different Voices': *Our Mutual Friend* and *The Waste Land*

Researcher: Associate Professor Allyson Booth

In an early draft of *The Waste Land* (1922), T. S. Eliot grouped the first two sections of the poem ("The Burial of the Dear" and "A Game of Chess") under a single title quoting a character from Charles Dickens's *Our Mutual Friend* (1864-65): "He Do the Police in Different Voices." This article traces the complicated reverberations of both Betty Higden's voice in *The Waste Land's* manuscript and of her eventual absence from its final published version, arguing that her presence in the poem's organizational structure would have suggested a closure more complete than anything that made it into the final draft.

Imagining a World of Communities: The American Festival Project

Researcher: Assistant Professor Anne M. Ellis

This is a book-length study of *The American Festival Project*, a coalition of community-based artists who use art as activism in a struggle for social justice and cultural equity in urban and rural communities throughout the United States. Much of the research is drawn from personal experience with the American Festival Project over the last seven years, including a projected trip to New Orleans for the *Eco-Arts/Environmental Justices Festival*. Questionnaires, project histories, and archival material are being made available through Project Director Michael Hunt, and personal interviews are ongoing.

Hearing the *Voices in the Rain*: Unmasking the Carceral Culture

Researcher: Assistant Professor Anne M. Ellis

The project revises a conference paper from 1997 ATHE National Conference into a publishable article concentrating on performance criticism examining Michael Keck's one-man multimedia performance piece *Voices in the Rain*, an examination of the effects of imprisonment on African-American communities. Interviews are completed; additional reading and revision are ongoing.

Economic Transformations in the *Canterbury Tales*

Researcher: Lieutenant Colonel Kent Esbenshade

This draft of a dissertation is about half completed; the research is nearly completed. The work deals with Geoffrey Chaucer's use and transformation of medieval economic paradigms in selected tales from the *Canterbury Tales*.

Midshipmen Literature

Researcher: Associate Professor C. Herbert Gilliland

Forthcoming in the *Encyclopedia of American literature of the Sea and the Great Lakes*, this article notes that from 1851 until the creation of Naval ROTC in 1925, the U. S. Naval Academy was the only source of U. S. Navy midshipmen, and it remains the primary source today. The article surveys all novels known to have Naval Academy midshipmen as protagonists, many of which are set at the Academy. Dozens of such novels have been published from 1885 to date.

Hank Searls

Researcher: Associate Professor C. Herbert Gilliland

This reference article, forthcoming in the *Encyclopedia of American literature of the Sea and the Great Lakes*, briefly surveys the career and writings of novelist Hank Searls.

Edward L. Beach, Sr.

Researcher: Associate Professor C. Herbert Gilliland

This reference article, forthcoming in the *Encyclopedia of American Literature of the Sea and the Great Lakes*, surveys the career and writings of novelist and naval officer Edward L. Beach, Sr.

Cyrus Townsend Brady

Researcher: Associate Professor C. Herbert Gilliland

This reference article, forthcoming in the *Encyclopedia of American Literature of the Sea and the Great Lakes*, surveys the life and writings (some 70 books, fiction and non-fiction) of 19th century author, minister and Naval Academy graduate Cyrus Townsend Brady.

Marcus Goodrich

Researcher: Associate Professor C. Herbert Gilliland

This reference article, forthcoming in the *Encyclopedia of American Literature of the Sea and the Great Lakes*, surveys the life and writings of Marcus Goodrich.

Untitled

Researcher: Associate Professor Mary D. Howland

A creative writing project with four-and-a-half chapters so far, this mystery novel, written in collaboration with S. L. Howland, focuses on murder on the internet.

An Encyclopedia of American War Literature

Researcher: Professor Philip K. Jason

This project presents in one volume capsule entries (biographical, historical, and critical) on those writers and works contributing to the American experience of war. The scope is from the colonial period to the present day. In addition to the entries on authors and their works, the encyclopedia contains topic essays–overview–on specific wars (the literature of World War One, for example) and specific issues (African-American War literature, Women's Narratives of the Revolutionary War). The researcher is co-editor

of this project, responsible for establishing the list of entries, seeking contributors, setting guidelines, editing manuscripts, and preparing introductory and ancillary materials (time lines, reading lists, etc.).

An Encyclopedia of Sea Literature

Researcher: Professor Robert D. Madison

The researcher in on the editorial board for this reference work to be published by Greenwood.

Hemingway's Short Stories

Researcher: Professor Charles J. Nolan, Sr.

"Hemingway's Short Stories" is a generic title covering research into various Hemingway texts. As the researcher determines the next story to work on, he gives that research a specific title and writes an article about the text.

Women and Violence in Chaucer

Researcher: Professor Timothy D. O'Brien

This project was designed to investigate a recurring motif in Chaucer's narratives: the unexpected, sudden association of women with violent events. The project involves 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. A shorter version was delivered at the Southeastern Medieval Association conference in Nashville in September.

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 & 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, former 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 National 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 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. This first stage of this project has entailed 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 Wikelund'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.

John Quincy Adams and the Rhetoric of the Smithsonian's Inception

Researcher: Visiting Assistant Professor Marlana Portolano

This study investigates the ways in which John Quincy Adams practiced a neoclassical theory of rhetoric during the Congressional debate over the founding of the Smithsonian Institution (1834-1843). Background chapters explicate Adams's *Lectures on Rhetoric and Oratory* (given at Harvard) and present the Smithsonian's scientific and educational precedents. The study's centerpiece is a close rhetorical analysis of the debate. Examination of primary sources (Congressional records; newspapers; Adams's diary, letters, and public addresses) reveals the debaters' techniques of rhetorical invention and argumentation. Rhetorical commentary explains how Adams and his opponents (Asher Robbins, Joel Poinsett, Benjamin Tappan, Rufus Choate, G. P. Marshall, Robert Dale Owen) were influenced by the cultural acceptance of belletristic, psychological, elocutionist, and romantic approaches to rhetorical practice. The analysis reveals how Baconian philosophy, also popular in American at the time, permeates the discourse of the debate. This research reveals that Adams's neoclassical rhetoric and Ciceronian ideals were formative in the debate's progress and outcome, while, at the same time, the newer approaches to rhetoric contributed to a compromise at the end of the debate.

Publications

DREW, Anne Marie, Associate Professor, *Letters from Annapolis: The Midshipmen Write Home: 1848-1969*. Naval Institute Press, 1998.

This volume contains selected letters from 13 different midshipmen. An introduction, biographies, and a glossary are also included with many photos. The original letters are housed in Special Collections at the Nimitz Library.

ELLIS, Anne M., Assistant Professor, "Performing Appalachia," *Southern Quarterly*, Spring 1998.

History and Praxis of Roadside Theater of Central Appalachia, included in a special issue of *Southern Quarterly* entitled "Recording Southern Culture/s."

FETROW, Fred M., Professor, "Murder, Music, and Meteorology: When the Russians Came to the Country," *Anne Arundel Country History Notes*, 29, 1(October 1997), 1-2.

When a small Russian fleet visited the eastern seaboard during the winter of 1864, they were implementing that nation's foreign policy, seeking to consolidate a political friendship with a United States divided by civil strife. Two of their number dropped anchor in the Severn River near Annapolis on January 29, 1864. Events associated with that visit continue to intrigue local historians because of an arcane mix of events and personages. For example, listed among the crews was a "musically talented midshipman named Nikolai Rimsky-Korsakov," who later turned from a naval career to his first love. In addition to latent fame, this story includes local infamy as well, involving the shooting death of a Russian sailor interred with diplomatic ceremony in the Annapolis National Cemetery on West Street. For a minor footnote in local history, the Russian ship visit of 1864 resonates within and beyond Annapolis and Anne Arundel County.

FETROW, Fred M., Professor, "Countee Cullen's 'Yet Do I Marvel,'" *The Explicator*, 56, 2 (Winter 1998), 103-105.

Countee Cullen's "Yet Do I Marvel" is perhaps as widely misinterpreted as Cullen has been misunderstood as a poet. His sonnet has seemed to many the lament of a defeated soul, a complaint by a man unable to resolve the dilemma of being both a poet and an African American. However, a close reading with attention to structural logic shows that Cullen, rather than bemoaning his fate as a real paradox, is instead expressing the resolution of a dilemma which is more apparent than real. Scrutiny of the logical divisions of the poem as implied by the rhyme scheme reveals four sequential apparent paradoxes, all of which are reconcilable and preface to the climactic couplet, which thereby is also "self-reconcilable." Thus the sonnet expresses the difficulty, but finally demonstrates the possibility, of rationalizing "that curious thing," just as the range and depth of Cullen's poetic canon prove that a black poet can verbalize his blackness as the means of singing his humanity.

FLEMING, Bruce E., Professor, *Twilley*. New York: Turtle Point Press, 1997.

An "avant-garde" novel detailing the world from the perspective of its central character, referred to (save in the title) as "he." The "he" walks through a department store, takes a ride on a bus to the small town where he has grown up, has lunch with a woman who turns out to be his grandmother, and rides in a car. The bare-bones plot is intercut with associations, stories and fantasies that are not so much those of the protagonist himself as parts of the "world's consciousness."

FLEMING, Bruce E., Professor, "Pounding Home the Point," *Poet Lore* 92:3 (Fall 1997), 70-72.

A review essay reacting to a book by Thomas Grieve on the early works of the poet Ezra Pound. The essay summarizes Grieve's argument that more attention should be paid to Pound the poet rather than merely to Pound the pundit, as well as his contention that Pound should be judged by criteria appropriate to what he was in fact doing rather than by standards more appropriate to other poets. Grieve, however, fails to say what this thing might be that Pound was doing, and never arrives at a discussion of the work that ostensibly shows his

mastery as a poet, the voluminous *Cantos*. Grieve seems unaware that his argument works, *mutatis mutandis*, with other Modernist writers, such as Gertrude Stein, and in fact can be generalized to all of Modernism as a whole.

FLEMING, Bruce E., Professor, "Bodies Beautiful," *Dance View* 15:2, 36-37.

A review essay of a book of dance photographs called *Dance Ink Photographs*, photographs that originally appeared in the design-heavy publication *Dance Ink*. The essay considers a number of the particular photographs in the book, describing and analyzing their content and implications. Photographs include work by K. C. Bailey, Guzman, Marcia Lippman, and Annie Liebowitz. It then characterizes the works as a "People magazine esthetic retooled by the Upper West Side," pointing out that for the viewer to find these photographs interesting, they must be understood as being pictures of people already known: all are in some sense the personal that presupposes the public facade. They are pictures for insiders, and are ultimately expressive of what the essay calls a "gossip esthetic."

FLEMING, Bruce E., Professor, "Cross-Culturalism Revisited," *Dance View* 15:1, 37-39.

This essay is a consideration of the last decade's interest in non-Western dance forms, and a consideration of the drawbacks of such interest. It then turns to a consideration of a south African Zulu version of Shakespeare's *Macbeth* to suggest a solution to some of the drawbacks in question. Western presentation of non-Western (which is inevitably to say, unfamiliar) art forms inevitably stints one of two qualities to the extent that it privileges the other; the qualities are comprehensibility and authenticity. The more authentic, which is to say rigorously non-Western, the production is, the less comprehensible it will tend to be for its Western audience. Appreciating a whole new art form requires knowledge of givens that few Westerns can marshal. The result is the more usual presentation by savvy impresarios that Hollywoodize and dilute the original art form. The essay suggests that *U Mabatha*, the Zulu Macbeth, blends these two qualities; at the same time it suggests that this solution is far too particular a success to become generally applicable.

FLEMING, Bruce E., Professor, "Yes, But is it Art?" *Dance View* 14:4, 29-31.

An essay attempting to define the distinction between artworks and public performances which resemble them and with which they may be confused, such as sporting matches or events and, in the case of this particular review, a "theatrical" circus. The essay argues that theoreticians such as Arthus Danto whose position is that the circumstances of presentation create the artwork as art, are wrong. These circumstances (such as the fact that this circus was taking place in a theater and invited theater and dance critics) can produce a certain set of expectations, but they cannot determine the nature of what the viewer ultimately sees. In sports, for example, the parameters of action are quite fixed: take ice skating, or gymnastics, which may seem to resemble theatrical dance. All an individual athlete can do is the same motion faster, or cleaner, or with more weight. Art, by contrast, expends the parameters of the actions: what we see is not only a new performance, it is a new work. The distinction between performance and work is far from absolute, but it can nonetheless be made.

FLEMING, Bruce E., Professor, "Gay poets, Women, and Other Threats to Group Loyalty," *Chronicle of Higher Education* 30 January 1998, A-1-A-2.

A personal essay focusing on an experience teaching the WWI English War Poet Wilfred Owen to a group of plebes at the U. S. Naval Academy. The article suggests that military structures are based on male bonding and highly personal interactions, and that the inclusion of gay men threatens this interaction. By extension, the inclusion of women does so as well. The article does not propose solutions, merely points out difficulties as a point of departure for open discussion.

FLEMING, Bruce E., Professor, "The Trouble with *Giselle*," *Dance View* 15:2, 45-47.

The essay is consideration of the seminal French Romantic ballet *Giselle* based on reactions to the current production of the ballet at the Opera de Paris. The kernal of the plot of *Giselle* comes from the German Romantic poet Heinrich Heine, who created a myth of "Wilis," spirits of dead maidens, in his book *De L'Allemagne*. This was transmuted by the critic and poet Theophile Gautier into a libretto for the ballet of 1841. The versions put on today exhibit what seem to

be inconsistencies of plot. In the first act, the heroin Giselle, a peasant girl carrying on a flirtation with a man she does not know to be the local Count, goes mad when she learns of her mistake. In the second act, she has become one of the "Wilis," a band of apparently vengeful female spirits that haunt the woods and cause any man they meet to dance to his death. No current production makes clear the genesis of their malevolence. Are they jilted maidens? Simply dead virgins? The former explanation is missing from Heine; the latter seems inadequate to explain what we see.

GILLILAND, C. Herbert, Associate Professor, "Just Give Me the Facts: Influences on Individual Choice of Learning Strategy at a Military Academy," Teaching and Learning in the next Century: Essays from a Conference for the Federal Service Academies, ed. Anita Gandolfo, West Point, 1997.

This essay examines the issue of "Gouge," memorize-and-dump learning, versus the assembly of large and powerful intellectual structures at a military academy. Concluding that the choice by individual students of one approach over the other is not a function of short-term versus long-term memory, but rather of the learning environment, it then suggests ways that individual teachers and the institution as a whole may influence that choice. Citing, among other things, popular culture, naval tradition and the work of William G. Perry, the essay laments the loss at the Naval Academy of the term "bull department."

JASON, Philip K., Professor, "Representations of War in Ethics Education," *Journal of General Education*, 46.2 (1997), 96-106.

The employment of war literature is an effective and exciting way to bring students into a focused discussion of ethical issues. Within the body of war literature, leadership skills and styles are often under scrutiny, a scrutiny in which ethical action and effective action are often found to be one and the same. Preparedness, courage, and fairness are engaged not as abstract issues but fully fleshed in conflicts and characters. Examples from the literature of modern wars (particularly Korea and Vietnam) provide insights into corruptions of authority, responsibility, and language as well as into positive, productive leadership. Issues of prejudice, favoritism, and dangerous incompetence are dramatized in ways that can lead to vigorous debate and self-definition. Alert students can discover that circumstances of war threaten mental health and the foundations of character when leadership is ethically compromised.

JASON, Philip K., Professor, "Vietnamese in America: Literary Representations," *Journal of American Culture*, 20.3 (Fall 1997), 43-50.

An expanded definition of the literature of the Vietnam War must include works that reflect the widest range of consequences. One body of writings not sufficiently explored is that which represents Vietnamese immigrants and their communities. These writings include such novels as Wayne Karlin's *Lost Armies*, T. Jefferson Parker's *Little Saigon*, Charles McDade's *The Gulf*, and two works by Robert Olen Butler. In several of these novels, the plot depends on a Vietnamese woman's relationship, past and present, with an American serviceman. Replacing the earlier vision of violent (American) masculine aggression, these new, gendered stories still configure Vietnam as a woman, but masculine aggression is replaced by a new warrior code of reconciliation. The post-Vietnam American community involves a Vietnamese presence in which gestures of healing dominate, often concluding a detective hero's search for the enemy within.

JASON, Philip K., Professor, "Bookbinders: Five Recollections." *Woodwrights* No. 11 (Fall-winter 19997): 38-40.

JASON, Philip K., Professor, Review of Milton J. Bates's *The Wars We Took to Vietnam: Cultural Conflict and Storytelling. American Literature* 69.4 (December 1997): 866-7.

JASON, Philip K., Professor, Review-Essays on Albert Goldbarth's *Adventures in Ancient Egypt* and Mary Oliver's *West Wind. Magill's Literary Annual 1998.* Pasadena: Salem Press, 1998.

MACE, Nancy A., Associate Professor, Review of Jill Campbell's *Natural Masques. Scriblerian* 29-30 (1997): 202-204.

While Campbell's book makes some excellent points about Fielding's reversal of gender roles in *Joseph*

Andrews and exploitation of gender in his political essays attacking the Jacobites, it is unconvincing in its assertion that Fielding was "obsessed by gender."

MADISON, Robert D., Professor, editor, Thomas Wentworth Higginson's *Army Life in a Black Regiment*. New York: Penguin Books, 1997.

A new edition of Higginson's classic Civil War memoire with five related essays, edited and with an introduction by Professor Madison.

REES, Elizabeth, Visiting Assistant Professor, "McFarland's Cove," *Poet Lore*, 1997.

REES, Elizabeth, Visiting Assistant Professor, "Sometimes About You," *Owen Wister Review*, 1997.

REES, Elizabeth, Visiting Assistant professor, "Ins...," *Liberty Hill Review*, 1997.

REES, Elizabeth, Visiting Assistant Professor, "Duet," *The Baltimore Review*, 1997.

REES, Elizabeth, Visiting Assistant Professor, "Home Movie," *Gargoyle*, 1998.

REES, Elizabeth, Visiting Assistant Professor, "At Lunch" *Confrontation*, 1998.

REES, Elizabeth, Visiting Assistant Professor, "Newborn Father of Twins," *Gulfstream*, 1998.

WHITE, David A., Professor, "Restoring History: A Review of Michael Davies' *For Altar and Throne*" *The Remnant*, 31 (January 15 1998), 1,6.

This review focuses on the recent work of historians in exploring the resistance to the French Revolution. The book by Michael Davies explores the uprising in the territory called the Vendee where thousands of French citizens took up arms to defend the church and the Monarchy against the revolutionary forces. The movement as well as the specific battles and personalities are presented with extraordinary drama and detail.

Presentations

BOOTH, Allyson, Associate Professor, "Narrative and littleness in Audrey Shulman's *The Cage*," Narrative Conference, Northwestern University, Evanston, Illinois, 2-5 April.

ELLIS, Anne M., Assistant Professor, "*Voices in the Rain*," ATHE National Conference, Chicago, Illinois, 8 August 1998.

ELLIS, Anne M., Assistant Professor, "Identity Crises: Roadside Theater and Appalachian Cultural Identity," SAMLA Conference, Atlanta Georgia, 14 November 1998.

ELLIS, Anne M., Assistant Professor, *Eastside*, One-Act Play, competitively selected for production at FemFest 97, Red Hen Theater, Cleveland Ohio, 7 & 14 November 1997. Produced again at Oberlin College, Oberlin Ohio, as part of Womens History Month, 31 March 1998.

FETROW, Fred M., Professor, "African American Poetry: Robert Hayden and Paul Robeson," Severn School, Severna Park, Maryland, 15 October 1997.

FETROW, Fred M., Professor, "Black Heroism in the Poetry of Robert Hayden," presentation for Black History Month, Naval Reserve Military Sealift Commend Office, East Med #106, Naval Reserve Center, Fort McHenry, Baltimore, Maryland, 7 February 1998.

HILL, John M., Professor, "Juridical Revenge and Group Reformation in *Beowulf*," South Atlantic

Modern Language Association Conference, Atlanta, George, 12 November 1997.

HILL, John M., Professor, "In-law Feuds in *Beowulf*," Annual Institute on Beowulf, Newberry Library, Chicago, Illinois, 6 February 1998.

HILL, John M., Professor, "Marxism, Anthropology, and *Troilus & Creseyde*," Medieval and Renaissance Conference, New College, University of South Florida, Sarasota, Florida, 14 Mary 1998.

HILL, John M., Professor, "Cultural Anthropology and Psychoanalysis: The Case of Troilus," Medieval Institute Conference Kalamazoo, Michigan, 10 May 1998.

JASON, Philip K., Professor, "Stewart O'Nan's *The Names of the Dead*," Popular Culture Association Annual Conference, Orlando, Florida, 9 April 1998.

JASON, Philip K., Professor, "Online Research Resources for Writers," Maryland Writers' Association Conference, Linthicum Heights, Maryland, 18 April 1998.

MACE, Nancy A., Associate Professor, "'To Render Their Music Compleat': Legal Disputes over Words and Music," at the American Society for Eighteenth-Century Studies, Notre Dame, Indiana, 2 April, 1998.

MACE, Nancy A., Associate Professor, "Copyright Agreements Among British Music Sellers, 1769-1782," at the East-Central American Society for Eighteenth-Century Studies, Ursinus College, 25 October 1997.

MADISON, Robert D., Professor, "Tuckahoe," Talbot Historical Society, Easton, Maryland, 23 February 1998.

MADISON, Robert D., Professor, "Tuckahoe," Oxford Cooperative Laboratory, Oxford, Maryland, 4 March 1998.

O'BRIEN, Timothy D., Professor, "Fire and Blood–'Queynte' Imaginings in Diana's Temple," Southeastern Medieval Association Conference, Nashville, Tennessee, 25-27 September 1997.

PARKER, Michael P., Professor, Introductory address at the inauguration of Laurence W. Mazzeno as president of Alvernia College, Reading, Pennsylvania, 17 October 1997.

PARKER, Michael P., Professor, "Passion and Precision." Address at English Majors Banquet, U. S. Naval Academy, Annapolis, Maryland, 23 April 1998.

PORTOLANO, Marlana, Visiting Assistant Professor, "Nineteenth-Century American Rhetoric," Catholic University graduate seminar in History of Rhetoric, 10 April 1998.

REES, Elizabeth, Visiting Assistant Professor, "Teacher Training in the Field of Creative Writing," Piney Branch Elementary School, Takoma Park, Maryland, 16 March 1998.

REES, Elizabeth, Visiting Assistant Professor, "Teacher Training in the Field of Creative Writing," Eleanor Roosevelt High School, Greenbelt, Maryland, 8 May 1998.

REES, Elizabeth, Visiting Assistant Professor, "Poetry Reading," Atticus Bookstore, Washington, DC, 19 September 1997.

REES, Elizabeth, Visiting Assistant Professor, "Poetry Reading," Takoma Park Public Library, Takoma Park, DC, 5 May 1998.

DEPARTMENT OF

History

Professor Robert Artigiani
Chair

Pursuing eighteen distinct research projects during the past academic year, the History Department's efforts were crowned by two significant recognitions. Locally, Professor Craig L. Symonds won the USNA Alumni Association Research Excellence Award. This was a well-deserved reward, for Professor Symonds has published more books and articles than any other member of the Department, and his writings have enjoyed both popular and critical success. Equally gratifying and deserved is the designation of Professor Thomas Brennan's *Burgundy To Champagne* as "the best book on French History by a North American." This prize was awarded by the Society for French Historical Studies, the premier international organization devoted to the study of French History. Professor Brennan's book is a richly detailed study of the French wine trade in the early modern period. Based on archival resources never systematically studied before, it provides a portrait of market developments in the seventeenth and eighteenth century which will serve as a model for economic histories in the future.

Other members of the department published at least eleven papers on a multiplicity of subjects. Covering topics ranging from the American Civil War to the theory of cultural semiotics, these publications dealt with American, Persian, British, Russian, and French History, and they explored topics from antiquity to the present. History faculty read thirty-two papers reporting their work at scholarly conferences from Washington, D.C. to Rome, Italy and Liverpool, England. Beyond any question, Professor Craig Symonds sixteen presentations to various Civil War studies groups was the most significant. His ability to locate relevant topics and articulate his findings is universally recognized. Professor Mary DeCredico's analysis of popular perceptions of major historical events, like the Civil War as depicted on PBS, have also won wide readerships and an appreciation of the expertise and public spiritedness of our faculty. Faculty were also asked to consult to government agencies from the Library of Congress to the Department of State. Faculty reputations reached beyond domestic venues, as well, which fact is exemplified by the Department chair's invitation by the Belgian government to participate in a series of seminars celebrating the Nobel Prize given to Ilya Prigogine. Meanwhile, Associate Professor Samuel Nelson's researches into AIDS in Africa seems to be virtually creating a new research field, which is gaining recognition in panel sessions at conferences on epidemiology and the History of Medicine.

Among the research projects currently being pursued by History faculty are, of course, Associate Professor Samuel Nelson's own studies of the African AIDS epidemic. Closer to home, Associate Professor William Roberts and Assistant Professor William McBride have advanced projects analyzing the history of USNA. Conceptually, departmental research projects are plumbing fields like early American democracy, societal self-organization, the origins of English nationalism, civil-military relations, Middle Eastern cultures, and Russian historiography. The temporal focus of faculty research and writing has been equally broad, traversing the period from antiquity to the 1980's.

Midshipmen History majors have been similarly enterprising and productive. Honors students often did graduate-level research in the estimation of external readers and referees. Honors theses were written on the Moral Foundations of Resistance to Hitler, colonial animosities, the Battle of Okinawa, media coverage of the space race, the 1982 Lebanon War, World War II, and the American Civil War. An honors paper by 1/C Shannon Martin won the USNA prize for the best contribution to women's history, while 1/C Timothy Feist's paper on The Great Awakening in Maryland won the Hussey Prize for originality and creativity. A plebe research paper on early aerial combat won a national prize for the best paper on World War I aviation, and 1/C Aschenbrenner won the Phi Alpha Theta regional Conference award for best paper. Several midshipmen also carried out specialized independent research projects in East Asian and Chinese Military History.

It is impossible in a summary to do justice to the range and depth of historical research carried out at USNA, which is a tribute to the energy, professionalism, and dedication of faculty and midshipmen. Perhaps most impressive is the fact that these researches have consistently led to improved classroom experiences. Clearly, the symbiotic relationship between teaching and research has been one of the most effective tools history faculty have used to cultivate the habit of lifetime learning so properly a part of USN goals and missions.

Sponsored Research

The Formation of the English Nation, c. 650-939

Researcher: Professor Richard P. Abels

Sponsor: Naval Academy Research Council (O&M,N)

Between the seventh and the early tenth century, 'England' emerged, both as a concept and a political entity. This project explores how the political and social world described by Bede, with its numerous small tribal kingdoms, evolved into the consolidated English kingdom of the tenth century.

Recent historians of Middle Saxon England have tended to concentrate upon establishing the basic chronologies of kingship. Archaeologists, on the other hand, tend to ignore names and dates in favor of reconstructing the material past. Over the last decade our understanding of Anglo-Saxon settlement, village and urban life, and commerce has been dramatically changed by discoveries of archaeologists. Recent excavations at London, for instance, have forced historians to reconsider received ideas about the history of that city. What this project attempts to do is bridge the two disciplines. The goal is a deeper understanding of the changing nature of early medieval governance and politics, and a firmer understanding of the meaning of 'nationhood.'

The project is in its beginning stages. Last summer was devoted to exploring questions of urban development in Middle Saxon England through examination of charters, numismatic studies, and archaeological reports.

Moral Communities: A Social and Cultural History of Early Modern Europe

Researcher: Professor Thomas E. Brennan

Sponsor: Naval Academy Research Council (O&M,N)

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 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.

Roman Popular Literacy

Researcher: Professor Phyllis Culham

Sponsor: Naval Academy Research Council (O&M,N)

This is one phase of a project using epigraphical texts (those engraved on stone, wood, or bronze) to study roman uses of literacy, both public and private.

This phase of the study concluded that roman curse-bearing tablets of the first century B.C. represented sophisticated literacy and control of texts among the non-elite urban population of Rome at the end of the Republic. Partial results were presented in two papers, one of them at an international conference, and one article has been submitted for publication.

The Democratization of American Society and the Virginia Electoral System, 1760-1820

Researcher: Associate Professor John G. Kolp

Sponsor: Naval Academy Research Council (O&M,N)

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

Scheduled for publication by Johns Hopkins University Press in August 1998 under the title *Gentlemen and Freeholders: Electoral Politics in Colonial Virginia.*

The Naval Academy Curriculum Since 1899

Researcher: Assistant Professor William M. McBride

Sponsor: Naval Academy Research Council (O&M,N)

This project is part of a long-term study of the history of American naval engineering. Research focused on obtaining a better understanding of the development of the technical/engineering curriculumat the Naval Academy and involved review of material in Record Group 405, Records of the Superintendent, U.S. Naval Academy, held in the archives in the Nimitz Library.

AIDS in Zimbabwe: The Making of a Stigmatized Disease

Researcher: Associate Professor Samuel L. Nelson

Sponsor: naval Academy Research Council (O&M,N)

The AIDS stigma in Africa remains one of the most troubling obstacles in the promotion of effective disease-prevention strategies because the nature of the stigma has not been fully understood. This project explores the making of the AIDS stigma in Zimbabwe by focusing on the ways ideas about AIDS propagated in society, and how these ideas have shaped attitudes and behaviors. By examining how people have acquired negative connotations about AIDS, and how these ideas have acquired people, this study seeks to make a significant contribution to an on-going ethical and health problem in Africa.

Discovering the Signs: Social Images of the Deaf Community in Nineteenth Century France

Researcher: Professor Anne T. Quartararo

Sponsor: Naval Academy Research Council (O&M,N)

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 research is studying the concept of how language and culture coalesced in the late eighteenth century in a way that led to the formation of an early Deaf community. In the second part of the project, the researcher is studying the emergence of Deaf community associations, initiatives for Deaf education and the role leading activists played 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. The researcher has analyzed the role of Deaf-run congresses and Deaf associations in the formation of Deaf culture. The researcher has developed the third part of the study and presented information and analysis about the Deaf identity in the *fin-de-siecle* (late nineteenth century) crisis at a conference at the University of Liverpool in September 1997.

War in the Caucasus: Russian and Chechen Views

Researcher: Associate Professor J. Thomas Sanders and Associate Professor Ernest Tucker

Sponsor: George Kennan Institute at the Woodrow Wilson Center of the Smithsonian Institution

The project will result in a book containing annotated English translations of two works: (1) Leo Tolstoy's

Hadji Murad and (2) Muhammad Tahir al-Qarakhi's Bariqat al-Suyuf al-Daghistaniya (The Shining Daghestani Swards), an important Chechen chronicle of the life of Imam Shamil (1797-1871), the great leader of Islamic resistance to the Russians in the northern Caucasus. Our goal is to help students and general readers explore the nineteenth-century Russian-Chechen encounter through primary sources. By juxtaposing accounts of participants on both sides of the conflict, we hope to foster comparisons between the different ways this conflict was remembered–a good way to begin to think about what separated the two cultures and what brought them together. The essential work of the project is translation, and approximately one-third has been translated. In addition to completing the translation, a general introductory article has to be written and a glossary aimed at the general reader prepared. The Kennan Institute seed grant is an indication of the excitement the project has generated and enabled us to get the project off the ground. In the fall, we coordinated our efforts to apply for an NEH grant with Professor Tucker as the first researcher, which was supported by the Academic Dean and the Director of Research. Any success the grant application enjoys will owe a great deal to Professor George Lucas of LEL, who was most generous with his time and his insights, advising us how to proceed with this grant application.

Independent Research

Human Values and Social Complexity

Researcher: Professor P. Robert Artigiani

Social systems emerge as solutions to survival problems computed by human interactions when populations exceed natural carrying capacities. When sustaining separately acting organisms with biologically stored genetic information no longer suffices, individuals cannot merely do what pleases or protects themselves. Tired, fearful, hungry, or excited, individuals cannot obey biological urges to rest, run, eat, or mate that neglect, threaten, or disrupt specialized tasks upon which communal welfare depends. To avoid breakdown, individuals must regularize behaviors, which correlate activities across space and time. Choices and actions regularized as "social roles" allow people to know what one another are doing and synergistically amplify the effects of each other's activities. Thus, societies become wholes greater than the sums of their parts, thereby transforming the environmental scale on which selection occurs. Societies, each of which correlates behaviors in different ways, now become objects of natural selection. Since moralizing choices constrains individual actions and correlates behaviors, variations in values, ethics, and morals (VEMs), the information structuring social systems, become potentially significant. VEMs encouraging individuality and autonomy prove advantageous because the roles they script efficiently access resources. But initiatives releasing new or amplified resource flows threaten stability. Survival solutions are computed by adding roles and redefining relationships, which increases complexity, accelerates change, and transforms VEMs. The possibility that contemporary science improves societal adaptability by reinforcing humanistic VEMs is explored.

The Emergence of Societal Information

Researcher: Professor P. Robert Artigiani

Evolution, according to the "punctuated equilibrium" model, is a discontinuous process by which qualitatively new structures "emerge." New structures emerge when their component parts interact in ways

that transform both themselves and their shared environments, which transformations create information about systemic wholes. Created information is stored when interactions are both capture and capturing, components become mutually interdependent, and structures self-organize. The scale on which selection occurs and the kinds of attributes selected then change. Systems are selected "environmentally" by the external world, while component behaviors are selected by criteria internal to the system. Thus, although self-organized systems emerge bottom-up, once in existence they change the attributes of their components by exercising authority top-down.

If human societies are systems, their self-organization may not be explainable by appeal to intentionally acting, conscious individuals. Functions of societal self-organization, intentionality and consciousness may be artifacts derived from individual experiences of system-level feedback to local initiatives. System -level feedback communicates information about the criteria for social selection through rewards and punishments. System-level information describes social relations, cannot be reduced to traits in separate individuals, and is stored in symbols outside human bodies. Symbols permit individuals to anticipate rewards and punishments, which serendipitously captures biological processes and puts them to qualitatively new uses by generating consciousness and intentionality. This presentation proposes to analyze origin myths from several cultures, searching for evidence that symmetry-breaking societies emerged when civilizations self-organized–even if people did not consciously intend to create them. It will also examine the possibility that, in the competition between civilizations, environmental selection favors societies which select for conscious, autonomous individuals.

Meaning and Change: The Semiotics of Social Evolution

Researcher: Professor P. Robert Artigiani

Borrowing from recent models for the self-organization of systems and the theories of semiotics, an argument is made that feedback from an environment locates components of systems and identifies them. In human societies the same argument should hold, for the effects of individualbehaviors on systemic wholes is the "meaning" of those behaviors. Societies evolve, it is argued, when individual behaviors transform structures by communicating new information about their environments. The role of religion is examined particularly as an example.

Gender, Property, and Voting Rights in Colonial Virginia

Researcher: Associate Professor John G. Kolp

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 chapter-length paper on women's property and men's voting rights. 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, has been selected to 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.

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

Researcher: Associate Professor John G. Kolp

Elections to the eighteenth-century Virginia House of Gurgesses have been of long-standing interest to historians because of the role they played in the early political careers of a number of America's Founding Fathers. Although these men were selected for office within their local country constituencies by a substantial proportion of the adult male population, it has never been completely clearly what meaning should be attached to these political events. What did this selection process prove? Was there any real difference between candidates? Did it really matter who won? Were these events merely social gatherings or was something important being decided at these elections? Despite considerable attention by scholars in several books and numerous articles, the precise way these elections fit into the social and political structure of colonial communities has remained obscure. Scheduled for publication by Johns Hopkins University Press in 1998 under the title Gentlemen and Freeholders: Electoral Politics in Colonial Virginia.

Confederate Admiral: The Life and Wars of Franklin Buchanan

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 to 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 (Merrick) 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 his role as a reformer in the 1840s, his attitudes toward discipline, his political importance, his resignation from the Navy in 1861, and his service as Confederate admiral. The Naval Institute Press will publish this book in 1999.

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.

Best Fitted to Command: The Military Leadership of Patrick R. Cleburne

Researcher: Professor Craig L. Symonds

The subject of a full-length biography by the researcher, Patrick Cleburne was a remarkable field commander in the American Civil War. This essay, part of an anthology on successful Civil War generals, seeks to explain the elements of Cleburne's successful command leadership.

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 included in an anthology entitled *The Art of command* edited by Steven Woodworth scheduled for publication in the Fall of 1998 by the University of Nebraska Press.

The Civil War Recollections of General Ellis Spear

Researcher: Professor Craig L. Symonds

Ellis Spear served throughout the American Civil War as an officer in the20th Maine regiment. First as a junior officer, later as its commanding officer, and finally as a brevet Brigadier General, Spear participated in most of the major battles of the eastern theater. He was the second in command of the regiment at Gettysburg when it successfully defended Little Round Top. These memoirs, made available here for the first time cast new light on the history of that regiment and on Civil War combat in general. The researcher's role in this project was to help prepare the manuscript for publication and write approximately 206 footnotes to explain references in the text or add context to the narrative. It was published by the University of Maine Press entitled *The Atlanta Campaign* Revisited.

Research Course Projects

The Great Awakening in Maryland: George White field and the New Birth

Researcher: Midshipman 1/C Timothy P. Feist, USN

Advisor: Associate Professor John G. Kolp

This History Honors thesis calls into question most previous interpretations of the 18th-century religious revival known as the Great Awakening while at the same time it asks historians to rethink the criteria traditionally used to evaluate the response to and impact of this extremely important colonial American event. Feist initially sought to describe more fully the reasons why Marylanders had not responded to the Great Awakening but in so doing he became satisfied with recent explanations which heavily relied on socio-economic, demographic, ethnic, or class analysis. He found, for example, that such analyses begin to unravel when Maryland and Virginia are compared – both very similar societies but presumably quite different responses to the Awakening. He came to believe, therefore, that while such factors may help historians determine which peoples were predisposed to a positive response to the Awakening, the key ingredient was the sustained delivery of the New birth message. By concentrating on the sustained and repeated delivery of the New Birth message by preacher George Whitefield – especially in 1746-47 on the Eastern shore – Feist was able to show that Maryland was not some strange anomaly after all but in fact typical of responses received throughout all of the American colonies.

Inter-Colonial Animosities: The Wyoming Issue, 1753-1782

Researcher: Midshipman 1/C Patrick Hourigan, USN

Advisor: Associate Professor John G. Kolp

This History Honors thesis clarifies much of the complicated local history of the Wyoming Valley of Pennsylvania before and during the American Revolution and shows how that local history adds to our general understanding of the difficulties faced in sustaining a war effort. First, the thesis ties together a series of local events - several of the so-called Pennamite Wars (battles between Connecticut and Pennsylvania over ownership of the Valley) and a number of local, state, and national military actions - into a connected and coherent narrative. Second, this project recognizes that these seemingly unconnected local events and inter-colonial struggles intersected with and influenced the broader struggle for independence from Britain.

Buckner's Fiasco?: Strategic Decision-Making and the Second Landing at Okinawa

Researcher: Midshipman 1C Richard Rusnok, USN

Advisor: Assistant Professor William M. McBride

This History Honors thesis attempted through a broad-based research of primary and secondary historical sources to understand why a second amphibious assault was not made on Okinawa in 1945 when American forces bogged down on the Shuri Line. The paper argued that the decision not to attempt to outflank the Japanese Shuri Line was a combination of high-level command disputes between General Douglas MacArthur and Admiral Chester Nimitz, logistics limitation imposed by the pending invasion of Japan, and issues of postwar unification in which the army and navy were sensitive to their political position after the war.

The 1982 Lebanon War: Its Effects on Veterans' Perceptions of the Israeli Military

Researcher: Midshipman 1/C Ryan Shadle, USN

Advisor: Associate Professor Ernest Tucker

The 1982 Lebanon War had drastic consequences for the nation of Israel. It is considered by most Israelis to be the first war not waged for the survival of the state. It is also considered by many to be Israel's first military defeat–if not tactically–then strategically. None of the stated political goals of the war were achieved. The 1982 Lebanon War marks the first time in Israeli history that widespread opposition to the use of military force developed during a conflict. It was certainly Israel's longest war. Lebanon still haunts Israeli headlines to this day. The general political, economic, and social consequences of the Lebanon War for Israeli society have been documented time and again. What has been lacking is a study of the effects of the war of the thoughts and attitudes of the Israeli soldiers who fought there. This work was an attempt to analyze some of these effects through interviews with a cross-section of Israeli veterans of the war.

This study concluded that for Israeli soldiers who fought there, the 1982 Lebanon War marked a major turning point in attitudes about the military in two important ways. Participation in the war brought about a realization of the limits of military power. It spurred a debate about the role of military force in achieving political goals, and it shattered the feeling of distance between Israel and its enemies, forcing Israeli troops to confront the possibilities of enemies within their own borders. Many of the soldiers even attribute the initiation of the current peace process to these changes in attitudes. The other important impact of the war on those interviewed concerned their images of the Israel Defense Forces as an institution and their views of the role of military service in Israeli society. Almost all of these Lebanon veterans agreed that the centrality of the Israel Defense Forces in Israeli society was weakened by the war. Their comments suggest that they believe the 1982 Lebanon War was responsible for a decline in military discipline and the common Israeli perception of army service as an important rite of passage. In all, Lebanon veterans' views display a recognizable shift away from traditional Israeli attitudes about the use of military power and the importance of military service.

PUBLICATIONS

ABELS, Richard, Professor, "Sheriffs, Lord-Seeking, and the Norman Settlement of the South east Midlands," *Anglo-Norman Studies* 19 (1997), 19-50.

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. This article identifies and analyzes the mechanisms whereby control over land in the counties of the south-east Midlands passed from native landholders to Norman newcomers. It focuses on two aspects of this process: 1) the role played by the king's juridical agents in the counties, the sheriffs, and 2) how traditional customs of Anglo-Saxon lord-seeking facilitated and helped shape the Norman Settlement.

King William the Conqueror's sheriffs in these counties were well positioned and dispositioned to profit from the powers of their office and the turmoil of the times. Though they engaged in the same activities as their English predecessors, they did so in a radically different social and legal climate that allowed them to build up extensive personal holdings fashioned from the estates of lesser free men who had traditionally sought the protection of the king and his local agents. They were aided in their endeavors by the very men whose lands they snatched. The traditional practice of lord-seeking survived the Conquest, but, like of the office of sheriff, was transformed by circumstance. Instead of finding shepherds, native landowners who

sought the lordship and protection sheriffs discovered they had given themselves over to wolves.

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 as the legal heirs to English thegns, the Normans erected a new tenurial world upon the foundations of the old.

ARTIGIANI, P.R., "Social Information: The Person Is The Message" *BioSystems* (Spring, 1998) pp. 1-9.

Shannon's concepts are extended to human social systems by showing that social information measures the reduction in uncertainties individuals have about the systemic effects of each other's behavior. Since systemic effects are what individual actions "mean", reductions in systemic uncertainties about the collective environment are also measured. Social information is stored in the symbols called Values, Ethics, and Morals, which encourage individuals to act predictably and replicate the improbable behaviors characterizing particular societies. When individuals internalize meaning, their personal identities communicate societal priorities to future generations.

ARTIGIANI, P.R., "Interaction, Information and Meaning" *World Futures: The Journal of General Evolution* (Fall 1997) vol 50, pp. 702-714.

The possibility of a unified theory of information which avoids reifying information or attributing agency to it is explored using the patterned processes characteristic of self-organization. Interactions are shown to create information from the level of quantum physics to human societies. The difference between meaningless and meaningful information is explained through the contextualizing role of systems.

BOGLE, Lori, Assistant Professor, "Paradox of Opportunities: Lucy Ston, Alice Stone Blackwell, and the Tragedy of Freedom," in Jack Tager, Martin Kaufman, and Michael F. Konig, *Massachusetts Politics: Selected Historical Essays* (Westfield, Mass.: Westfield State College, 1998).

BOGLE, Lori, Assistant Professor, "Project Alert: Radical Right Propaganda and the Navy, 1958-1962", *New Interpretations in Naval History*. Edited by William Cogar. (Annapolis, Maryland: Naval Institute Press 1997).

BRENNAN, Thomas, Professor, Burgundy to Champagne: The Wine Trade in Early Modern France. Baltimore, The Johns Hopkins University Press, 1997.

Early modern viticultural society depended on markets, perhaps more than any other part of rural society. This is a study of the provincial brokers who gained economic power through their enterprise, wealth, networks, and simple ruthlessness, rising the late seventeenth and early eighteenth century to positions of unprecedented control over the wine trade and wine growers. It analyzes their commercial techniques to understand the levers of their economic power and addresses the controversies provoked by their commercial transformations.

Beginning with an initial examination of viticultural society and the process of creating wine, the book examines the wine trade in Champagne and Burgundy and reveals the crucial role played by provincial brokers. Subsequent chapters analyze the viticultural communities' response to the innovations and rowing power of these brokers, interpreting the language of judicial, political silent protests to understand the competing conceptualizations of the market's role in society.

Final Chapters address the internationalization of the wine trade, as commercial ties grew to knit most of France together in the late eighteenth century, and certain provinces moved to thrust themselves into a wider, European, commercial world. The end of the old regime was a time of commercial difficulty for the wine trade but also a time of crucial innovation on the part of wine brokers that would lay the ground work for their triumph in the following century.

This book was awarded the 1997 Pinkney Prize for best monograph on French history of any period by the Society for French Historical Studies.

CULHAM, Phyllis, Professor, "Did Roman Women Have an Empire?" in M. Golden and P. Toohey, eds. Inventing Ancient Culture: Historicism, Periodization, and the Ancient World. New York: Routledge, 1997, pp. 192-204.

This article takes off from Joan Kelly's famous "Did Women Have a Renaissance?" to ask similar question

about whether the standard periodization of Roman history reflects only certain kinds of evidence about the lives of males or whether it is also useful in describing the lives of women. The more recent writers to address the topic of how Roman women's history fits with the traditional, mainly political "eras" of Roman history have tended to believe that women's history is not well werved by current periodization. In at least one case, however, that of Augustus, the first emperor, his political actins also created a social watershed for women in several ways. It is therefore fair to say that women also had an imperial era.

DeCREDICO, Mary A., Professor, "*Image and Reality: Ken Burns and the Urban Confederacy*" Journal of Urban History, 23 (1997): pp. 387-405.

The PBS series "Ken Burns' Civil War" captivated the viewing public with its evocative images and moving narrative. Yet Burns' efforts to portray this most significant event tended to emphasize stereotypes over historical accuracy. Nowhere is this more apparent than in his treatment of the urban Confederacy. Though they began the war as symbolic targets, Atlanta and Richmond quicky were metamorphosed into decisive points targeted by the Federal high command. Only by understanding the contribution of Southern cities can we understand, the transformative impact of the war.

SANDERS, Thomas, Associate Professor, Guest Editor, Russian Studies in History, Spring, 1998.

This journal makes available to the English-speaking world the latest in Russian historical writing. The issue for which I am serving as guest editor is devoted to Russian writing on historiography. In particular, the volume includes the work of four eminent historians (three of them members of the Historical Division of the Russian Academy of Sciences) exploring the contributions of the most important Russian historians of the late nineteenth and early twentieth centuries. They pay special attention to the legacies of these prominent historians with an eye toward the Russian regeneration of a sense of its own unique, non-Soviet historical evolution. One of the most important tasks underway in Russia today is the effort at re-defining the historical meaning of their national experience, and these historians are looking to the greatest prerevolutionary historians for elements of continuity and coherence. The volume includes a brief introduction by me.

SYMONDS, Craig L., Professor, U.S. Navy, Encyclopedia of the Mexican-American War, Simon and Shuster, 1997.

This is a 1500-word entry that chronicles the role of the 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.

SYMONDS, Craig L., Professor, The Atlantic Campaign Revisited, Savas Publishing, Keith Bohannon, ed. 1997.

This article address the historiographical issues that have swirled around the campaign for Atlanta in the Spring and Summer 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.

SYMONDS, Craig L., Professor, The Civil War Recollection of General Ellis Spear, University of Maine Press. 1997.

Ellis Spear served throughout the American Civil War as an officer in the 20th Maine regiment. First as a junior officer, later as its commanding officer, and finally as a brevet Brigadier General, Spear participated in most of the major battles of the eastern theater. He was the second in command of the regiment at Gettysburg when it successfully defended Little Round Top. These memoirs, made available here for the first time cast new light on the history of that regiment and on Civil War combat in general. The researchers's role in this project was to help prepare the manuscript for publication and write approximately 200 footnotes to explain references in the text or add context to the narrative.

Presentations

ARTIGIANI, P.R., Professor, "Meaning and Change: The Semiotics of Social Evolution," Sixth Annual Conference of the Washington Evolutionary Systems Society, Washington, D.C., 12-15 May 1998.

BOGLE, Lori, Assistant Professor, "NSC 68, American Civil/Military Religion, and the Search for a National Will," at the Organization of American Historians (Indianapolis, Indiana) April 3, 1998.

BOGLE, Lori, Assistant Professor, Critic for "The Cold War and Beyond" at the Southwestern Social Science Association Conference (Corpus Cristi, Texas) March 18, 1998.

BOGLE, Lori, Assistant Professor, Critic for "What Makes you the Expert?: Civilian vs. Military Expertise in the Twentieth Century" at the Society for Historians of Foreign Relations (College Park, Maryland) June 18-20, 1998.

BOGLE, Lori, Assistant Professor, Critic for "Nations, Nationalism, and War: The Forging of American National Identity, 1789-1830" at the Society for Historians of the Early Republic (Harpers Ferry, West Virginia) July 16-19, 1998.

CULHAM, Phyllis, Professor, "Architectural 'Archives' in Antiquity?: The Theater and Other Sites in Aphrodisias," Panel on Ancient Archives, Annual Meeting of the American Philological Association, Chicago, IL, December 29, 1997.

CULHAM, Phyllis, Professor, "Roman Magical Texts and Popular Literacy," Inaugural Meeting for the History of the Text, Seattle, WA, October 29, 1998.

CULHAM, Phyllis, Professor, "Five Roman Tabulae Defixiones of the First Century B.C." Meeting of the International Association for Epigraphy, Rome, September 23, 1997.

DeCREDICO, Mary A., Professor, "Hardships Most Bitter: The Impact of War on Urban Families, Richmond, 1861-1865," Conference on Families at War: Loyalty and Conflict in the Civil War South, April 24-26, 1998.

QUARTARARO, Anne T., Professor, "Deaf Autonomy, Deaf Pathology: The Crisis of Cultural Identity for the Deaf Community in fin-de-siecle France" Association for the Study of Modern and Contemporary France, University of Liverpool, September 9-11, 1997.

SANDERS, Thomas, Associate Professor, "Science in Russian Historical Writing," Paper presented in my role as commentator, 1997 Annual Convention of the American Association of Slavic Studies, November 22-24, 1997, Seattle, WA.

SANDERS, Thomas, Associate Professor, "The Russian Image of Self in the 1920s and Its Contemporary Relevance" Roundtable Discussion, "National Identity in Recent Russian Historiography", 1997 Annual Convention of the American Association of Slavic Studies, November 22-24, 1997, Seattle, WA.

SANDERS, Thomas, Associate Professor, "Catherine the Great: Image and Reality," in USNA, Women's History Month Films.

SYMONDS, Craig L., Professor, "Patrick Cleburne and the Civil War," Washington, D.C. Civil War Round Table, Ft. McNair, December 9, 1997.

SYMONDS, Craig L., Professor, "The Critical Battle of Franklin," Smithsonian Institution, March 11, 1998.

SYMONDS, Craig L., Professor, "Patrick Cleburne and the Civil War," Albany Civil War Round Table, Albany, NY, April 18, 1998.

SYMONDS, Craig L., Professor, "Patrick Cleburne and the Civil War," Buffalo Civil War Round Table, June 26, 1997.

SYMONDS, Craig L., Professor, "Davis and Johnston at War." Civil War Institute, Gettysburg, PA, June 30, 1997.

SYMONDS, Craig L., Professor, "Modern War," WETV Television Program, July 7, 1997.

SYMONDS, Craig L., Professor, "Patrick Cleburne's Proposal to Free the Slaves." National Meeting, Sons of Confederate Veterans, Nashville, TN, July 31, 1997.

SYMONDS, Craig L., Professor, "Iron Against Wood: Franklin Buchanan and the Battle of Hampton Roads," Blue and Gray Education Society, Hampton Roads, Virginia, August 8, 1997.

SYMONDS, Craig L., Professor, "Patrick Cleburne and the Civil War," Philadelphia Civil War Round Table, September 16, 1997.

SYMONDS, Craig L., Professor, "The Perils of Civil War Biography," Handley Regional Library, Winchester, Virginia, September 20, 1997.

SYMONDS, Craig L., Professor, "Patrick Cleburne and the Civil War," Wilmington Civil War Round Table, Wilmington, North Carolina, October 21, 1997.

SYMONDS, Craig L., Professor, "Patrick Cleburne and the Civil War," New York City Civil War Round Table, New York, November 12, 1997.

SYMONDS, Craig L., Professor, "Patrick Cleburne and the Civil War," Washington, D.C. Civil War Round Table, Ft. McNair, December 9, 1997.

SYMONDS, Craig L., Professor, "The Critical Battle of Franklin," Smithsonian Institution, March 11, 1998.

SYMONDS, Craig L., Professor, "Patrick Cleburne and the Civil War," Albany Civil War Round Table, Albany, NY, April 18, 1998.

SYMONDS, Craig L., Professor, "Patrick Cleburne and the Civil War," Civil War Round Table of Central New Jersey, May 11, 1998.

SYMONDS, Craig L., Professor, "Leadership in the American Civil War," Civil War Leadership Conference, Alexander, Virginia, May 15, 1998.

SYMONDS, Craig, L., Professor, "Best Fitted to Command: The Military Leadership of Patrick R. Cleburne," Blue and Gray Educational Society Annual Meeting, Fredericksburg, Virginia, May 16, 1998.

SYMONDS, Craig L., Professor, "Patrick Cleburne and the Civil War," Kansas, City Civil War Round Table, May 26, 1998.

TUCKER, Ernest, Associate Professor, "Ottoman Tradition: Ottoman Legacy," National Foreign Affairs Training Center, Arlington, VA, October, 1997.

TUCKER, Ernest, Associate Professor, "The Internet in the Middle East History Classroom," Middle East Studies Association Meeting, San Francisco, CA, November, 1997.

TUCKER, Ernest, Associate Professor, "Shamil's Chechnia," Library of Congress, Washington, D.C., March, 1998.

TUCKER, Ernest, Associate Professor, "Iranian Media and the World Wide Web," Society for Iranian Studies Biennial Conference, Bethesada, MD, May, 1998.

TUCKER, Ernest, Associate Professor, "Nadir's New Capital: Time and Space Redefined in Afsharid Khurasan," Society for Iranian Studies Biennial Conference, Bethesada, MD, May 1998.

DEPARTMENT OF

Language Studies

Professor Sharon Dahlgren Voros

Chair

During the 1997-1998 academic year, the Language Studies Department conducted important research in a wide variety of fields within the area of foreign languages. Faculty members produced a total of 5 sponsored research projects, 20 Independent Research Projects, 12 published articles, and 32 presentations at professional conferences, both national and international, including Argentina, Canada, Great Britain, France, and Japan. Of particular note this year is the award granted to Associate Professor Elizabeth Knutson. She received the prestigious Stephen A. Freeman Award for the best published article for 1997 in the field of foreign-language teaching. The Northeast Conference on the Teaching of Foreign Languages presented her the award at a special ceremony in New York City.

Among the various publications this year are the following. Professor Eva Corredor, the department's nominee for the USNA Research Excellence Award for the publication of her book on Luckács After Communism continued her study of post-Communist Eastern Europe. Associate Professor Marianne Bosshard published two articles, on Chantal Chawaf and on "writing in the feminine," and one review article on Annie Cohen. Assistant Professor Clementine Creuziger [Fujimura] published two articles in Anthropology, on religious identity and on Russia's orphans. Associate Professor María Castro de Moux published an article on the myth of Prometheus in the seventeenth-century dramatist Pedro Calderón de la Barca. Her book on the Puerto Rican poet Luis Palés Matos was accepted for publication and will be available later this year. Associate Professor Elsa Gilmore published an article on the Chilean playwright Marco Antonio de la Parra. Associate Professor Ludmila Pruner published two articles on Russian cinema and one film review. Professor and Chair Sharon Voros published an article on the seventeenth-century woman dramatist Leonor de la Cueva y Silva. She has written two articles also accepted for publication this year. This wide range of scholarly expertise provides a rich learning environment for midshipmen studying the culture, literature, history and language of other nations. Our students ultimately are the beneficiaries of faculty research when they take classes from active, productive scholars.

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 William Fletcher continued his pioneering development of organizational infrastructures for net-based instruction delivery of multimedia lesson materials to midshipmen in the laboratory, classrooms, and Bancroft Hall. These delivery systems provide access to world-wide authentic foreign-language material for instruction at all levels of proficiency. Associate Professor Elsa M. Gilmore completed the final lessons in Intermediate Spanish with the latest technology-supported computerized programs in digitized video, now fully integrated into course syllabi. Professor Gladys Rivera-La Scala conducted a study of computer-based aural and written practice and its impact on the learning and retention of specific grammatical and syntactical structures in Spanish. This research was conducted with guidance from the National Capital Language Resource Center. In addition, Professor Rivera-La Scala, with assistance from Professor John Hutchins (ret.) and Professor Emeritus Guy Riccio (ret.), completed a totally new project on programs from the Televisión Azteca that reflect more critical approaches to Mexican society. Lieutenant Homero Cruz, exchange officer from the Mexican Navy, also assisted in this project and taught one of the sections in the spring. Lessons were 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 involving Mexican society and politics.

While the Language Studies Department does not offer a major in foreign languages, it has a strong minors program with 109 minors in all languages, including 4 double minors, among the 1998 graduates.

These midshipmen 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 a summer-cruise exchange with the French Naval Academy in Brest. Graduates of the Class of 1998 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

Perspectives on the Lives of Adoptive Families

Researcher: Assistant Professor Clementine Creuziger

Sponsor: Kennan Institute

Along with recent social, political and economic developments in Russia has come a new crisis: that of unwanted children. As the researcher points out in her recent study, "Russia's Unwanted Children" (Childhood, 1997, p. 343): "Once hailed under the Soviet regime as the future of modern society and the responsibility of all adults, thousands of children have since been labeled as unwanted beggars (nishchie)." Indeed, many children, both orphaned and adopted have been forced to survive as marginalized. Even orphans now living as members of American families are coping with their often stigmatized status as adopted children. However loved these children are by their families, their issues are unlike those of children living with their birth parents. Within the U.S., they will always be seen as different. In Russia, they are regarded as inferior, stemming from "bad blood."

How do the families and children cope with such stereotypes? How do these American families redefine themselves as kinship units in a society which still questions the adaptability and success of Russian adopted children? How do children who for many years saw themselves as existing outside the family reconceptualize themselves as newly adopted "Americans"? Such questions, as they are embedded in the context of Russian orphanhood, Russian society and American society, are the focus of this research. Not only does this project explore the process of self-definition of families of Russian adopted children, but it also addresses social issues faced by both Russian orphans in Russia and Russian orphans adopted by American families. It is hoped that via this paper, marginalized children will be seen as a valuable focus for further social scientific research.

This project was partially sponsored by The Kennan Institute, Washington D.C. and the United Sates Naval Academy.

Strengthening the Infrastructure

for Net-Based Instruction Delivery in Language Courses

Researcher: Associate Professor William H. Fletcher

Sponsor: Curriculum Development Project, USNA

This project continues developing the software, hardware, and organizational infrastructure for delivering multimedia lesson materials to language learners in the laboratory, classroom, and Bancroft Hall, via the Internet. During the time frame covered by this report, the researcher led the efforts to upgrade all faculty and staff computers to support multimedia, and set up 10 classroom multimedia display stations. He also procured equipment and initiated procedures for encoding instructional support materials in highly compressed digital video and audio standard formats of MPEG and RealAudio, and piloted deploying such digital media clips via the World Wide Web to enhance 200- and 300-level language courses. One result of this work was his seminar for USNA faculty, "Making Instructional Digital Video and Audio Work", supplemented by materials and annotated links at http://www.chesapeake.net/fletcher/mpeg.html.

Tradition and Innovation in France's Minority Language Theater

Researcher: Associate Professor Audrey Gaquin

Sponsor: Naval Academy Research Council (NARC)

This project consists of a series of articles exploring the ways that France's minority language theaters communicate across linguistic and cultural barriers. The first article, currently in preparation, is a general introduction to minority language theater in France, based on interviews with Claude Alranq, Goulc'han Kervella, and Joseph Fenninger, conducted in summer 1997, as well as studies of the minority theater heritage by Alranq, Gwennole Le Menn, Georges Hérelle, and Jocelyne Fritsch, and the examination of scripts and videos of some recent productions. The second article is a study of verbal and non-verbal signs in the Alsatian Théâtre de la Chimère's production Le Retour d'Ubu. Future articles concerning Claude Alranq's production of Vaudeville d'Oc and Goulc'han Kervella's passion play Ar Basion Vras, as well as other productions the researcher may be able to view in summer 1998 are planned.

The first article, an introduction to minority language theater in France, will also serve as the basis for a presentation in summer 1998 at the annual conference of the American Association of Teachers of French in Montreal.

Digitized Video-Based Cooperative Lessons for Intermediate Spanish

Researcher: Elsa M. Gilmore

Sponsor: Curriculum Development Project, USNA

This year, the researcher completed the final 5 cooperative video lessons for FS201-202. She selected and digitized five segments which were needed to complete 15, or a full complement (one per chapter), for the Intermediate Spanish syllabus. All of the segments and accompanying lessons complement the syllabus topics culturally and linguistically. They have now been integrated into the FS202 curriculum for use by a large number of sections.

The Reliability and Construct Validity Study of a Self-Concept Scale for College Students

Researcher: Chie M. Paik

Sponsor: Naval Academy Research Council(O&M,N)

For a sample of 400 midshipmen taken from the United States Naval Academy, the twofold purpose of this study is to obtain evidence of the internal-consistency reliability and construct validity of scores on each of six dimensions of an academic self-concept measure entitled Dimensions of Self-Concept (DOSC), Form H. The original DOSC has been revised and the data has been collected. The following statistical analyses are being performed using the Statistical Packet for Social Sciences (SPSS): (1) The mean and standard deviation for scores on each of the six factor subscales, (2) a coefficient alpha estimate of internal consistency, (3) Pearson produce-moment correlation coefficients, (4) exploratory factor analyses, and (5) confirmatory factor analyses.

The Effects of Combining Computer-Based Aural and Written Practice in the Learning and Retention of Specific Grammatical and Syntactical Structures in Spanish

Researcher: Professor Gladys M. Rivera-La Scala

Sponsor: Curriculum Development Project, USNA

The purpose of this project is to test the effectiveness of certain types of instructional materials delivered via computer on the learning and retention of Spanish verb usage and form. With the 1997 summer CDP grant the researcher developed over 30 Lab programs integrating digitized sound and text. These programs have been field tested by midshipmen in Intermediate Spanish II, Spring semester of 1998. With the guidance from senior researchers from the National Capital Language Resource Center the researcher created a research design that she is currently using to analyze the data she has collected this year on the student use of these

programs. When this phase of the experiment is completed, the researcher hopes to publish her findings in light of other studies that have been done on the effects of this type of instructional treatment on second language acquisition of the Spanish subjunctive, and include a bibliography.

Independent Research

The Uses and Exploitation of the Impersonal Pronoun Se in Spanish

Researcher: Associate Professor Penelope M. Bledsoe

The researcher continues to prepare a 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 usage 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 the 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 agent less passive, and pragmatic exploitation of the 'impersonal' se to sustain certain sociolinguistic principles of communication.

The Relationship Between Measures of Attitude and of Achievement in Second Language Acquisition

Researcher: Associate Professor Penelope M. Bledsoe

The researcher has been exploring the relationship between measures of attitude and of achievement in second language acquisition. The research has been conducted in the researcher's classes at the USNA during the 1997-98 school year via questionnaires and surveys which question the attitude of students toward language learning in general, value of knowing a foreign language and culture, and attitude toward/value of learning the Spanish language in particular. The researcher is looking for links between the attitudes students profess toward these subjects and their achievement in Spanish. In addition to surveys and questionnaires, the researcher has conducted interviews of students to explore and clarify their responses. The results of this study will be presented at the Congress of the American Association of Teachers of Spanish and Portuguese in Madrid, Spain, during August 1998.

Chantal Chawaf: Evolution of a Literary Ethic

Researcher: Associate Professor Marianne Bosshard

In November 1997, the researcher completed 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. It contains six chapters dealing with the following topics: (1) the literary ethics of the author; (2) her poetics; (3) the theme of the maternal; (4) the "Other" and the quest for identity; (5) the reformulation of ancient myths, and (6) the sociological aspect of the oeuvre. The manuscript is scheduled for publication in the fall of 1998 by Editions Rodopi, Amsterdam, the Netherlands, in their monograph series on contemporary French writers (Collection monographique Rodopi en littérature française contemporaine.)

Maryse Condé: A Historical Reading

Researcher: Associate Professor Marianne Bosshard

In 1997, the well known author and university professor, Maryse Condé, published a novel entitled Desirada. The title refers to a small island in the French Antilles which received its name from Christopher Columbus when he and his crew, after a seemingly endless voyage, finally spotted a much "desired" island. Occupied by the French since 1648, "La Désirade," however, soon became a place where the French government sent its "undesirable" subjects (des "mauvais sujets") including those afflicted by leprosy. In Condé's novel, in spite of its title, the island does not serve as the locale for most of the novel's action and little is said about its history.

In the first part of the project, the researcher will analyze the role and function of the protagonist of Desirada in the context of this island's socio-political history in order to offer a historical interpretation of the link between the title and the narrative of Condé's novel. The results of this research will be presented at the International Conference on Contemporary French Literature, to be held at Dalhousie University, Halifax, Canada, September 1998.

The second part of the project concerns a different novel by the same author, Traversée de la Mangrove, published in 1989. It is the goal of the researcher to analyze the circular structure of the novel, its elusive main character, and the numerous contradictory narratives in the context of the four main historical functions of the traditional "conteur créole" as outlined by Patrick Chamoiseau and Raphaël Confiant.

The researcher will carry out the major part of this project on the above mentioned island and plans to discuss the project with the author, Maryse Condé, at that time.

La negritud de Luis Palés Matos
(The Black Poetry of Luis Palés Matos)

Researcher: Associate Professor Maria E. Castro de Moux

This is a study of Luis Palés Matos' search for Puerto Rican cultural and political identity through his early works to his Black poetry. It presents an overview of the impact of his early years on his later poetry, especially his Masonic and spiritualistic beliefs. His search encompassed European Vanguardist movements, also Marxist theory of art which he abandoned, settling for Taine's theory of the "milieu" as developed by Oswald Spengler. His search for Puerto Rican ethnic roots led him to a poetry supporting an Afrohispanic cultural identity as a basis for an independent nation. The manuscript is currently formatted for publication.

Alchemy and Emblems in Calderon de la Barca

Researcher: Associate Professor Maria E. Castro de Moux

This is a study of the meaning and function of alchemical symbols and images in 17th-century Spanish playwright Pedro Calderon de la Barca's theological and mythological plays. The study draws from art, history, theology, philosophy and 17th-century science.

The Dynamics of Eastern Europe

Researcher: Professor Eva L. Corredor

Research was carried out during a five-week tour of Austria, Hungary, and Slovenia (17 May-20 June 1997) the purpose of which was to study the cultural and socio-political situation of Eastern Europe after the collapse of Soviet Communism. It involved visits to numerous museums, universities, libraries, courts of justice, banks, radio-television stations, and industrial sites and, at each stop, included lectures by experts in the field. Since this was a group study exchange tour fully sponsored by Rotary International, the East-European hosts encouraged reports about equivalent aspects of the United States. As organizer and leader of the study group, the researcher delivered six lectures (in German) during the trip in Eastern Europe and, since her return, was asked to lecture to several academic and civic groups. She was the invited speaker at eight Rotary Club Meetings in the Washington, D.C. and Central Maryland area. Her comments on the experience and the benefits of the study tour appeared in an article, entitled "The Dynamics of Eastern Europe," published in the August edition of The Rotary District 7620 BEACON. A second article, "Impressions of Hungary," requested by the editor of a journal in Budapest, has been submitted and is forthcoming later this year.

The Hungarian Cinema After 1989

Researcher: Professor Eva L. Corredor

During the summer of 1997, the researcher continued to observe the development of post-1989 cinema in Eastern Europe, and more specifically in Hungary. This was part of a research interest in Hungarian film begun in 1996. The purpose was to determine the changes in form and topics that were likely to manifest themselves in response to the post-revolutionary, socio-political situation in the newly liberated country. This led to the discussion of films such as the Fellini-inspired Bolshe Vita by Ibolya Fekete and Privát Magyarország ("Private Hungary") by Peter Forgács at a session organized and chaired by the researcher for the Annual Congress of the Modern Language Association in Toronto, CA, December 1997. The researcher will further develop her interest in the relationship between history and artistic form in a session she is currently organizing as executive committee member of the Discussion Group of Hungarian Literature for the MLA Annual Congress in San Francisco, December 1998.

Ethical Confrontations at the Time of the Millennium

Researcher: Professor Eva L. Corredor

This is part of an ongoing study of the work of Jacques Derrida begun in 1995. The researcher has been confronting the theories of the 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-vision" of each of the theoreticians and their projections as to the survival of their own theories. Parts of this research have been discussed at professional meetings in 1996-97. The most recent results of this project, "An Ethical Inquiry Into Derrida's Specters and Lukács's Perspectives," were presented at the Annual Conference of the International Association for Philosophy and Literature at which Jacques Derrida himself was present.

Making Instructional Digital Video and Audio Work: An Educator's Guide

http://www.chesapeake.net/fletcher/mpeg.html

Researcher: Associate Professor William H. Fletcher

This webpage is the written and constantly updated version of a presentation for colleagues at USNA on producing and using digital audio and video (DAV) to support instruction. It focuses on technologies for creating, editing and delivering DAV on a Windows 95-based platform, and emphasizes affordable MPEG-1, and other evolving standards. It assumes content distribution via a high-capacity medium (LAN, CD-ROM), and thus does not address alternatives such as real-time streaming of low-bandwidth video via the Web.

After a discussion of the rationale for choosing MPEG-1 video, and MPEG or RealAudio audio, this page explains over three dozen key terms and concepts in DAV. It then discusses the process of capturing and encoding digital video and audio. Several variants of this process are described and evaluated. The pros and cons of hardware and software playback solutions are then presented. Alternative approaches to storing and distributing DAV are explored, and specific products in various price ranges for capturing, deploying, and playing DAV are recommended (due to these recommendations this page cannot be hosted by the USNA website). Guidelines for fair use of copyrighted material are presented. This on-line article concludes with over 100 annotated links to complementary information, and to product manufacturers and vendors.

Euromosaic and France's Endangered Languages

Researcher: Associate Professor Audrey Gaquin

This article 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 Union. The Euromosaic report gives the results of exhaustive research carried out by sociolinguists Peter Nelde, Miquel Strabell and Glyn Williams among the more than fifty non-immigrant minority cultures of the European Union. The report evaluates minority language production and reproduction among these groups and predicts the probability of survival of each language based on eight criteria which include government policy and institutional support. This article studies the current situation of France's seven minority languages as described by Euromosaic and in recent minority periodicals and makes proposals for increasing the chances of survival of these languages, most of which are considered seriously endangered by the Euromosaic researchers.

Les Langues minoritaires de France et la nouvelle Europe

Researcher: Associate Professor Audrey Gaquin

This article discusses the provisions of the European Charter for Regional and Minority Languages drawn up by a committee of language policy experts for the Council of Europe. The article analyzes the reasons for France's refusal to sign the Charter, the actions taken by minority leaders to promote the signature of the Charter, the implications of Article 2 of the French constitution, added in 1992, for minority languages, and the decision of the French Conseil d'Etat in 1997 concerning the Charter. Because of new developments in French minority language policy, this article has been revised and updated several times. It was submitted for consideration to The French Review in April 1998.

Expansion and Update of Interactive Video Lessons in Lower-Level Language Courses

Researcher: Associate Professor Audrey Gaquin

The purpose of this Curriculum Development Project is to create two-level interactive video lessons. A single video segment will be used to provide listening comprehension practice, vocabulary analysis and practice, cultural background information and analysis, and a review quiz.

During the summer of 1996, the researcher, with the help of Mr. Ryan Collinson, taped twenty news broadcasts, selected five for use in FF201-202, transcribed all five segments and developed comprehension exercises, vocabulary lists and exercises, cultural explanations and quizzes for each segment. During 1996-97 and 1997-98, assisted by mentee Tiffany Slentz-Whalen, she developed written exercises based on the transcribed segments and selected additional segments. Further work on the project has just become possible due to the recent development of lesson authoring software for the current digital video system by Mr. Christopher Buck. A pilot lesson using the new software is being developed.

These lessons will be available for use as soon as software for digitized interactive video lessons becomes available. At that point, using available on-line resources, the researcher will draw up a list of suggested projects for on-line lexical or cultural research based on the content of the original lesson.

Marco Antonio de la Parra and the New Chilean Theater

Researcher: Associate Professor Elsa Gilmore

The researcher is continuing her long-term project on the work of the well-known and prolific Chilean dramatist Marco Antonio de la Parra. During 1996-1997 she read one paper entitled "The Dead Father: Between Hegemony and Marginality" at the Latin American Cultural and Literary Institute Conference held in Bariloche, Argentina. She also published an article, "Gardel, Tango, and Popular Culture in Matatangos," in Hispania. Another article, entitled "The Dead Father: Ekphrasis and History," will appear in the Fall 1998 issue of Gestos.

The Politics of Foreign Language Textbooks

Researcher: Associate Professor Elizabeth Knutson

This essay is proposed for inclusion in a book, entitled The Cultural Politics of Language Study, to be edited by Claire Kramsch. The researcher examines political dimensions of the representation of language and culture in a survey of elementary and intermediate French textbooks published in the U.S. and currently used in American colleges and universities. The political dimensions of these textbooks include the treatment of language variation in the French-speaking world, social differences among native speakers, language behavior or pragmatics, and idealized vs. real colloquial language. With respect to treatment of the concepts of *Francophonie* and Francophone world, the analysis focuses on the *kind* of cultural content conveyed (e.g., values, behavior, heritage or institutions), the *genres* of texs involved, and the manner in which information is *voiced*. The survey also examines the explicit or implicit definitions of culture which emerge from textbook presentations, determining whether culture is defined as relational or static, whether interaction between home and target culture is treated, and whether the cultural subjectivity of the observer is addressed.

Strategy Use in Foreign Language Writing

Researcher: Associate Professor Elizabeth Knutson

This project is an outgrowth of a workshop on classroom-based action research sponsored by the National Capital Language Resource Center which the researcher attended in July 1997. The object of the research is to investigate the nature of strategy use by strong and weak foreign language writers via a qualitative study of six students enrolled in elementary or intermediate level French courses. Areas of particular interest in this study are strategies involving circumlocution and the use of simple, known structures and vocabulary to convey a message. Research for this study involves a review of literature in relevant fields (second language acquisition, ESL, and foreign language pedagogy) to determine the most appropriate tool for assessing foreign language writing proficiency (i.e., a writing rubric) and to establish a list of strategies and/or thinking processes involved in foreign language writing. Instruments appropriate to the investigation of strategy use include questionnaires, structured interviews, and/or think-aloud interviews. Preliminary

bibliographic research and organization of the study have been completed, in consultation with the Teacher as Researcher Institute trainers at the National Capital Language Resource Center.

Writing as Thinking: Foreign Language Literature and Process Pedagogy

Researcher: Associate Professor Elizabeth Knutson

This project is an article on the use of writing in the literature classroom as a vehicle for the stimulation of thought and discussion. The article is based on a conference paper which the researcher delivered at the Northeast Modern Language Convention, and on her continued research in the area of computer-mediated writing and English composition studies. An outgrowth of the researcher's experience teaching French literature in translation, the article explores the relevancy of process pedagogy for the teaching of literature in a foreign language.

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 study of the four works based on themes, imagery, meter, and rhyme. In the second chapter the author gives detailed, firsthand descriptions of the manuscripts and 16th-century printings used in establishing the base text and discusses the interrelationships that exist between the many versions of the works. A corrected version of the continuations in modern script follows. Editorial, literary, and linguistic notes comprise the next section which ends with a glossary of medieval Spanish terms and one of proper names. Included in this volume is an extensive bibliography of primary and secondary source materials on Spanish and European 15th-century didactic poetry. The manuscript has been accepted for publication in Maryland: Studia Humanistica.

Adjuvancy and Opposition: A Study of Supporting Roles/Women's Roles and Gender in Pedro Calderón de la Barca (1600-1681).

Researcher: Professor Sharon Dahlgren Voros

This book-length study, still in progress, combines the methodology of semiotics with archival research on Pedro Calderón's secular and religious drama. While supporting/ secondary roles and often women's roles are often overlooked in drama studies, they provide keys for interpreting the play text, since they complement and comment on the action of the main characters. Adjuvancy and opposition, terms from A. J. Greimas's semiotic model, imply actantial functions of characters of subordinate social rank, and hence often

marginalized figures of Spanish society. The researcher presented several papers this year in connection with gender issues that evolve from study of feminine characterization and stage practice. The project will be recast as "Eve's Patrimony: Women on the Calderonian Stage" to include notions of the legacy of original sin brought into the world by the first woman. While Eve does not appear as a character in Calderón's allegorical plays, she is evoked in his dramatic discourse by his female characters who reject Aristotelian notions of feminine weakness. Although Calderón is not a feminist, he does insist on the notion of free will as he rejects deterministic notions of the human subject. This study will incorporate previous work done on Calderonian works and re-focus issues of women on the stage according to philosophical ideas voiced by them.

Publications

BOSSHARD, Marianne, Associate Professor. "Chantal Chawaf: de l'eu-topie champêtre, intra-utérine et féerique à l'uchronie linguistique." Réécriture des mythes: l'utopie au féminin. Eds. Joëlle Cauville and Metka Zupancic. Amsterdam: Editions Rodopi, 1997. 75-82.

For this essay, the researcher analyzed three different versions of utopias in the works of Chantal Chawaf that span this author's oeuvre on a thematic as well as a linguistic level. The researcher focused on four literary texts and two theoretical essays by the author and, among others, used Michel Serres' Eclaircissements (1992), Antoinette Fouque's Il y a 2 sexes (1995), and Henri Laborit's L'Inhibition de l'action (1986) as primary references for her interpretation.

BOSSHARD, Marianne, Associate Professor. "Quelques réflexions sur le 'moment post/post-structuraliste,' l'écriture du/au féminin et l'éthique de l'écriture chawafienne." Continental, Latin-American and Francophone Women Writers, Vol. IV. Eds. Ginette Adamson and Eunice Myers. Lanham: University Press of America, 1997. 215-228.

This article examined the "writing in the feminine," and in particular the poetics of Chantal Chawaf, in light of "post/post-structuralist feminist criticism" concerned with "the politics of recuperation and negotiation." The article is a response to a text by the feminist critic, Laurence Enjolras (Femmes écrites: Bilan de deux décennies, Stanford French and Italian Studies, 1990), who arrived at the conclusion that the movement of "writing in the feminine" has come to an end due to the inability to transcend paternalistic values that, historically speaking, always have defined the concept of "femininity." By taking into account more recent works by the writers referred to in Enjolras' study, as well as recent debates on this issue, the researcher demonstrated that the "écriture du/au féminin," rather than being a "closed chapter," has entered a new phase, searching for values that re-connect aesthetics with ethics.

BOSSHARD, Marianne, Associate Professor. Rev. of Le Marabout de Blida, by Annie Cohen. The French Review 71.5 (April 1998): 873-4.

In this review article, the researcher touched on the major topics presented by a less well known contemporary French woman writer, Annie Cohen, in her seventh novel, Le Marabout de Blida (1996). By placing the novel in the context of Cohen's literary trajectory, which the researcher has been following closely over the past few years (with other publications on this author and conference papers), she pointed out Cohen's particular status in contemporary French literature as an author who, like Cixous, Cardinal and others, was born and raised in Algeria and who, at this particular point in her life, wrote a text that deals with childhood memories.

CASTRO DE MOUX, Maria E., Associate Professor. "Astral Myths and Emblems: The Duality of Calderón's La estatua de Prometeo." A Star-Crossed Golden Age: Myth and the Spanish *Comedia*. Ed. Frederick A. de Armas. Lewisburg: Bucknell University Press and London: Associated University Presses, 1998. 179-196.

The myth of Prometheus, as presented by Calderón de la Barca, is studied through 16th-century Emblems by Andrea Alciatus, various Spanish emblem books, and two Golden Age mythological handbooks, Juan Pérez de Moya's Philosophia secreta (Secret Philosophy, 1585) and Fray Baltasar de Vitoria's Teatro de los dioses de la gentilidad (Theater of Pagan Gods, 1620,

1623). This article explores duality in human psychology, as well as moral and spiritual development as illustrated by the play's characters.

CORREDOR, Eva L., Professor. "The Dynamics of Eastern Europe." The Rotary District 7620 BEACON 15.1 (August 1997) 4-5.

In this illustrated article, the researcher reports on political, economic, and cultural experiences gained during a five-week study tour through Eastern Europe in 1997. She establishes comparisons between the peoples and cultures of three countries, Austria, Hungary, and Slovenia, which are linguistically and ethnically very different from each other, and shares her observations concerning their relative successes and predicaments in adjusting to their post-Soviet, newly instituted democratic system.

CREUZIGER, Clementine, Assistant Professor. "God's Russian Experiment: Hope in the Wake of Deconstruction of Gender and Religious Identity." The Anthropology of East Europe Review 15.2 (Autumn 1997): 51-57.

This article relies on information from the fields of history, literature and philosophy as well as ethnographic data collected from 1991 to 1997. A discussion of the background to the notion of "avos" and common suffering leads into a brief review of debates among Russian philosophers and social thinkers on the subject of Russian culture. These debates will ultimately help to formulate an understanding of the commonalities among Russians in their belief in being a chosen people and on Russian culture in general. A particular Russian perspective on these themes will be depicted through personal memories of Russians interviewed, poetry and prose. Finally, this paper hopes to enlighten readers on the value placed on a common Russian "stradanie" and notions of victimhood. Research for this article was funded by NARC.

CREUZIGER, Clementine, Assistant Professor. "Russia's Orphans: A Cultural Anthropological Study." Childhood 4.3 (August 1997): 343-358.

This study focuses on the plight of various categories 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 as background to the study, this article investigates the changing cultural views of marginalized children that Russian adults have developed since the Second World War. 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.

GILMORE, Elsa M., Associate Professor. "Gardel, Tango, and Popular Culture in Tangokiller, by Marco Antonio de la Parra" (Gardel, tango y cultura popular en Matatangos, de Marco Antonio de la Parra). Hispania 80.3 (September 1997): 472-479.

In the last decade, Marco Antonio de la Parra's theatre has abandoned the themes of political resistance which were its hallmark during the years of the Pinochet dictatorship. The Chilean playwright has turned his attention to themes related to the construction of national and cultural identities. This article demonstrates that these concerns were present in embryonic form in de la Parra's early play Matatangos (1978), a parody of Argentine singing sensation Carlos Gardel (1890-1938) and of the international tango industry which he brought into being. Utilizing postcolonial theory, the researcher argues that Matatangos' treatment of Gardel and of the industry which simultaneously promoted and exploited him anticipates later plays' interest in the relationship of hegemonic institutions and marginalized art forms in Latin America, and in the role of this cultural site in the definition of Latin American identity.

PRUNER, Ludmila, Associate Professor. "Shankhai ili ischezaiushchee i rozhdaiushcheesia kino" (Shankai or a New Reality in Russian Cinematography). Iskusstvo kino 10 (1996): 103-104.

Since Glasnost that started under Gorbachev's initiative in the mid-1980s, Russian cinema has undergone a transition from rigorous state control by Goskino to a state of total chaos. During the last ten years, production of the national movie industry fell five to six times while audience attendance decreased thirteen to fourteen times. This article examines the reasons for the decline of the national film industry and provides an overview of Russian cinematic production of the 1990s.

PRUNER, Ludmila, Associate Professor. "Kinotavr 1996: An End and a New Beginning." The Russian Review (April 1997): 294-298.

The 1996 Kinotavr Open Russian Film Festival made it obvious that Russian and CIS film makers are moving toward mass audiences. The noticeable increase of genre films at the Festival indicates that the filmmakers have begun to appeal to the psychological comfort zone of genre cinema. The article examines current genres present in post-Glasnost Russian cinema.

PRUNER, Ludmila, Associate Professor. "Sushchnost pustoty" (The Essence of Nothingness). Kinotavr Review 5 (June 1997): 3.

This film review analyzes the philosophical and literary connections of Strannoe vremya (Strange Time), a cinematic "confession" by Natalia Piankova that unveils the trends of the post-Afghan war generation in Russia.

VOROS, Sharon Dahlgren, Professor. "Armesinda's Dream: Leonor de la Cueva y Silva's Challenge to the Patriarchy in La firmeza en la ausencia." Monographic Review XIII (1998): 74-86.

In this article, the researcher analyzes dream discourse from the play, La firmeza en la ausencia [Firmness in Absence] by a seventeenth-century woman dramatist, Leonor de la Cueva y Silva. While the Renaissance had its own system for analyzing dreams, twentieth-century views of dreams as a form of linguistic discourse assist in interpretation of this on-stage, vocal dreaming by the female main character, Armesinda, a lady-in-waiting besieged by King Filiberto of Naples. Cueva explores the depth of resolve of Armesinda to resist sexual submission to a monarch even at her most vulnerable, in her private chamber. The researcher compares Armesinda's accusations toward the king in her dream as a tyrant with Inquisition documents of a sixteenth-century case in which Lucrecia de Leon was prosecuted and sent to prison for similar dreams about King Philip II as tyrannical. Dream narrative then was taken seriously in inquisitorial practice as the Holy Office sought to control and regulate seditious expression toward the Crown. Armesinda's dream, however, is not prophesy but admonition of the king and his moral irresponsibility.

Presentations

BLEDSOE, Penelope M., Associate Professor. "Theories of second language acquisition beyond the basic level of instruction: an overview and commentary." Department of Iberian Languages and Literatures, University of California, Santa Barbara, Santa Barbara, CA. 20 May 1997.

BLEDSOE, Penelope M., Associate Professor. "Content-based instruction at the advanced level." Mountain State Foreign Language Conference. East Carolina State University, Greensboro, NC. 16-18 October 1997.

BLEDSOE, Penelope M., Associate Professor. "The use of L1 in the intermediate foreign language classroom: a survey." Annual Congress of the Modern Language Association of America. Toronto, Canada. 27-30 December 1997.

CASTRO DE MOUX, Maria E., Associate Professor. "Objetos mágicos en El Conde Partinuplés de Ana Caro" (Magic in El Conde Partinuplés by Ana Caro). Conference of Women Writers of the Spanish Golden Age and Latin Colonial Period. University of Virginia, Charlottesville, NC. 1 November 1997.

CASTRO DE MOUX, Maria E., Associate Professor. "Luis Palés Matos y la personalidad cultural de Puerto Rico" (Luis Palés Matos and Puerto Rican Cultural Identity). International Congress on Luis Palés Matos.

InterAmerican University, San Juan, Puerto Rico. 19 March 1998.

CORREDOR, Eva L., Professor. Organizer and chair of session, "The Hungarian Cinema After 1989." Discussion Group on Hungarian Literature. Annual Congress of the Modern Language Association of America. Toronto, Canada. 27-30 December 1997.

CORREDOR, Eva L., Professor. "The Dynamics of Eastern Europe." Humanities and Social Sciences Lecture Series. United States Naval Academy, Annapolis, MD. 15 January 1998. The researcher presented slightly varying versions of this lecture as invited speaker to eight civic groups in the Washington, D.C. and Central Maryland area between September 1997 and February 1998.

CORREDOR, Eva L., Professor. "Andrei Makine's Le Testament français: Creating a European Identity between the Seine and Siberia." Annual Congress of the American Comparative Literature Association. Austin, TX. 25-29 March 1998.

CORREDOR, Eva L., Professor. Moderator of three-day seminar, "History and the Construction of Identity." Annual Congress of the American Comparative Literature Association. Austin, TX. 25-29 March 1998.

CORREDOR, Eva L., Professor. Chair of session, "Colonialism and Narrative." International Conference on Narrative Literature. Northwestern University, Evanston, IL. 2-5 April 1998.

CORREDOR, Eva L., Professor. "An Ethical Inquiry into Derrida's Specters and Lukács's Perspectives." Annual Meeting of the International Conference on Philosophy and Literature. University of California at Irvine, Irvine, CA. 4-9 May 1998.

CORREDOR, Eva L., Professor. "Organizing a Study Tour Through Eastern Europe." 4-H Center, College Park, MD. 1 November 1997.

CORREDOR, Eva L., Professor. Discussion and Signing of Lukács After Communism. Barnes and Noble Bookstore, Harbor Center, Annapolis, MD. 13 November 1997.

CREUZIGER, Clementine, Assistant Professor. "Marginalization and Redefinition of the Russian Orphan." Conference sponsored by the Social History Society, entitled "Family and Household Revisited." Nottingham Trent University, Nottingham, GB. 2-4 January 1998.

FLETCHER, William H., Associate Professor. "Making InstructionalDigital Video and Audio Work." Technology-Assisted Teaching and Learning Seminar. Center for Teaching and Learning, US Naval Academy, Annapolis, MD. 31 March 1998.

GILMORE, Elsa, Associate Professor. "The Dead Father: Between Hegemony and Marginality." Latin American Cultural Institute Conference. Bariloche, Argentina. 11-16 August 1997.

KNUTSON, Elizabeth, Associate Professor. "Reading in the Foreign Language Classroom." Maryland Foreign Language Association Fall Conference. Largo, MD. 18 October 1997. Presented with Professor Ana Echavarri-Dailey, Prince Georges Community College.

KNUTSON, Elizabeth, Associate Professor. "Perspectives on the Use of English in the Intermediate Foreign Language Classroom: A Survey of Student and Teacher Views." Annual Congress of the Modern Language Association of America. Toronto, Canada. 29 December, 1998. Presented with Professor Penelope Bledsoe, U.S. Naval Academy.

KNUTSON, Elizabeth, Associate Professor. Chair of session, "Cultural Learning: Issues and Applications." Annual Congress of the Modern Language Association of America. Toronto, Canada. 27 December, 1998.

KNUTSON, Elizabeth, Associate Professor. Proposed, organized and chaired panel, "Teaching Literature in a Foreign Language: Student-Centered Approaches." Northeast Modern Language Association Annual Convention. Baltimore, Md. 17 April 1998.

PAIK, Chie M., Assistant Professor. "Understanding Learning Disabilities." International Conference on Learning Disabilities. Hitachi, Japan. 27 July 1997.

LANGUAGE STUDIES

PAIK, Chie M., Assistant Professor. "Academic Self-Concept: Cultural Differences." Intercultural Education Conference. Jooriku University, Niigata, Japan. 30 July 1997.

PAIK, Chie M., Assistant Professor. "The Language Experience Approach (LEA) As Applied to Improving Writing Skills for the Advanced Japanese Language Students in College." The Twelfth New England Japanese Pedagogy Workshop. Wesleyan University, Middletown, CT. 13 June 1998.

PAIK, Chie M., Assistant Professor. "Instructional Conversations (ICS) As Applied to Developing Students' Oral Expressions in the Advanced Japanese Class." The Southern California Japanese Teachers Association. Pomona College, Pomona, CA. 15 June 1998.

PRUNER, Ludmila, Associate Professor. "Sergei Bodrov's Cinematic Production of The Prisoner of the Mountains. International Conference on Contemporary Post-Soviet Cinema. Bristol University, Bristol, UK. 16-22 October 1997.

PRUNER, Ludmila, Associate Professor. "Russian History Through Art: XI-XX Centuries." National Gallery of Art, Washington, D.C. 24 January 1998.

VOROS, Sharon D., Professor. "El espacio escénico femenino: El Conde Partinuplés de Ana Caro Mallén y La firmeza en la ausencia de Leonor de la Cueva y Silva" [Theater Space in Woman Dramatists]. International Studies Conference on Mediterranean Space, Annual Meeting XIX. Organized by Dowling College. Ecole des Hautes Etudes en Science Sociales, Paris, France, and the University of Bordeaux. July 1997 [in Spanish].

VOROS, Sharon D., Professor. Relaciones de fiestas: Women's Accounts of 17th-Century Public Spectacles, Ana Caro, Leonor de la Cueva, Sor Juana, and Eugenia Buesso." Second Annual Conference on Early Modern Hispanic Women Writers of Spain and Colonial Latin America. The University of Virginia, Charlottesville, VA. 30 October to 1 November 1997.

VOROS, Sharon D., Professor. "Ana Caro's Accounts of Public Festivals in 1628 and 1637." South Atlantic Modern Language Association [SAMLA], Annual Convention. Atlanta, GA. 13-15 November 1997.

VOROS, Sharon D., Professor. "The Stage is the Thing: Performance and the Future of Comedia Studies." Annual Congress of the Modern Language Association of America. Toronto, Canada. 28 December 1997.

VOROS, Sharon D., Professor. "Gendered Spaces in Ana Caro Mallén and Leonor de la Cueva." Spanish Golden Age Drama Symposium. Sponsored by the Association for Hispanic Classical Theater and the University of Texas at El Paso. El Paso, TX. 4-7 March 1998.

VOROS, Sharon D., Professor. "Weakness and Gender in Leonor de la Cueva's La firmeza en la ausencia." NorthEast Modern Language Association [NEMLA], Annual Convention. Baltimore, MD. 16-18 April 1998.

DEPARTMENT OF

Political Science

Professor Stephen E. Frantzich
Chair

The multi-faceted field of political science continues to illuminate diverse geographical regions and a broad spectrum of human behavior. Research in the Political Science Department reflects this variety and vitality while maintaining focus on contemporary research methodology. From empirical data manipulation to inductive analysis to field experimentation to case studies, faculty in the political science department have set the pace for scholarly research. Furthermore, members of our faculty have seamlessly merged onto the information highway and Internet for use both as a research tool and for access to the most up-to-date pedagogical methods. Political Science faculty have published widely this year in numerous formats and have been actively sought out for professional presentations and policy-making forums. Additionally, student research projects remain an integral part of the department's independent research efforts.

Departmental faculty this year published two books and numerous articles, contributed articles to journal publications, provided chapters to books, presented congressional testimony and conducted book reviews. Among the varied topic areas are explorations into the necessity for a Post-Cold War NATO, the codification of "moral development" among Naval Academy Midshipmen, and South Africa in a world of weapons proliferation. This year departmental faculty received external research funding from sources as diverse as the United States Air Force Academy Institute for National Security Studies, the International Social Science Council, the Dirksen Center, and the Robert Bosch Foundation.

The department is fortunate to have hosted three distinguished visiting professors in National Securities Studies: Robert B. Zoellick, the John M. Olin Foundation; David Gompert, the RAND Corporation; and Warwick Boulton, the Britannia Royal Naval College.

A reflection of the quality of our faculty is the large number of prestigious speaking engagements to which they were invited as well as the academic conferences and seminars they attended. Members of our faculty traveled widely, both in the United States and abroad. They shared knowledge and exchanged ideas, enriching our faculty's understanding of their fields and of the rapidly changing world that they study.

Independent research performed by midshipmen in the department is equally important, as independent scholarly research is rare among undergraduates. This year, five midshipmen took advantage of the two semester independent research program. The honors thesis program affords the student the opportunity to participate in advanced research under the close mentorship of a faculty advisor. The culmination of this experience is an honors thesis presented by the student before a faculty panel, where it is critically judged and evaluated. As a result of their efforts, all five participating midshipmen graduated with an Honors designation.

Seven midshipmen from the Political Science Department have been awarded advanced education programs, either through the Voluntary Graduate Education Program or as Olmsted Scholars. All of these outstanding midshipmen will go on to receive masters degrees as junior officers.

This year midshipmen activities and achievements once again extended beyond the classroom to participating in and organizing conferences, including the Naval Academy Foreign Affairs Conference (NAFAC), the Model United Nations (MUN), and Model NATO.

The theme for the Thirty-eighth NAFAC was "Asia Rising?". This extraordinary conference included a keynote address by former Secretary of State James A. Baker III, among other prestigious guests. Students participated in round table sessions exploring prominent issues and had the opportunity to conduct several challenging "What if?" scenarios. From 86

colleges and universities across the nation and 20 foreign countries, over 200 students attended this extremely successful event. This type of academic and cultural exchange among undergraduate students demonstrates the commitment of the Political Science Department to remain on the vanguard of undergraduate international political studies.

In its fifth year, the United States Naval Academy's MUN Club has experienced remarkable growth and success. This year midshipmen participated in collegiate-level Model United Nations at Montreal, Canada (MECMUN) and in Model NATO in Washington, D.C. The club also hosted the Fourth Annual United States Naval Academy Model United Nations (USNAMUN). More than 500 students from high schools as far away as Wisconsin and California participated in the four-day conference, which was completely organized and staffed by 170 midshipmen.

Throughout the month of June, the department sponsored 24 workshops for the Naval Academy Summer Seminar. These workshops are designed to mentally challenge promising high school students. Additionally, this program often serves as a useful recruiting tool for teenagers who may be considering applying to the Naval Academy.

An overview of departmental research efforts reveals in depth activity on the part of all members of the faculty. The knowledge and excitement of research produces invaluable dividends in the classroom, where faculty can use their newfound knowledge to educate and stimulate students. This energy and enthusiasm is reflected in the midshipmen activities and research, and reaches beyond the academy to the wider academic, political, and social world.

Sponsored Research

The Divided Community: Prayer in the Public Schools of Platteville, Colorado, 1925-29

Researcher: Professor Karl A. Lamb

Sponsor: Naval Academy Research Council (O&M,N)

To what extent must a community be united on fundamental issues to remain viable? This question was illuminated in the particular place and time being studied. The community was a small market center on the Platte River; religious conflict was the source of division; and the issue was resolved, without satisfying the disputants, by the Colorado Supreme Court in 1921.

Examining the "Authoritarian Advantage" in Southeast Asian Development in the Wake of the Asian Economic Failures

Researcher: Associate Professor Stephen D. Wrage

Sponsor: Naval Academy Research Council (O&M,N)

Many scholars have argued that authoritarian regimes possess an advantage over more democratic ones in launching and promoting economic development. The benefit and indeed the existence of this putative "authoritarian advantage" began to be doubted by scholars in the mid 90's, and the ongoing Asian economic crisis provides more evidence for doubt. This research assesses the state of the argument and considers new evidence from the crisis. It finds significant reason to abandon the notion of an "authoritarian advantage," particularly because authoritarian states have shown themselves poor at

providing accountability and transparency in financial affairs.

Environmental Security and Regional Instability in Southern Africa

Researcher: Helen E. Purkitt

Sponsors: Institute for National Security Studies and U.S. Naval Academy (O&M,N)

This study develops a three-fold analytical approach that can be applied to any geopolitical region to develop systematic monitoring procedures to assess how environmental problems may affect future regional stability. The multi-level approach was described and applied in preliminary fashion to the Southern African region. A summary of these results and relevant web links can be found at http://members.tripod.com/~loose/.

The second phase of research is to analyze interview data collected in Washington D.C. and in six countries in southern Africa during 1996/7 to better understand how policy makers and concerned citizens in both countries "frame" or represent environmental and security issues in Southern Africa. The results of this analysis will be presented at the International Political Psychology Society's July 1998 Conference and to the Institute for National Security Studies at the U.S. Air Force Academy. Results of this project and related analyses will be summarized in three article-length manuscripts to be completed in late Spring through Summer, 1998. These article-length analyses will cover: 1) a summary of the most interesting findings from this project and a discussion of the merits of the analytical framework; 2) the role of planned Peace Parks in Southern Africa to promote peace, security and prosperity in the region; and 3) the effects of illegal migrants, poaching and disease for national and regional political stability. This last analysis relies upon original data collected during field research trips completed in 1997.

Status: Field research completed during Summer 1997 in southern Africa with support of INSS Travel Grant. Most sections of the final report are written and I plan to complete this research and these three article-length manuscripts by mid-summer.

Making a Difference: Citizen Courage in a Cynical Age

Researcher: Stephen Frantzich

Sponsor: Dirksen Center, Rowman and Littlefield Publishers

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 which secured its passage). The individual profiles will be placed in the larger context of citizen activism in a democracy. Initial research has begun and all profiles are in preparation. The project has resulted in one conference paper and is under contract with Rowman and Littlefield Publishers.

Harnessing Technology to Enhance the Teaching of Public Affairs

Researcher: Stephen Frantzich

Sponsor: C-SPAN Education Foundation

New video and computer technologies provide numerous opportunities for enhancing teaching and learning. The benefits of these technologies will not be felt unless teachers have a perceived need for the information the technologies can impart and access to the required technology. The first step in this project involved a national survey of social studies teachers to assess their perceived subject matter needs, assess the availability of technology and determine a method of imparting pedagogical information. The completed survey included data from over 1100 respondents and is serving as the basis for the C-SPAN Foundation's initiative toward high school teachers. The investigator was responsible for writing the survey, overseeing its mail distribution and analyzing the results.

Avoiding Humanitarian Crises and State Failure: A Comparative Analysis of Conflictual and Cooperative Events in Burundi, Rawanda, and Zaire

Researcher: Professor Barbara Harff

Sponsor: International Social Science Council, Conflict Early Warning (CEWS) Grant

In this paper the researcher reports the results of retrospective daily monitoring of high risk situations that are pre-identified by using the Minorities at Risk and state failure projects. All prespecified factors are operationalized as events and are those that are likely responsible for crisis diffusion or escalation. The aim is to advance early warning capacities. In the three cases conflictual events (accelerators) far outweigh cooperative events (deaccelerators) in the period coded (two years).

European Security Arrangements and Implications of German Unification

Researcher: Professor Gale A. Mattox

Sponsor: Naval Academy Research Council (O&M,N)

Concepts of European security have undergone dramatic change and significant transformation since the turn of the decade – states have turned democratic, economies have become free markets, and military threats have decreased in intensity and changed in character, when not vanished altogether. These changes have naturally challenged the Cold War European security system to reflect the realities of the post-Cold War era. The European security system today is a necessarily broad-based European security system anchored by NATO within a framework which includes other structures, including the Organization for Security and Cooperation in Europe (OSCE), the Western European Union (WEU) and the European Union (EU), among others. The research focused on the fundamental changes NATO undertook at its 1996 summit and 1997 Special Summit on Enlargement and the subsequent impact on the European security architecture. Later work will address the subsidiary but important other elements of the architecture.

Germany after Unification

Researcher: Professor Gale A. Mattox

Sponsor: Robert Bosch Foundation

Germany after Unification will appear in the Bosch Series with Westview. Publication in Fall 1998. Co-edited with Geoffrey Oliver and Jonathan Tucker, it will consider the process by which Germany has unified with the eastern states based on an examination of selected foreign policy, economic and business, and minority issues.

Europe and NATO: Is NATO Necessary in the Post-Cold War Era?

Researcher: Professor Gale A. Mattox

Sponsor: Institute for National Security Studies, U.S. Air Force Academy

Awarded USAF grant from the Institute for National Security Studies (INSS) at the USAFA with Daniel Whiteneck which included travel to Brussels in May 1997 and Warsaw in July 1997 for research and interviews. Paper submitted in November 1997 to INSS addressed the relevance of NATO to the United States in the Post-Cold War era in light of NATO enlargement and the restructuring of NATO. Although the function of NATO in the Cold War was clearly to deter a threat from the Soviet Union, the Alliance played an important role as a community of common values for democratic, free market nations based on the rule of law. These values continue to be important as the foundation of the Atlantic Alliance. For this reason, broader membership has become inevitable, but needs to be accompanied by continued reforms which reflect the post-Cold War challenges of ethnic conflict, rising nationalism, and resource disputes, among other emerging threats.

Independent Research

DIT Data Compilation

Researchers: Associate Professor Eloise Malone and Professor Charles L. Cochran

Having compiled the DIT findings into an SPSS save file and merged this data with ACE data and findings from the Myers-Briggs personality inventory, researchers are beginning to develop a time series database of midshipmen attitudes, behaviors and temperament. Most of these findings are of interest to the Office of Institutional Research. This January (AY97-98) intersessional a post-test of the DIT was implemented and a survey was administered which asked first class midshipmen about "moral development" issues and the impact of core courses, the IDS and other USNA activities on individual growth in moral reasoning. The findings were coded and imported to SPSS for statistical analysis. Researchers will continue this work during the summer 1998.

Foreign Policy Belief Structures in the U.S.: Comparisons of Elite and Attentive and Non-attentive Publics

Researcher: Associate Professor Eloise Malone

Along with colleagues at USIA, researcher purchased a recent Chicago Council data set on foreign policy beliefs and opinions. They plan to replicate a factor analysis done earlier in which they reduced the general public's foreign policy attitudes into three clusters. Using the same analytical technique, they plan to compare the general (non-attentive) public's factor dimensions with those of the elite (attentive) public. This research is ongoing. The findings will be presented at the ASPA meetings in Boston in September 1998.

South Africa in a World of Proliferating Biological, Chemical, and Nuclear Weapons

Researcher: Professor Helen Purkitt

This research is based on a case study completed during a funded research project in 1994/5 on why South Africa denuclearized. Field research completed during 1997 was designed to collect data for the third section of a book-length manuscript. Current work focuses on three topics that will eventually be chapters in this manuscript: South Africa's decision to terminate the Space-launch vehicle program and related program; efforts since 1994 to restore civilian control over the military: "Summary: The Case of Former South Africa;" and "How Serious Are Proliferation Threats in Former Pariah States: Some Lessons from the South African Case." Preliminary drafts of these three topics in the form of article-length manuscripts were completed during a Spring 1997 sabbatical and in Summer 1998. Article-length manuscripts will be circulated for possible publication before the end of the Summer 1998 session.

Lessons Learned?: Comparing Vocational Treatment in Military and Civilian Prisons

Researcher: Assistant Professor Priscilla H. M. Zotti

This conference paper compares the use of vocational treatment as a method of rehabilitation in military and civilian prisons in the United States. The article focuses on the success military prisons have had with relevant and widespread vocational education as compared to the limited use such programs have in civilian prisons. Particulars of these programs are revealed in analyzing the use and success of them at the United States Disciplinary Barracks, Fort Leavenworth and USP Leavenworth.

This paper will be presented at the Southwestern Political Science Association Conference in March 1998. It will most likely be submitted to Justice Quarterly for publication by the end of the Spring 1998 semester.

Injustice for All: The Tale of Dollree Mapp, the Police, and Arrest and Search and Seizure

Researcher: Assistant Professor Pricilla H. M. Zotti

This project encompasses years of interest in the Fourth Amendment. The aim of this book is to explain the changes in the criminal justice system, in policing, and even to the particular litigants through the lens of the famous U.S. Supreme Court case of Mapp v. Ohio. Three chapters of the book have been written and chapter four is in progress. The expected completion date is 1999 or 2000.

Research Course Projects

The Influence of Western Society and Economic Structures on National Minorities Problems in Eastern Europe and the Former Soviet Union

Researcher: Midshipman 1/C Jason Berg, USN

Advisors: Professor Gale Mattox and Professor Arthur Rachwald

Since the end of the Cold War and the fall of the totalitarian regimes of Eastern Europe and the Former Soviet Union, the issues of nationalism and ethno-political conflict have emerged as significant dangers to regional stability. However, the Council of Europe and the Organization for Security and Co-operation in Europe (OSCE) have developed standards for the treatment and protection of national minorities and have instituted programs for the adoption of these standards in the countries of Eastern Europe and the Former Soviet Union. At the same time, the possible enlargement of NATO and the EU have provided the incentive for countries to voluntarily adopt those standards. This has had a significant influence on non-violent resolution of ethnic problems in former Eastern-Block countries.

By examining the ethnic problems in two case studies (Estonia and Romania) and the actions taken by the western security and economic structures to resolve those problems, this paper determines the connection between NATO and EU enlargement, Council of Europe and OSCE standards, and the adoption of laws and policies that reduce ethnic tensions. In Estonia, ethnic relations between Estonians and Russians were extremely unstable. However, the economic and security benefits of EU and NATO membership have given Estonian politicians the will to voluntarily accept the recommendations of the Council of Europe and the OSCE and to adopt treaties that bring Estonian law into compliance with European standards. In Romania, a similarly unstable situation existed in the relations between Romanians and Hungarians. In this case, the drive for NATO and EU membership has influenced the Romanians to give greater autonomy to ethnic Hungarian regions, to provide legal guarantees of education in Hungarian, to give Hungarians a greater role in government, and to adopt other laws to protect the rights of its national minorities to bring it into compliance with Council of Europe and OSCE standards. In both cases, there has been a significant improvement in ethnic relations.

The examination of the Estonian and Romanian case studies demonstrates that western security and economic structures can have a significant, stabilizing effect on ethnic relations in the countries of Eastern Europe and the Former Soviet Union. The establishment of standards by the Council of Europe and the OSCE and the tying of those standards to the security and economic benefits of membership in NATO and the EU with enlargement criteria have proven to be a powerful tool to increase stability and prevent ethnic violence. This has led to a strengthening of the state system in Europe and to an increasing importance of the western security and economic structures.

MFN Policy with China

Researcher: Midshipman 1/C Darren Salapka, USN

Advisor: Associate Professor Stephen Wrage

This project examines the 1997 renewal of Most Favored Nation for the People's Republic of China. The analysis adopts a research method developed by James Rosenau and employed by two political

scientists, Charles Kegley and Eugene Wittkopf, in their text, American Foreign Policy. This text describes foreign policy as a dependent variable based on five sources of influence: external, societal, governmental, role, and individual. These five sources interact to give rise to specific foreign policy outcomes. The study focuses on how American foreign policy leaders were influenced to renew Most Favored Nation trading status with the People's Republic of China. The research concludes that the MFN renewal follows President Clinton's policy of engagement; however, the MFN carrot must be reinforced with the stick of economic sanctions in order to improve Chinese behavior in the international community.

Dealing with Terror: Considerations Negotiating with Terrorists

Researcher: Midshipman 1/C Timothy Clark, USN

Advisor: Associate Professor Willie Curtis

This research aims to determine when the United States should engage in negotiation with terrorists in hostage situations. A U.S. policy that neglects negotiation as an option in hostage situations denies a potentially effective means of resolving the situation. Negotiation should only be employed in situations where certain characteristics are present however. This research outlines a model of characteristics that must be considered when determining whether or not the U.S. should engage in negotiation with terrorists in situations where hostages are being held.

The Use of Force and the Limits of Diplomacy

Researcher: Midshipman 1/C Ken Vogel, USN

Advisor: Instructor Douglas Brattebo

The United States has traditionally followed a slow and cautious course toward crisis resolution. Gradually escalating diplomatic pressures are typically pursued to exhaustion before force is utilized. However, in the post-Cold War world, sometimes it may be more expedient and effective to use force earlier to end a crisis. The purpose of this study is to examine and explore the various factors decision-makers will need to address when considering diplomatic and forceful options. It is not the goal of this research to test a hypothesis, nor to establish a rigid criteria for crisis management. Rather, it is an attempt to uncover information that may prove useful for the preparation and handling of future crises.

Urban Counterinsurgency Warfare: Lessons from Northern Ireland

Researcher: Midshipman 1/C James Neal, USN

Advisor: Major Charles Locke, USMC

This study considers the experience of the British in Northern Ireland and derives lessons regarding the ways counterinsurgency warfare ought to be conducted by democracies. It takes note of the special constraints on a democracy, including the need to sustain public support, to permit media inquiry, to avoid indiscriminate uses of force and to uphold fair judicial processes. The study concludes that a democratic society must establish an exceptionally cohesive civil-military framework capable of coordinating military, economic, social and political initiatives if it is to carry out urban counterinsurgency warfare in a democratic manner.

Fighting Terrorism in a Democracy: The Case of Israel

Researcher: Midshipman 1/C Faith Tabatsko, USN

Adviser: Professor Barbara Harff

The research question is, first, whether human rights violations by Israeli security forces increased in three specific eras: the aftermath of the 1967 war, in which Israel acquired substantial new territories; the Intifada (the Palestinian uprising on the West Bank); and the post-Oslo Accords period. The second question is the extent to which security concerns have impacted on the observance of democratic norms.

Publications

COCHRAN, Charles L., Professor, and Eloise F. MALONE, Associate Professor, Public Policy: Choices and Perspectives, Second Edition, New York: McGraw Hill, forthcoming fall 1998.

CURTIS, Willie, Associate Professor, "The Grey Zone: The United States and the Illusory Zone Between Peacekeeping and Peace Enforcement," The Journal of Conflict Studies, Spring 1998.

The post-Containment period has not been characterized by the peace of a new world order as envisioned by many Americans; indeed, since the end of the Cold War the international landscape has been witness to a proliferation of conflicts that seem to defy traditional solutions that had offered some measure of stability during the Cold War decades. The new challenges in the "new world" disorder suggested that the demise of the Cold War stability had produced a vacuum in strategic thinking leading to a fundamental policy dilemma for the new Clinton Administration in the wake of the U.S. involvement in Somalia. This vacuum can best be described as an inability to advance a consistent strategy for adapting peacekeeping policies and methods to the changing nature of conflicts in the post-Containment international environment. This article will advance the thesis that a zone of illusion or uncertainty exists in the form of a gap between traditional peacekeeping and warfighting and ask the question whether the Administration's policies are clarifying the United States' role in the increasingly complex post-Cold War peacekeeping environment. The article examines the (1) nature of conflict and its implications for peacekeeping in the post-Containment era, (2) the evolving Clinton Administration's policy on the use of force and the national security strategy which call for the sequential or simultaneous conduct of numerous peacekeeping operations (Somalia, Haiti, and the former Yugoslavia), (3) major criticism of the Administration's policy, and (4) answer the question of whether these policies are clarifying the United States' role in peacekeeping operations in the grey zone between traditional peacekeeping and warfighting.

FRANTZICH, Stephen, Professor, America At Odds, West / Wadsworth International Thompson Publishers, 1998.

A multi-media interactive public policy textbook on CD-ROM. The project provides students with an in-depth and balanced look at 20 conflictual issues in American politics. An emphasis is placed on using the new interactive technology to engage students in public policy thing and analysis. A tailored version of the CD-ROM product is also being made available on the Worldwide Web. The author was responsible for conceptual design, substantive content, interactive components and suggested multi-media.

FRANTZICH, Stephen, Professor and Sheilah Mann, "Experiencing Government: Political Science

Internships," Chapter 3 in Richard M. Battistoni and William E. Hudson (eds.) Experiencing Citizenship, Washington, D.C.: American Association for Higher Education, 1997.

A discussion of the history and operation of political science internships at the undergraduate and graduate level. Special attention is paid to techniques for expanding the academic components of internships.

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, published in the committee hearings and on the committees Worldwide Web site.

An analysis of the mismatch between contemporary media procedures and the desire of the House to reduce unnecessary conflict in congressional procedures. A series of minor reforms in congressional procedures are presented.

HARFF, Barbara, Professor, "Bosnia and Somalia: The Strategic, Legal and Moral Aspects of Humanitarian Intervention," in Barbara MacKinnon (ed.), Ethics: Theory and Contemporary Issues, Second Edition, Belmont, CA: Wadsworth, 1998, 449-456. (Originally published in Report from the Institute for Philosophy and Public Policy, College Park: University of Maryland, Fall 1992, 1-7.)

HARFF, Barbara, Professor, "Early Warning of Humanitarian Crises: Sequential Models and the Role of Accelerators," Chapter 5 in John L. Davies and T.R. Gurr (eds.), Preventive Measures: Building Risk Assessment and Crisis Early Warning Systems, Lanham, MD: Rowman and Littlefield, 1998.

HARFF, Barbara, Professor, "How and Why the Global Community Should Respond to Humanitarian Crises," Futures Research Quarterly 13 (Spring 1997), 25-44.

HARFF, Barbara, Professor, "Humanitarian Intervention: At Issue," in Peter Wallensteen (ed.), International Intervention: New Norms in the Post-Cold War Era? Uppsala University: Department of Peace and Conflict Research, Report No. 45 (1997), 61-67.

HARFF, Barbara, Professor, Daniel C. Esty, Jack Goldstone, T.R. Gurr, Pamela T. Surko, Alan N. Unger and Robert Chen, "The State Failure Project: Early Warning Research for U.S. Foreign Policy Planning," Chapter 2 in John L. Davies and T.R. Gurr (eds.), Preventive Measures: Building Risk Assessment and Crisis Early Warning Systems, Lanham, MD: Rowman and Littlefield, 1998.

HARFF, Barbara, Professor, John L. Davies and Anne L. Speca, "Dynamic Data for Conflict Early Warning," Chapter 6 in John L. Davies and T.R. Gurr (eds.), Preventive Measures: Building Risk Assessment and Crisis Early Warning Systems, Lanham, MD: Rowman and Littlefield, 1998.

LAMB, Karl A., Professor, Reasonable Disagreement: Two U.S. Senators and the Choices They Made. New York: Garland Publishing, 1998.

MALONE, Eloise F., Associate Professor, Alvin Richman and David B. Nolle, "Testing Foreign Policy Belief Structures of the American Public in the Post-Cold War Period, Cross Validations from Two National Surveys," Political Research Quarterly, 50 (December 1997), 939-955.

MALONE, Eloise F., Associate Professor, Charles L. COCHRAN, 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," Minerva (double issue, acceptance letter fall 1997).

MATTOX, Gale A., Professor, "European Security Architecture: An American View," Chapter 6 in David Albright (ed.), Ukraine and European Security, New York: MacMillan Press, 1998.

MATTOX, Gale A., Professor, "European Security Identity," in Clay Clemens (ed.), NATO and the Quest for Post-Cold War Security, London and New York: MacMillan Press, 1997.

MATTOX, Gale A., Professor, "Introduction," to "Six Russian Views on Politics, Foreign Policy, and Civil-

Military Relations in a Post-Cold War World," and Russian version, co-edited with Linda Racioppi, Occasional Paper Series, University of Maryland, 1997.

MATTOX, Gale A., Professor, "NATO Enlargement from the U.S. Perspective," in Charles-Phillippe David and Jacques Levesque (eds.), The NATO Debate in Canada and the Alliance, McGill-Queens University Press, 1998.

MATTOX, Gale A., Professor, and Daniel Whiteneck, "Europe and NATO: Is NATO Necessary in the Post-Cold War Era?" Institute for National Security Studies, Department Air Force, November 1997.

MATTOX, Gale A., Professor, and Daniel Whiteneck, "NATO's Future Role: From Collective Defense to Cooperative Security", Institute for National Security Studies, Department Air Force, November 1997.

MATTOX, Gale A., Professor, Book Review of Patrick McCarthy (ed.), France-Germany 1983-93 (MacMillan, 1993), in German Studies Review 21 (no. 1), March 1998.

MATTOX, Gale A., Professor, Crafting a New European Order, Ukrainian Monograph / Journal contains a summary translation of a presentation by the author in Odessa, Ukraine, 1997.

MATTOX, Gale A., Professor, edited with Linda Racioppi, "The Politics of Conflict Resolution in Contemporary Russia," by Tatiana A. Shakleina, Occasional Paper Series, University of Maryland, 1997.

PURKITT, Helen E., Professor, ed. Annual Editions: World Politics 98/9, Sluice Dock, CT: McGraw-Hill / Dushkin Publishing Group, 1998.

This book is the nineteenth edition of an annual collection of 44 articles, including 32 new selections, 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 police 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. This volume is used as a supplemental text in introductory courses in International Relations, U.S. foreign policy and national security issues.

PURKITT, Helen E., Professor, "Problem Representations and Political Expertise: Evidence from "Think Aloud" Protocols of South African Elites," in D. Sylvan and J.F. Voss (eds.), Problem Representation in International Relations, Cambridge, UK: Cambridge University Press, forthcoming 1998.

This study of political expertise is based on protocol analyses of verbatim speech during a "think aloud" exercise with a variety of political experts and novices in South Africa in the early 1990s. The major finding from this study is that political experts are more articulate and "verbose" than political novices while the structure of the cognitive problem representation of the current political situation are remarkably similar in the sense that all subjects evidenced a simple cognitive structure.

PURKITT, Helen E., Professor, and Gale MATTOX, Professor, "Bridging Gaps: The Experience of Two First Generation Civilian Women Professors at USNA," in F. Damico and Laurie Weinberg (eds.), Gender Camouflage: Women and the U.S. Military, New York: New York University Press, 1998 forthcoming.

This book chapter essay discusses the experiences of the authors as members of the first generation of women civilian professors at the U.S. Naval Academy. After describing parallel experiences growing up, in graduate school, and as working professionals at the Academy and abroad, they discuss some of the more important changes that have occurred at USNA during the past two decades. This article was written during Spring 1998 and revised twice during Fall 1998. It is scheduled to be published in 1998 but not before June 15th (first listing).

RACHWALD, Arthur R., Professor, "NATO: Hopes and Frustrations," in Richard F. Staar (ed.), Transition to Democracy in Poland, Second Edition, New York: St. Martin's Press, 1998, 261-282.

This chapter discusses national security and,

specifically, Poland's entry into the North Atlantic Treaty Organization as well as other political and economic structures in Western Europe. The government in Warsaw had laid the foundations for this policy by concluding a special agreement with Germany in 1991. Relations vis-à-vis Russia have been less satisfactory, primarily because of Poland's desire to join NATO and the 9 July 1997 invitation from the latter to begin negotiations for membership in 1999.

This study explains this attitude in terms of past experience, which had emphasized bilateral agreements that failed and led to World War II. Polish culture is based on a Western orientation, and the success of "shock therapy" should facilitate integration with other free market economies. Warsaw hopes to join the European Union after the year 2000 – Poland is already a member of the Organization for Economic Cooperation and Development (OECD) – and to become a full-fledged participant in the Euro-Atlantic structures.

WRAGE, Stephen D., Associate Professor, "The Perils of Presidentialism Reconsidered," Review of Kurt Von Mettenheim (ed.), Presidential Institutions and Democratic Politics: Comparing Regional and National Contexts, (Pittsburgh: University of Pittsburgh Press, 1995), Mershon International Studies Review, Summer, 1998.

ZOTTI, Priscilla, Assistant Professor, "Nothing Personal," Book Review of C.K. Rowland and Robert A. Carp, Politics and Judgement in Federal District Courts, in Judicature 80 (no.6) (May-June 1997), 294-296.

A review of Rowland and Carp's quantitative look at judicial behavior of federal court judges. The book is a continuation of their analysis of a large (both in terms of size and duration) database concerning the decision making process of federal district court judges. The authors attempt to go beyond case variables and consider human cognitive decision making processes.

ZOTTI, Priscilla, Assistant Professor, Contributor and Consultant to the Final Report, The Impact of Judicial Performance Evaluations on Attitudes of Judges and Behavior of Voters, American Judicature Society, Chicago, IL, forthcoming.

The study takes a comprehensive look at the role of judicial performance evaluations in the selection of judges and how judicial performance evaluations are perceived by both judges and voters. The study includes an exhaustive literature review, an analysis of the states which use judicial performance evaluations and the legislation of states that are considering using them. Judicial performance evaluations are one of the most significant new developments in judicial administration. The increased concern about judicial independence and judicial competence make this study both timely and significant. The publication of the research and its findings is long overdue. The original publication date was January 1998. It is expected to be published June 1998.

Presentations

COCHRAN, Charles L., Professor, "Addendum to the Senate Finance Committee Report on Faculty Compensation at USNA," July 1997.

COCHRAN, Charles L., Professor, and Eloise F. MALONE, Associate Professor, "The Impact of the Naval Academy on Midshipmen Personal, Academic and Professional Development," Inter-University Seminar, Baltimore, MD, 25 October 1997.

CURTIS, Willie, Associate Professor, "Peacekeeping in the Pre-Westphialian Zones of Instabilities: Is There a Policy Void In U.S. Strategy for the 21st Century," International Studies Association 39th Annual Convention, Minneapolis, MN, 17-21 March 1998.

CURTIS, Willie, Associate Professor, "The American Perspective on Peacekeeping," Peacekeeping Management, Command and Staff Course, The Lester B. Pearson Canadian International Peacekeeping Training Centre, Nova Scotia, Canada, 2 October 1997.

CURTIS, Willie, Associate Professor, "The American Perspective on Peacekeeping," Peacekeeping Management, Command and Staff Course, The Lester B. Pearson Canadian International Peacekeeping Training Centre, Nova Scotia, Canada, 7 May 1998.

FRANTZICH, Stephen E., Professor, "Reducing Unproductive Conflict in the House: The Members And The Media ," Invited testimony before the Subcommittee on Rules and Organization of the House, May 1, 1997.

FRANTZICH, Stephen E., Professor, "Using C-SPAN in the Classroom", Seminar for College Faculty sponsored by C-SPAN, August 7,8,1997 and January 5,6, 1998.

FRANTZICH, Stephen E., Professor, "Technology Applications of New Technology in Political Science," In-service training session, Annapolis MD, August 24, 1997.

FRANTZICH, Stephen E., Professor, "Technology and the Future of Congress," Annual Meeting of the American Political Science Association, September 3, 1997.

FRANTZICH, Stephen E., Professor, "Making A Difference, Models of Citizen Activism," Annual Meeting of the Providence Center Board, December 1997.

FRANTZICH, Stephen E., Professor, "The Who, When, Where and How of Politics on the Internet," Lobbying on the Internet Conference, February 23, 1998.

HARFF, Barbara, Professor, Invited Participant, Seminar on Human Rights: Positive Policies in Asia and the Pacific, sponsored by Harvard University and Soka University of America, Malta, January 1998.

HARFF, Barbara, Professor, Presentation on the role of accelerators in early warning research, Woodrow Wilson Center, March 1998.

HARFF, Barbara, Professor, Task Force Planning Meetings, State Failure Project, San Diego, January 1998, and McLean, VA, February 1998.

MALONE, Eloise F., Associate Professor, "Provincial Politics and Canada's Role in the International System," 39th Annual International Studies Association Conference, Minneapolis, MN, 17-21 March 1998.

MALONE, Eloise F., Associate Professor, and Charles L. COCHRAN, Professor, "Approaches to Evaluating International Education Programs: A Roundtable and Poster Presentation," 39th Annual International Studies Association Conference, Minneapolis, MN, 17-21 March 1998.

MATTOX, Gale A., Professor, "European Security Architecture: Fashioning a New Order in Europe after the Cold War," International Studies Association, Annual Conference, Minneapolis, MN, 19 March 1998.

MATTOX, Gale A., Professor, "National Security Policy: Main Issues for Classroom Discussion," Panel before a Visiting Group of Russians/Ukrainians/Chinese academics, Monterey Institute for International Studies, Washington, D.C., 23 June 1997.

MATTOX, Gale A., Professor, "New Directions for International Security," Opening Lecture, Women in International Security Summer Symposium, St. John's College, MD, 17 June 1997.

MATTOX, Gale A., Professor, "The Compelling Argument in Favor of NATO Enlargement," Institute for Russian and Slavic Affairs, Indiana University, 5 April 1998.

MATTOX, Gale A., Professor, "The History and Debate over NATO Enlargement," Presenter, Miller Center Forum, Charlottesville, VA, 8 September 1997.

MATTOX, Gale A., Professor, "Views on NATO Enlargement from Moscow and Washington," Institute for Russian and Slavic Studies, University of California at Berkeley, 9 March 1998.

MATTOX, Gale A., Professor, "Women in International Relations Careers," National Youth Leadership Forum, Arlington, VA, 12 February 1998.

MATTOX, Gale A., Professor, Chair and Commentator, "The Russian-NATO Relationship: What Should It Achieve? What Can't It Achieve?," WIIS and Institute for East-West Studies, New York, NY, 13 June 1997.

MATTOX, Gale A., Professor, Chair and Discussant, "EU/NATO III – Trans-Atlantic Concerns," International Security Studies Section Annual Conference, Norfolk, VA, 23 October 1997.

MATTOX, Gale A., Professor, Chair, "Civil-Military Relations in Russia," International Studies Association, Annual Conference, Minneapolis, MN, 21 March 1998.

MATTOX, Gale A., Professor, Chair, "New Issues Confronting Europe in the Post-Cold War," American Political Science Association, Washington, D.C., 30 August 1997.

MATTOX, Gale A., Professor, Chair, "Publish or Perish: Publishing in Professional Journals," American Political Science Association, Washington, D.C., 29 August 1997.

MATTOX, Gale A., Professor, Commentator, "European Security in the 21st Century," WIIS and Brookings Institution, Washington, D.C., 2 February 1998.

MATTOX, Gale A., Professor, Convener plus Introduction and Concluding Address, "Europe in Transition: Avoiding New Conflicts," Conference on Regional Cooperation in the New Europe: Military, Economic and Political Dimensions," Budapest, Hungary, 13-17 October 1997.

MATTOX, Gale A., Professor, Discussant, "European Views of NATO Enlargement," Institute for Russian and Slavic Studies, University of California at Berkeley, 10 March 1998.

MATTOX, Gale A., Professor, Formal presentations on "Women in International Security: The States of the Field and the Role of Women," given in various forms at International Graduate School, Mierki, Poland, 29 July 1997; at Miller Center, University of Virginia, 9 September 1997; George C. Marshall, 26 February 1998.

MATTOX, Gale A., Professor, Interview with Charlie McDowell on NATO Enlargement, filmed at Miller Center, Charlottesville, VA, broadcast on 27 February 1998 on Virginia PBS.

MATTOX, Gale A., Professor, Invited Participant, "National Military and Civilian Service," U.S. Military Senior Conference XXXV, West Point, NY, 4-6 June 1998.

MATTOX, Gale A., Professor, Member of U.S. Delegation, "NATO's Future After Enlargement: American, German, and Polish Perspectives," Warsaw, Poland, 5-7 December 1997.

MATTOX, Gale A., Professor, Panel Presenter, "Central Europe and Russia: Alliances, Business, and Culture," Institute for Russian and Slavic Affairs, Indiana University, 6 April 1998.

MATTOX, Gale A., Professor, Roundtable Participant, "Careers in International Security," International Studies Association, Annual Conference, Minneapolis, MN, 18 March 1998.

PURKITT, Helen E., Professor, "Environmental Security in Southern Africa," Institute for Global Cooperation and Conflict, University of California, San Diego, 22 April 1997.

PURKITT, Helen E., Professor, "Environmental Security in Southern Africa," South African National Intelligence Agency, Pretoria, South Africa, 9 July 1997. (Invited presentation and meetings with NIA personnel requested by South Africa's Minister of Water, Kadar Asmal.)

PURKITT, Helen E., Professor, "Environmental Security: An American Perspective," South African Army College, Johannesburg, South Africa, 21 February

1997.

PURKITT, Helen E., Professor, "South Africa's Decision to Terminate It's Space-launch Vehicle and Related Programs," The Cooperative Monitoring Center, Sandia National Laboratories Center for Defense Monitoring, New Mexico, 8 August 1997.

PURKITT, Helen E., Professor, Discussant on Panel on Public Opinion, Conference on the Use of Force After the Cold War, George Bush Center, Texas A&M, 9 September 1997. (Written comments on two panel papers also supplied at request of panel organizers).

PURKITT, Helen E., Professor, Moderator, Roundtable on the Role of the Vice President in Bi-national Commissions in U.S. Foreign Policy, American Political Science Association, 31 August 1997.

RACHWALD, Arthur R., Professor, "Central European Roads to Europe. Integration and Fragmentation: Politics vs. Economics," European Politics Workshop, Warsaw, Poland, 10-12 June 1998.

RACHWALD, Arthur R., Professor, "Euroregions in Central Europe: Sub-Nation-State Analysis," Conference on New Regionalism in Europe, University of Warsaw, Warsaw, Poland, 5-6 June 1998.

RACHWALD, Arthur R., Professor, "NATO Enlargement Debate. A View from Central Europe," Political Economy Roundtable, The Puget Sound University, Tacoma, WA, 21 November 1997.

WRAGE, Stephen D, Associate Professor, "Teaching Ethics By Means of Case Studies," Series of lectures at U.S. Naval Academy Summer Seminar in Ethics, June 1998.

WRAGE, Stephen D., Associate Professor, "American Foreign Policy Making," Series of four lectures at Johns Hopkins University's School of Advanced International Studies, June 1997 and again in June 1998.

WRAGE, Stephen D., Associate Professor, "Commentary on Paper by Bryan Hehir," Opening Conference for George Bush School of Public and International Affairs, College Station, TX, October 1997.

ZOTTI, Priscilla, Assistant Professor, "Lessons Learned?: Vocational Treatment Programs in Civilian and Military Prisons," Southwestern Political Science Association Conference, Corpus Christi, TX, March 1998.

ZOTTI, Priscilla, Assistant Professor, with John C. Domino and Kevin M. Esterling, "The Impact of Judicial Performance Evaluation Reports on Voter Attitudes and Behavior in Judicial Retention Elections," Southern Political Science Association Conference, Norfolk, VA, November 1997.

ZOTTI, Priscilla, Assistant Professor, with John C. Domino, "The Implementation of the Americans with Disabilities Act in the Texas and Maryland Court Systems," Southwestern Political Science Association Conference, Corpus Christi, TX, March 1998.

Division of Mathematics and Science

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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 funded through the prestigious Henry Dreyfus Teacher/Scholar Award (one of five nation-wide), providing funding for his own research and for the Department. Associate Professor Judith Harrison continues to develop an international reputation in the emerging field of tribology, and has supported again a post-doctoral associate within the Department. Associate Professor Robert Ferrante was awarded the Kinnear Fellowship at the Naval Academy in support of his work in cometary chemistry.

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 study of methodology in capillary electrophoresis, and 4 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 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 to specialized medical scanning technology, detonation simulations, electrochemical studies of fused salts, development of analytical methods based on electrophoretic techniques, synthesis and characterization of organic and organometallic species, and the effects of chemical agents in atmospheric chemistry, 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: Assstant Professor John W. Bodnar

Midshipman 1/C Suneil Ramchandani, USN SC432 Class (22 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 genes interact into the genetic control network that regulates organismal growth, viral infection, and carcinogenesis.

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 Camille and Henry Dreyfus Foundation

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 in varying stages of completion: (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.

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.

Deposition of Niobium and Tantalum from Room-Temperature Molten Salts

RESEARCHER: Professor Graham T. Cheek

SPONSOR: Naval Research Laboratory / Air Force Office of Scientific Research

Continuing studies of niobium/aluminum and tantalum/aluminum deposition involved reduction of $NbCl_5$ and $TaCl_5$ from the $AlCl_3$: 1-ethyl-3-methylimidazolium chloride molten salt system. Deposition at the 70 $\mu A/cm^2$ level onto platinum prevented the formation of an extremely loose deposit of Nb or Ta, as was observed at higher current densities. Characterization of the deposits by XES revealed that a small amount of Nb or Ta was present in the deposits.

In view of the fact that niobium and tantalum can be deposited from high temperature fluoride molten salt systems, the influence of fluoride added to the room temperature system was investigated. Addition of fluoride, either as NaF or tetraethylammonium fluoride, to the acidic melt caused the disappearance of the aluminum reduction process, apparently by interaction of fluoride with $Al_2Cl_7^-$. The niobium reduction process was also greatly changed, occurring as a broad plateau rather than as peak responses. A well-defined oxidation peak was observed on the reverse sweep, implying formation of a deposit.

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

In a continuation of studies begun in the previous year, molecular dynamics simulations were used to investigate the effects of changing the amount of energy released in a chemical reaction of a detonating material on the properties of the detonation. The simulations were based on a model diatomic system which has been previously shown to produce reasonable values for shock wave properties. It was found that sustained detonation could not be produced in model systems with exothermicity below 2.5 eV regardless of the impact velocity of the flyer plate used to initiate the detonation. Above this threshold, minimum impact speed for initiation was a strongly decreasing function of exothermicity. Reaction zone temperature and shock front velocity were found to be linearly related to exothermicity, but reaction zone density was essentially independent of the amount of energy released.

Studies of the Mechanism of Anomalous Low Temperature Crystallization on Laboratory Analogs of Interstellar Grains

RESEARCHER: Associate Professor Robert F. Ferrante

SPONSOR: NASA/Goddard Space Flight Center / Kinnear Foundation

Comets and other interstellar objects are believed to have formed by the accretion of silicate dust 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 have been used to model such condensation processes, and their results employed in the interpretation of the thermal- and radiation-processing history of the natural systems. Such models have always assumed the formation of amorphous ice at low temperatures. However, our work over the last few years, utilizing silicate grain analogs as a substrate for simple ices of astrophysical interest (H_2O, CH_3OH, etc.), have indicated that the nature of the dust particle surface may have an effect on the crystallization behavior of the ice coating. 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. If these laboratory studies represent good models for the natural process, then a re-evaluation of the amorphous ice assumption is warranted. The work performed here is designed to explore the mechanism of the observed anomalous low-temperature crystallization (LTC). The goal is to provide a better understanding of the significance of these observations towards interpretation of astrophysical data.

Our evidence suggests that the LTC effect is associated with the degree of oxidation of the silicate grains, and with the surface area and pore size distribution of the material. We are using thermal and chemical treatments to vary the surface properties. Silicate "smoke" substrates are baked at varied temperatures and durations, in vacuum, hydrogen and oxygen. Some samples are exposed to chemical oxidation by ozone. Samples are also being processed by electron, proton, and argon ion irradiation in and attempt to alter pore characteristics. Treated samples are analyzed for surface area and pore size distribution, and tested for efficacy in the LTC effect by low temperature FTIR spectroscopy of condensed adsorbate ices. Current evidence suggests that the LTC may be an extreme example of the lowering of phase transition temperatures for materials confined to small pores. Additional ices, and other model grain models with different (e.g., Fe and Mg silicates) or sharp (silica aerogels; molecular sieves) pore size distributions will also be utilized.

Explorations of Laboratory Models for the Catalytic Formation of Methane by Silicate Interstellar Dust Grains

RESEARCHER: Associate Professor Robert F. Ferrante

SPONSOR: NASA/Goddard Space Flight Center

In the molecular cloud from which the solar system condensed, CO was the most abundant carbon-bearing molecule. However, gas-phase reactions converting CO to methane are quite slow, and are thought to be insufficient to account for the large amount of organic material observed. Catalysis by dust grains, especially those bearing transition metal atoms, may offer an alternative route to methane and other organics. The Fischer-Tropsch synthesis of methane grain

$$3\,H_2 + CO \text{ ----------> } CH_4 + H_2O$$

catalyzed by Fe or Ni surfaces, has been considered theoretically, and appears to provide reasonable yields of organics under some appropriate conditions. This research, which is just getting underway, will explore this possibility experimentally, using our silicate grain analogs.

Molecular Oxygen Activation by Sterically Hindered Metallotetraazaporphyrins

RESEARCHER: Associate Professor Jeffrey Fitzgerald

SPONSOR: Kinnear Foundation

Molecular oxygen is an inexpensive and thermodynamically powerful oxidant. However, O_2 is also a kinetically slow oxidant. The "dual" nature of oxygen makes it of limited use to the synthetic chemist; typically it is unreactive and when it does react, it is completely unselective. Nature, however, has developed catalysts (enzymes) which allow it to use dioxygen efficiently. Most of these enzymes contain iron porphyrins at their active sites. Thus, metalloporphyrins and their analogs are being studied as potential dioxygen activation catalysts. Recently, Lyons and Ellis reported sterically hindered, perhalogenated iron porphyrins which catalyze the conversion of alkanes to alcohols by O_2 under extremely mild conditions. Lyons and Ellis designed their porphyrin catalysts to resist two inactivating side reactions. Their best catalysts bear large pendant groups on the porphyrin periphery which prevent the close approach of two molecules necessary to form a catalytically inactive dimer. Lyons and Ellis also placed halogens on the periphery of their porphyrin catalysts in order to make the ring electronically resistant to oxidation and to raise the metal(III/II) reduction potential. Positively shifted metal redox potentials have been shown to increase catalytic activity.

Tetraazaporphyrins, which are structurally similar to porphyrins yet have positively shifted metal redox potentials, are particularly promising O_2 activation catalysts. With this goal in mind, we had previously developed a synthesis of a sterically hindered tetraazaporphyrin. This synthesis has now been optimized. This key molecule can now be produced in an overall yield of 12% (up from 4%!) on the gram scale. Iron, manganese and ruthenium complexes have all been prepared and adequately characterized. The iron complex has been examined as an O_2 activation catalyst but so far has been unsuccessful. Investigation reveals the metal oxidation potential has been shifted so far positive that the complex has no detectable affinity for O_2 (Murphy's Law at work!). While disappointing, this material may be an excellent candidate for a carbon monoxide detector. Based on periodic trends, the manganese and ruthenium complexes are expected to have a higher affinity for O_2. These complexes, however, are not at a point where they can be tested as catalysts. In the case of the ruthenium derivative, a carbonyl ligand, which renders the complex catalytically inactive, must be removed. This has been accomplished by photolysis on a similar model compound but the sterically hindered tetraazaporphyin is not stable to photolysis. Thus chemical methods of removing the carbonyl group are being explored. Before it can be studied as an O_2 activation catalyst the manganese complex must be reduced from Mn(III) to Mn(II) and this is also being investigated.

Molecular Dynamics Investigations of the Tribology of Diamond Surfaces

RESEARCHER(S): Dr. Steven J. Stuart (postdoctoral associate), Midshipman 1/C Peter Lombard, USN

FACULTY ADVISOR: Associate Professor Judith A. Harrison

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 are placed in sliding contact was examined. The friction and tribochemical reactions were examined as a function of load, sliding direction, chemisorbed groups on the diamond surface, and third-

body molecules trapped between the diamond surfaces. 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, we have been re-fitting the potential energy function needed to carry out these simulations. We have adapted this potential so that, in addition to solid and gas phase hydrocarbons, liquids can also be simulated. This will allow us to examine the break down of liquid lubricants. We are in the final stages of testing this re-fit potential energy function.

Investigation of the Physical Properties of Carbon Nanotubes

RESEARCHER(S):Dr. Carter T. White (Naval Research Lab), Dr. Daniel H. Robertson, Indiana University Purdue University, Dr. Steven J. Stuart (postdoctoral associate)

FACULTY ADVISOR: Associate Professor Judith A. Harrison

SPONSOR: The Naval Research Laboratory / The Office of Naval Research

It has been recently proposed that carbon nanotubes might constitute well-defined tips for scanning probe microscopies (SPM). Multiwalled nanotubes have been shown to perform well as SPM tips when used in tapping mode, due to their desirable combination of stiffness and flexibility. We have been using molecular dynamics simulations to examine the physical properties of hemispherically-capped carbon nanotubes. These simulations should lend insight into the utility of these tubes as scanning force microscope tips. Preliminary simulations demonstrate that the capped nanotubes, although undergoing complex deformations, have the remarkable ability to recover reversibly when pushed into a hard substrate, such as diamond.

Synthesis and Study of a Series of Tripodal Ligands Containing Amine and Heterocyclic Ligating Groups

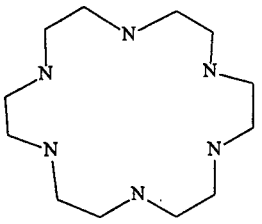
RESEARCHER: Judithann R. Hartman, Assistant Professor

SPONSOR: Naval Academy Research Council, ONR

Crown and cryptand ligands are useful for binding metal ions because the constrained nature of crown

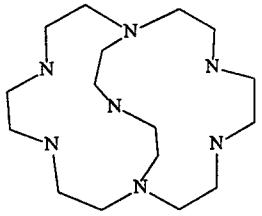
and cryptand ligands allows them to form metal-complexes in which the metal has unusual steric and electronic properties. Unfortunately, crowns and cryptands are difficult to prepare and purify, and hence expensive.

Crown



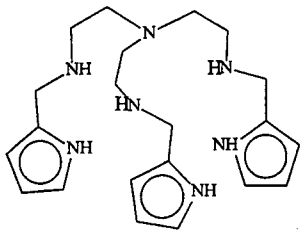
Cryptand

TREN-Podand



Podands ("many-armed" ligands) can act as either constrained ligands that form cryptand-like metal complexes or as unconstrained ligands that form cross-linked polymeric metal complexes. In the proposed research, the chemistry of a novel series of TREN-based tripodal ligands have been synthesized and are being studied to characterize their method of binding and to determine where they fit in the scale of preorganization that ranges from linear ligands to cryptands.

We studied the binding properties of TREN-based podand ligands by determining the properties of both free ligands and metal-ligand complexes. First, we measured the binding constants of a series of podands to those of the analogous linear ligands (that we synthesized)to determine if the tripod structure is conferring any metal selectivity. Second, we prepared the copper complexes and we will measure the magnitude of the Cu(II)/Cu(I) redox couple to determine if the tripod "cavity" is constraining the conformation of the copper ions.



In addition, we studied the binding modes (i.e. relative amounts of and binding) exhibited by a variety of heterocyclic functional groups by characterizing the electronic states of the Cr(III) complexes formed by this series of tripodal ligands.

Supramolecular Inclusion of Non-Linear Optical Chromophores by Amylose

RESEARCHER: Assistant Professor William B. Heuer

SPONSOR: Naval Research Laboratory (ONR)

We continue to be engaged in the synthesis and study of functionalized hemicyanine chromophores bearing long alkyl-chain substituents. These chromophores have been specifically designed to function as guests for supramolecular complexation by amylose, a linear polysaccharide which adopts a rigid, helical structure in solution. Supramolecular complexes of hemicyanine chromophores are of fundamental interest for their possible application in fabrication of non-linear optical (NLO) devices. Supramolecular complexation of hemicyanine chromophores within the hydrophobic cavity of helical amylose prevents aggregation effects which degrade the NLO properties of thin films derived from such chromophores. Additionally, such complexes exhibit greatly reduced susceptibility to oxidative degradation of the chromophore by both thermal and photochemical processes. A manuscript describing results of studies demonstrating the ability to influence the structure of the host-guest complex by synthetic modification of the chromophore guest is

nearing completion. Continuing work in this area focuses on synthesis and characterization of oligomeric chromophore assemblies and their supramolecular complexes with amylose.

Preparation of Organic Radiotracers

RESEARCHER: Assistant Professor Christopher M. Kinter

SPONSOR: Naval Academy Research Council (ONR)

Typically 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 methods 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. [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 a 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.

Preparation of N1'-([F-18]Fluoroethyl)Naltrindole: A Radioligand for Positron Emission Tomographic Studies of Delta Opioid Receptors

RESEARCHER: Assistant Professor Christopher M. Kinter

SPONSOR: Naval Academy Research Council (ONR)

Previously we have developed N1'-([C-11]methyl)naltrindole as a radioligand for selective localization of the delta opioid receptor by positron emission tomography (PET). In order to monitor the pharmokinetics of radioligand binding to the delta receptor over a longer time interval with improved signal intensity and counting statistics we are also investigating naltrindole analogs that are radiolabeled

with fluorine-18. This research has led to the synthesis of N1'-([F-18]Fluoroethyl)Naltrindole, [F-18]FEtNTI, which is currently undergoing evaluation as a radioligand for use in PET. The precursor for radiolabeling was obtained in a four step synthesis from naltrexone hydrochloride in an overall yield of 47%. Nucleophilic displacement of a tosyl leaving group by [F-18] fluoride, followed by hydrogenolysis of a benzyl protecting group gave [F-18]FEtNTI. The average time for radiosynthesis, HPLC purification, and formulation was 77 minutes from end of bombardment. [F-18]FEtNTI was produced in sufficient radiochemical purity and specific activity to permit initial in vivo binding studies which shows specific binding to the delta opioid receptor in vivo. Thus, [F-18] FetNTI warrants further investigation as a radioligand for PET studies of delta opioid receptors.

Web-Based Feedback and Reporting for a Colorimetric Experiment Using a Series of CGI/Perl Scripts

RESEARCHER: Associate Professor Joseph F. Lomax

SPONSOR: Curriculum Development Program

A series of CGI/Perl scripts for a chemistry laboratory report have been written, implemented and tested. These scripts assist the students by providing feedback on their data and analysis. Once the students have learned how to correctly perform the analyses, they submit their results to their instructor, who can use the output for evaluation. Student assessment of this series of scripts is overwhelming positive. Scripts are included and programming considerations are discussed.

Association Reactions of Manganese, Iron, and Ruthenium with Nitric Oxide

RESEARCHER: Assistant Professor Roy E. McClean

SPONSOR: Research Corporation

This work is a continuation from academic year 1996 -1997. In brief, the association reactions of ground state manganese, iron, and ruthenium with nitric oxide in the gas phase were studied over the total pressure range 5 - 700 Torr (Ar buffer gas). Manganese, iron, and ruthenium atoms were produced by the 248 nm laser photodissociation of methylcyclopentadienyl manganese tricarbonyl, ferrocene, and ruthenocene, respectively. Detection of the formed transition metal atoms was by laser-induced fluorescence. Previous work concentrated on the reactions of iron and ruthenium with nitric oxide at room temperature. During this academic year, this work was extended to include a study of manganese with nitric oxide at room temperature as well as at elevated temperatures. The iron and ruthenium reactions (with nitric oxide) were also studied at elevated temperatures.

All reaction rates increased with increasing total pressure, an indication of adduct formation (association reaction). Ruthenium was found to be more reactive towards nitric oxide than manganese and iron. This observation is interpreted in terms of the different electron configurations of the transition metal atoms. Ground state manganese and iron have $[Ar]3d^5 4s^2$ and $[Ar]3d^6 4s^2$ configurations, and ruthenium has a $[Kr]4d^7 5s^1$ 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 manganese and iron have closed s-subshells, electronic repulsive effects are encountered in the reactive surfaces of Mn and Fe with NO.

We have also carried out RRKM calculations on the mononitrosyls (the adducts containing nitric oxide) of these transition metals. The molecular parameters needed for these calculations were obtained

from density functional theory (DFT) results.

Depletion Kinetics of Nickel Atoms by Sulfur Dioxide

RESEARCHER: Assistant Professor Roy E. McClean

SPONSOR: Research Corporation

The interaction of sulfur dioxide, SO_2, with transition metals is an attractive subject because SO_2 is an air pollutant. In this work, the gas phase depletion kinetics of ground state nickel atoms in the presence of SO_2 was studied as a function of temperature and total pressure using argon as the bath gas in order to determine the reactivity of nickel towards SO_2. Nickel atoms were produced by the 248 nm photodissociation of nickelocene and were detected by laser-induced fluorescence. The overall reaction rates increased with increasing total pressure and decreased with increasing temperature, an indication of adduct formation between nickel and SO_2. The reaction rates were relatively fast and reaction was found to proceed with little or no barriers. In order to determine the binding energy of the adduct, density functional theory (DFT) and RRKM calculations were performed. The DFT calculations provided molecular parameters of the adduct. The rate data and DFT results were then used in the RRKM calculations to determine a binding energy of $\approx$ 50 kcal/mol.

The Distribution of Hydrogen Peroxide, Methyl Hydroperoxide and Formaldehyde and their Influence on the Tropospheric Chemistry of Ozone in the Southeastern Pacific

RESEARCHER: Assistant Professor Daniel W. O'Sullivan, Co-PI and Associate Professor Brian G. Heikes, PI (University of Rhode Island)

SPONSOR: National Aeronautics and Space Administration

During the NASA's Global Tropospheric Chemistry Pacific Exploratory Mission Tropics (PEM Tropics) field program, we measured the distribution and gas phase concentrations of hydrogen peroxide, methylhydroperoxide, and formaldehyde on board the NASA P3-B aircraft during the first year of the contract. During the final year, these data will be coupled to other measurements to examine the dynamics of tropospheric oxidant chemistry in clean tropospheric air. The peroxides are critically linked to the net production of tropospheric ozone through the reactions of peroxyl radicals. Consequently these measurements will be used to enhance our understanding of the net ozone production in the troposphere, and to constrain tropospheric photochemical models. We will also evaluate the role of atmospheric peroxides in the gas phase oxidation of sulfur dioxide in the lower marine troposphere. In addition we will evaluate the role formaldehyde and methylhydroperoxide have in the oxidation of methane in the remote troposphere.

Hydrogen peroxide, methylhydroperoxide, and formaldehyde: Their relationship to tropospheric oxidant chemistry and transport over the equatorial South Pacific

RESEARCHER: Assistant Professor Daniel W. O'Sullivan, Co-PI and Associate Professor Brian G. Heikes, PI (University of Rhode Island)

SPONSOR: National Aeronautics and Space Administration

We propose to make measurements of gas-phase hydrogen peroxide, methylhydroperoxide, and formaldehyde on board both the NASA DC-8 and P3-B aircraft as part of the NASA/GTE PEM-Tropics B mission. The target species are directly coupled to tropospheric oxidants as sources of odd-hydrogen and odd-oxygen radicals, as reservoirs of the same, and as conductors in their loss. The net production of ozone or odd-oxygen in the troposphere is largely predicted on the basis of photochemical point model simulations based upon measured concentrations of hydrocarbons, nitric oxide, water, carbon monoxide, ozone, and sunlight and both measured and model diagnosed concentrations of nitrogen dioxide, perhydroxyl, methylperoxyl, and hydroxyl radicals. The species to be measured provide mechanistic insight and chemical constraints to these purely chemical model simulations and provide an additional measure of confidence in their results. Multi-dimensional space-time models suggest that atmospheric motions, the vertical transport and mechanical redistribution of the hydroperoxides, may have a profound effect on odd-O and odd-H chemistry in the upper troposphere. The proposed hydrogen peroxide, methylhydroperoxide, and formaldehyde measurements will add needed information on transport, chemical redistribution, and scavenging by cloud and precipitation systems (meteorological conditions which are expected to have a larger role in the tropospheric chemistry than in PEM-Tropics A). Also, the target species are coupled to the gas-phase and, more significantly, to the heterogeneous chemistry of sulfur dioxide and its oxidation to sulfuric acid.

Impact of Superoxide Redox Cycling on the Chemical and Optical Properties of Coastal Seawater

RESEARCHER: Assistant Professor Daniel W. O'Sullivan

SPONSOR: Naval Academy Research Council/ONR

Interest in reactive oxygen species in the environment has been stimulated by atmospheric chemical problems such as smog formation, stratospheric ozone depletion, and acid rain. Because of the need to understand these chemical problems, atmospheric gas-phase reactions of oxidants and the related primary photochemical processes have been intensely studied. As a result atmospheric photochemistry has become a highly developed subdiscipline. Aquatic photochemistry is less well developed, largely because of the complex chemical composition of most natural waters. Recent studies indicate that photo reactions producing reactive oxygen species (O_2^-, superoxide; $^1O_2$, singlet dioxygen; OH, hydroxyl radical, and RO_2, organic peroxy radicals) can significantly influence the cycling of carbon, oxygen, sulfur, and biologically important trace metals. As in the atmosphere, reactive oxygen species can act to cleanse the aquatic environment of bioactive pollutants or in some cases, convert wastes into more toxic substances. Superoxide has the highest steady state concentration of reactive oxygen species in natural waters, and is the first intermediate in most oxygen mediated oxidations. In spite of the central role of superoxide in natural water photochemistry, the kinetics and mechanisms of its formation and destruction are poorly understood. This proposal will address this gap in our understanding through the development of a luminol-based chemiluminescence method for superoxide in natural waters. The method will have the sensitivity, selectivity, and sampling

resolution required to perform detailed kinetic studies in natural waters.

Particle Diffusion Through Natural Rubber Latex

RESEARCHER: Assistant Professor Maria J. Schroeder

SPONSOR: Naval Academy Research Council (ONR)

Controversy exists over the effectiveness of natural rubber latex as a protective barrier to viral-sized particles. The concern centers on the possible transmission of disease-causing agents such as hepatitis and HIV. Viruses can range in size between 0.1 and 5.0 microns. Defects in rubber latex due to poor manufacturing processes or existing as intrinsic flaws inherent to the material can be orders of magnitude larger. This project investigates the extent to which small particles can pass through ostensibly intact natural latex rubber and examines possible explanations for any permeation.

Barrier performance of natural rubber latex was investigated by monitoring diffusion of fluorescently-labeled polystyrene microspheres through commercial latex samples. Microsphere particles having diameters of 0.1 and 1.0 microns were used to approximate the size of small viruses. In a special diffusion cell, the latex sample separated one side of the cell containing the microsphere solution (of approximately 10^{10} particles/ml) from another side containing pure water. The extent of diffusion through the membrane was monitored by the appearance of the fluorescent micro spheres on the pure water side of the cell.

Results indicate that more than 10^6 particles of the 0.1 micron size passed through a square centimeter of sample within 30 minutes compared to about 10^3 particles of the 1.0 micron size. Although permeability was observed, the experiment does not reveal the cause of this permeability. Latex processing, rather than intrinsic flaws in the rubber itself, may result in poor barrier performance. Latex rubber is formed from discrete particles, which are coated with naturally occurring proteins and surfactants, and dispersed in an aqueous medium. During commercial processing, drying and curing occur almost simultaneously. This can lead to incomplete coalescence resulting in a residual capillary structure and concomitant permeability. Future studies include investigations of alternatively-processed membranes or latex substitutes to address the origins of this permeability.

Dielectric Properties of Polymer Blends

RESEARCHER: Assistant Professor Maria J. Schroeder

SPONSOR: Naval Academy Research Council (ONR)

When two or more polymer components are combined, the blend can exhibit vastly different properties from the individual components. Determining the origins or mechanisms of this observed behavior remains one of the primary goals of characterization studies. Dielectric spectroscopy is well suited to probe the chain dynamics of polyisoprene chains within a polybutadiene matrix. Cis-polyisoprene is dielectrically active since its dipoles are aligned perpendicular to the backbone of the chain. Polybutadiene is dielectrically inert and will not contribute significantly to the dielectric signal of the sample. Therefore, the dynamics of the polyisoprene chains can be selectively probed within this blend. If the polybutadiene matrix is altered, the resulting effect on the dynamics of the polyisoprene chains can be observed and the extracted chain dynamics can be used to test proposed molecular theories of polymer melt dynamics.

Experimental procedures for preparing miscible polyisoprene/polybutadiene blends have been

developed. Polyisoprene chains of low molecular weight (MW 5000) and moderate molecular weight (MW 20,000) provide evaluations of both non-entangled and entangled polyisoprene systems. Polybutadiene samples of high molecular weight with varying microstructure composition provide different matrix environments. By utilizing a solvent-cast procedure, thin films of the blends have been prepared. Thin films are necessary for maximizing the dielectric response since the capacitance is inversely proportional to the film thickness. A blend composition of 15% polyisoprene and 85% polybutadiene provides sufficient dielectric signal while satisfying dilute probe chain conditions. Current work involves extraction of the probe dynamics from the dielectric measurements obtained over wide frequency and temperature conditions.

Pentaphenylcyclopentadienyl Derivatives of Molybdenum and Tungsten Carbonyls

RESEARCHER: Professor Joyce E. Shade

SPONSOR: Professor Rheingold - Univ. of Delaware

Previous work by this collaborative team 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-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 $(Ph_5C_5)M(CO)_3$-CH_2-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.

Electrodeposition of Aluminum Alloys from Ambient-Temperature Molten Salts: Preparation and Characterization

RESEARCHERS: Professor Graham T. Cheek (USNA), Assistant Professor Paul C. Trulove (USNA)

SPONSOR: Air Force Office of Scientific Research

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.

Investigations of Ionic Liquid-Polymer Gel Electrolytes

RESEARCHERS: Professor Graham T. Cheek (USNA), Assistant Professor Paul C. Trulove (USNA)

SPONSOR: Air Force Office of Scientific Research

Room-temperature ionic liquids composed of perfluoroanions and 1,3- dialkylimidazolium and 1,2,3-trialkylimidazolium cations possess a number of unique properties that make them ideal electrolytes for compact power sources. In particular, they are nonflammable, nonvolatile, and chemically inert, and they display wide electrochemical windows, high inherent conductivities, and wide thermal operating ranges. Also, unlike room-temperature ionic liquids based on chloroaluminate anions, these perfluoroanion electrolytes are not moisture sensitive.

For manufacturing and design optimization, solid-state electrolytes with high ionic conductivities are preferred to liquid electrolytes. In this research program we are investigating the generation of solid-state electrolytes that incorporate perfluoroanion ionic liquids into a poly(vinylidene fluoride)-hexafluoropropylene copolymer. These free-standing rubbery electrolytes appear to retain much of the desirable properties of the perfluoroanion ionic liquids. In this project we will be investigating the physical and electrochemical properties of these gel electrolytes using thermal mechanical analysis, differential scanning calorimetry, imbedded microelectrode techniquess, AC-impedance, and luminescent probe molecules. In addition this project will evaluate graphite intercalation anodes and cathodes with the inoic liquid-polymer gel electrolytes in solid-state cells empolying the dual intercalating molten electrolyte (DIME) concept.

Conformational Analysis of Biologically Active Compounds

RESEARCHER: Assistant Professor Joseph J. Urban

SPONSOR: Office of Naval Research

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 variety 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.

Structure Elucidation of Possible Anti-Malarial Compounds from Verbinia sp

RESEARCHER: Captain Robert L. von Tersch, PhD, USA and Associate Professor Debra Dillner, Colonel John Scovill, PhD USA

SPONSOR: Walter Reed Army Institute of Research

This work has focused on elucidating the structure of biologically derived compounds that have shown efficacy against organisms that pose a threat to US forces in various theaters of operation. The materials have previously been extracted from foliage native to Thailand and have been assayed for efficacy against Plasmodium falciparum. Structure determination has involved a number of analytical techniques, most notably high resolution mass spectrometry and one- and two-dimensional nuclear magnetic resonance spectroscopy.

Analysis of the Stereoisomers of 3,3-Dimethyl-butyl-2-ol-methylphosphonofluoridate(Soman) and Related Compounds

RESEARCHER: Captain Robert L. von Tersch, PhD, USA

SPONSOR: US Army Medical Research Institute of Chemical Defense / Steroids Limited

The generation of biological scavengers capable of hydrolyzing nerve agents is a major research effort of the chemical defense program of the Army. The scavenger molecules currently under investigation are genetically engineered proteins such as human butyrylcholinesterase or catalytic antibodies. In either project, it is of considerable importance to ascertain the stereospecificity of the scavenger molecule with respect to the nerve agent whose hydrolysis is being catalyzed. Since we wish to maximize the effectiveness of such scavenger molecules in conferring protection against nerve agent intoxication, knowledge of the absolute configuration of the nerve agent molecules is necessary to determine the amino acids to be subjected to site-directed mutagenesis or the design of the transition state analogues. Since soman possesses two chiral centers, four stereoisomeric analogues have been synthesized. The structures have been verified by X-ray analysis and attached to a succinyl spacer group prior to attachment to proteins for use as immunogens. As a means of assessing the stability of the resulting adducts, ^{31}P nuclear magnetic resonance (NMR) spectroscopy was employed to determine whether the phosphorous chiral center had degraded or had been cleaved from the succinylated protein molecule. These experiments coupled with ^{13}C NMR data correlate the NMR chemical shift with the relative configuration at the soman phosphorous and carbon chiral centers. Similar

studies have indicated the phosphorous and carbon chemical shift position of soman analogues of known absolute configuration at phosphorous and carbon. The initial data suggests the following correlations: C(+)P(+) = C(S)P(S), C(-)P(+) = C(R)P(S), C(+)P(-) = C(S)P(R), and C(-)P(-) = C(R)P(R). Molecular modeling using conformational search techniques has begun to address the stereochemical binding environment of the toxic soman stereoisomers. Taken together these experiments can provide a reference relating absolute and relative phosphorous stereochemistry by NMR and will permit this technique to be used as a novel method of rapidly screening the stereospecificity of newly developed biological scavengers.

Independent Research

Electrochemical Reduction of Tantalum(V) Chloride in Acetonitrile/Aluminum Chloride Solvent System

RESEARCHER: Professor Graham T. Cheek

The reduction of $TaCl_5$ in acetonitrile/$AlCl_3$ has been studied as a comparison to behavior seen in room-temperature molten salt systems. Upon dissolution in acetonitrile (AN), the Ta(V) species is $TaCl_5AN$, which rapidly undergoes chloride transfer to produce both $TaCl_6^-$ and $TaCl_4AN_2^+$. One-electron reduction of $TaCl_6^-$ results in formation of $TaCl_5AN^-$, which then quickly loses a further chloride ligand to form $TaCl_4AN_2$. The latter species apparently undergoes disproportionation over several hours to yield the initially observed $TaCl_6^-$ and unidentified lower valent products.

Synthesis of Novel Organic Diphosphonates

RESEARCHER:

FACULTY ADVISER: Associcate Professor Debra Dillner

The creation of a methanol fuel cell offers an economical and environmentally safe alternative to current methods of supplying power. A major challenge in making an efficient methanol fuel cell is the synthesis of a central component of the system, the separator. An ideal separator must be able to prevent the flow of methanol from the anode to the cathode while allowing protons to move freely from anode to cathode.

This research project involves investigations into the organic portion of a proposed separator. The proposed separator, a Molecularly Engineered Layered Structure (MELS) consists of a layered zirconium (IV)-organic diphosphonate compound. This type of compound should have the stability of inorganic compounds and the design control of organic compounds which will allow them to be altered to produce the desired properties. In order to evaluate the suitability of MELS to serve as separators for fuel cells, the organic diphosphonate components must first be synthesized.

The diphosphonates desired for this project are alkyl diphosphonates of various chain lengths. Initial studies have focused on three, five and seven carbon chains. The alkyl chain will have a phosphonate group at each end. In addition, an electronegative group will be introduced at the central carbon. The role of the phosphonates is to bond to the zirconium layers and provide stabilization of the layered structure. Varying the chain length will also allow for variations of the

distances between zirconium layers. Permeability of the layered structure to methanol will partially be determined by this interlayer spacing. The electronegative group is included to enhance proton conductivity. Many types of electronegative groups can be introduced and proton conductivity studied in a systematic manner.

To date, three several organic diphosphonates have been prepared. These are ethyl 1,3-propanediphosphonate, ethyl 1,5-pentanediphosphonate, ethyl 1,7-heptanediphosphonate and ethyl 2-hydroxy-1,3-propanediphosphonate. These compounds were difficult to prepare and purify. While they are prepared by condensation of alpha,omega-dibromide with triethyl phosphite, the temperature of the reaction and rate of addition of the dibromide was critical. Their successful synthesis has allowed for testing of the appropriate conditions for the preparation of substituted derivatives. The hydrolyses of these compounds to the diphosphonic acids has been optimized and their conversion to layered materials is under investigations. These compounds will also be useful in initial studies into the preparation of MELS. MELS must not only be prepared, they must be characterized and the distance between zirconium layers determined. The preparation of the unsubstituted derivatives will allow this to be done in simpler systems.

The compounds described above were all prepared from commercially available starting materials. Appropriate dibromides must be synthesized to prepare further diphosphates. The five-carbon dibromides are currently being prepared by two routes. One is applicable to preparation of the alcohol substituted compounds and the sulfate ester compounds. An alternative route is being developed for preparation of the sulfonate esters. These synthetic pathways are yielding fruitful results and the alcohol substituted dihalide is one step from preparation. Earlier efforts had successfully prepared appropriate dichlorides but it was found that they did not readily undergo Arbuzov reactions under moderate conditions. For this reason, the synthesis is being re-configured to allow preparation of dibromides or dihalides, both of which are more reactive.

Several organic diphosphonates with unusual structures have been prepared and their incorporation into MELS is currently being investigated. As the results from these model MELS are determined, further organic diphosphonates will be prepared from compounds which have been synthesized in these laboratories. In the near future, conductivity and methanol permeability studies will be carried out in collaboration with Assoc. Prof. J.F. Lomax and Prof. M. Wintersgill.

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 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).

$MOCl_2 + 2x\ H_3PO_4 + (1\text{-}x)\ 1 \rightarrow$

$M(PO_4)_{2x}[(PO_3)\text{-}(CH_2)_n\text{-}CHX\text{-}(CH_2)_n\text{-}(PO)_3]_{1\text{-}x} + 2\,HCl + H_2O$

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.

Photochemical Study of Cyano-Isocyanide-Phosphine Complexes 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, (^{5}-C_5H_5)Fe(CO)(CN)($CNCH_3$), in the presence of a slight excess of triphenylphosphine at room temperature gave the desired product [(^{5}-C_5H_5)Fe(CN)($CNCH_3(PPh_3)$] with loss of one equivalent of carbon monoxide. Two additional products have been obtained, however: (^{5}-C_5H_5) $Fe(CNCH_3)_2(CN)$ and (^{5}-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. Manuscipts 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.

Charge Delocalization in Fluoromethyl Fluorophenols: Model Compounds for Fluorinated Tyrosines

RESEARCHERS: Assistant Professor Joseph J. Urban and CPT 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.

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Computational Analyses of 4-Aminopyridine and its Analogues

RESEARCHER: CPT Robert L. von Tersch, PhD, USA and Assistant Professor Joseph J. Urban

Tetrodotoxin and saxitoxin are potent neurotoxins affecting the transmission of nerve impulses through their disruption of sodium channels. Aminopyridines, such as 4-amino- or 3,4-diamino-, have been shown by a number of researchers to be efficacious in reversing the effects of these toxins if they are administered shortly after toxin exposure. Even though extensive experimental studies have been performed with the aminopyridines, very little computational analyses have been undertaken in a effort to understand the interactions of these materials with the aqueous biological environment in which they exert their effect. To address this point, we have been studying both gas phase and solvation effects on various neutral and protonated analogues of 4-aminopyridine. All calculations have been performed on a Silicon Graphics Indigo II at AM1 or HF 6-311+G(2d,p) level of theory with and without solvent as implemented in the SPARTAN and Gaussian94 software packages. The results of these calculations are considered with a view toward the possible biological fate of these materials.

Computational Analyses of Ethopropazine Hydrochloride and its Interaction With Human Butyrylcholinesterase

RESEARCHERS: CPT Robert L. von Tersch, PhD, USA, Assistant Professor Joseph J. Urban

Ethopropazine hydrochloride is a tricyclic neuroleptic used to treat Parkinsonism through a unknown

mechanism. Recently this compound has been shown to be a potent inhibitor of the human butyrylcholinesterase enzyme. Studies analyzing the active site gorge of members of the cholinesterase family suggest that the inhibition that is observed derives from the larger volume found in human butyrylcholinesterase. Molecular dynamics (MD) calculations could help to further explain the interaction of ethopropazine hydrochloride with human butyrylcholinesterase. As a prelude to MD studies, high level ab initio calculations have been conducted to generate suitable force-field parameters for ethopropazine hydrochloride.

Research Course Projects

"Developing Methods in Capillary Electrophoresis for Detection of Carbon Monoxide Poisoning"

RESEARCHER: Midshipman 1/C David P. Durkin, Trident Scholar, USN

FACULTY ADVISOR: Assistant Professor Christine L. Copper

This project demonstrates the use of capillary electrophoresis as an improvement to existing methods of analysis for carbon monoxide (CO) in human hemoglobin (Hb).

Current methods for CO analysis are CO-Oximetry and tonometry/gas chromatography, which involve lengthy sample manipulation followed by spectroscopic or gas displacement measurements. These methods are time-consuming and technically difficult because of the many manipulations they require. Capillary electrophoresis (CE), a modern analytical technique, is presented as a faster and easier method to quantify CO in Hb.

Several steps towards the development of a CE procedure to detect CO in blood have been completed. The first step of this analysis involved isolating heme, the CO binding site in Hb, from the Hb molecule. Initially, mixtures of reduced heme and heme-CO were successfully isolated from Hb standards and separated using CE. Finally, reduced heme and heme-CO were isolated from blood samples of CO-related accident victims and analyzed using CE. Differences in the heme-CO signals from blood samples known to contain fatal and non-fatal levels of CO were observed. These differences were quantified by measuring the areas under the peaks representative of reduced heme and heme-CO. Results indicate that an improvement was made to the current methods of CO analysis; especially with regard to low CO levels.

Studies Directed Towards the Preparation of N1'-([F-18]Fluoropropyl)Naltrindole: A Radioligand for Positron Emission Tomographic Studies of Delta Opioid Receptors

RESEARCHER: Midshipmen 1/C Shawn E. Williams and Shawn M. Triggs, USN

FACULTY ADVISER: Assistant Professor Christopher M. Kinter

Binding studies have shown there to be three opioid receptor types (mu, delta, and kappa). The delta opioid receptor has been identified as playing a role in neuropsychiatric, neurodegenrative 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 has the potential for positive impact upon the study of the opioid receptor function in healthy subjects and in a number of patient populations. ([C-11]methyl)naltrindole, an analog of the delta selective ligand naltrindole, has been prepared and has

undergone evaluation as an imaging agent in normal subjects an well as seizure patients. Additionally, the synthesis of fluorinated analogs of naltrindole have been initiated to try to take advantage of the decay characteristics of fluorine-18 relative to carbon-11. ([F-18]fluoroethyl)naltridole has been prepared and is currently undergoing evaluation as a radioligand in positron emission tomography studies. As an extension to this work efforts are currently being directed towards the synthesis of fluoropropylnaltrindole, [F-18]FPrNTI. To dates several different routes have been explored for the synthesis of a precursor compound with the appropriate functional groups to allow introduction of isotopic F-18 by nucleophilic displacement. A precursor compound has ben prepared, albeit in unsatisfactory yields. Future work will focus on optimizing the synthetic sequence and exploring the conditions necessary for producing radioactively labeled [F-18]FPrNTI.

CO_2 Ocean Disposal: Mechanisms, Methods, and Effects

RESEARCHER: Midshipman 1/C Jennifer Werner,USN

FACULTY ADVISER: Assistant Professor Daniel W. O'Sullivan and Commander W. Wright

SPONSOR: Oceanography Department Capstone Research

The ocean is a vast resource, covering nearly 70% of the Earth. It has many characteristics which make it suitable for the disposal of carbon dioxide. Increased burning of fossil fuels has caused concentrations of CO2 in the atmosphere to increase annually. An injection of CO2 below the thermocline would be an effective and ecologically safe method of alleviating this problem. The residence time using this method is estimated at 600-1000 years. The residence time of carbon dioxide is dependent on the concentration of carbonates. Carbonates in the ocean neutralize CO2 and form bicarbonate. The formation of hydrates when CO2 enters the ocean could cause the formation of a lake of disposed CO2 on the ocean floor. This would further increase the residence time. There appears to be a number of suitable sites throughout the world for such disposal. Interaction of the CO2 with the atmosphere poses little risk. The overall increase of CO2 in the ocean would only be 0.016%. The environmental effects of such disposal appear to be minimal. Marine life would be affected only slightly in the injection area. Given these factors, ocean disposal of CO2, though logistically difficult, remains an option for ridding the atmosphere of excess CO2 and slowing the global warming of the Earth.

Conformational Analysis of Acetylcholine and Related Compounds

RESEARCHER: Midshipman 1/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 and NMR studies that have been reported in the literature provide a hypothesized "bound conformation" (to the nicotinic acetylcholine receptor). 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 have been employed to determine the difference in energy

between the bound and unbound conformations of acetylcholine. The results indicate that the bound conformation reported in the previous NMR work lies significantly above the ground state in energy. This suggests that further experimental work is needed to establish the bioactive conformation of acetylcholine when bound to its receptor. In addition, this work established the effects of substituents (N-methyls) and the surrounding environment on the conformational preferences of acetylcholine and similar systems.

Publications

BODNAR, John W., Associate Professor, Programming the Fly (Computer program). The BioQUEST Library. The Press Project, University of Maryland, College Park. Vol. V (1997).

A pilot project simulation developed to investigate how well current theory and experimental data could be integrated into a coherent mechanism for programming Drosophila embryogenesis. The bioQUEST Library is a compendium of computer-based tools, simulations, and textual materials that supports collaborative, research-like investigations in biology classrooms and laboratories.

BODNAR, John W., Associate Professor, Programming the Drosophila Embryo. *Journal of Theoretical Biology* 188, (1997) 391-445.

A developmental program is a process which depends both on genetic information contained in the organismal genome and epigenetic information stored in the egg. Genetic information can define what the egg will become, but it is the epigenetic program that defines how that occurs. Therefore, a critical step in understanding the mechanisms of development is in defining that epigenetic program - so that given the egg one can predict not only how the embryo will develop but also how that embryo evolved from its ancestors. Based on the assumption that a developmental program shares many characteristics with a computer program, I have found that current theory on developmental programming is sufficiently robust and sufficient experimental data is available to write a computer program to calculate a developmental program. I first present an underlying generic method for computing the egg based on gene switching in a single cell cycle and repetitive switching during multiple cell cycles. I then apply that method to show that common sets of initial conditions and genetic networks found in many organisms can program differentiated cells to form a "French flag", double the number of existing stripes, and draw a single line of cells. Thirdly, I show that these generic programs can be applied specifically to the *Drosophila* egg to compute fruitfly embryogenesis up to the cellular blastoderm. Finally, I show how the *Drosophila* program can be modified - in effect de-evolved - to compute embryogenesis of a hypothetic short germ band insect precursor. By going from very general principles to a method that can compute the cascade of genetic networks in a real organism, I provide a new calculational tool that can apply current theory to current experimental data to study the evolution of developmental programs.

BODNAR, John W., Associate Professor, Jeffrey Killian, Michael Nagle, and Suneil Ramchandani. Deciphering the Language of the Genome. *Journal of Theoretical Biology* 189, (1997) 183-193

The noncoding DNA in eukaryotic genomes encodes a language which programs organismal growth and development. We show that a linguistic and cryptographic approach can be used to deduce the syntax of this programming language for gene regulation and to compile a dictionary of enhancers which form its words.

CAMPBELL, Mark L., Associate Professor, "Kinetics of the Termolecular Insertion Reaction of Ground State Rhodium with Methane," *Journal of the American Chemical Society*, 119 (1997), 5984-5985.

The gas-phase removal rate constants for the reaction of ground state rhodium ($a^4F_{9/2}$) with methane in argon buffer are reported as a function of total pressure. The pressure dependence indicates a termolecular insertion mechanism. The limiting low-pressure third-order rate constant, k_o, the limiting high-pressure second-order rate constant, k_∞, and broadening factor, Fc, for the

reaction in argon buffer at room temperature are $(5.3\pm0.9)\times10^{-31}$ molecule^{-2}cm^{6}s^{-1}, $(6.7\pm0.7)\times10^{-13}$ molecule^{-1}cm^{3}s^{-1}, and 0.93±0.14, respectively.

CAMPBELL, Mark L., Associate Professor, co-author, "Temperature Dependent Study of the Kinetics of $Sc(a^2D_{3/2})$ with O_2, N_2O, CO_2, NO and SO_2" *Chemical Physics Letters*, 274 (1997), 7-12.

The gas phase reactivity of $Sc(a^2D_{3/2})$ with O_2, N_2O, CO_2, NO and SO_2 in the temperature range 298 - 523 K is reported. The bimolecular rate constants (in molecule^{-1}cm^{3}s^{-1}) are described in Arrhenius form by $k(O_2) = (1.7\pm0.4)\times10^{-10}\exp(-7.9\pm0.7$ kJ/mole/RT), $k(N_2O) = (1.7\pm0.3)\times10^{-10}\exp(-12.0\pm0.6$ kJ/mole/RT), $k(CO_2) = (7.3\pm1.3)\times10^{-11}\exp(-12.3\pm0.6$ kJ/mole/RT) where the uncertainties are ±2 . The rate constants with NO and SO_2 were temperature insensitive with room temperature rate constants of 1.5×10^{-11} and 2.0×10^{-10} molecule^{-1}cm^{3}s^{-1}, respectively. The disappearance rates for all the reactants are pressure independent indicating a bimolecular abstraction mechanism.

CAMPBELL, Mark L., Associate Professor, "Kinetic Study of the Reaction of $Ir(a^4F_{9/2})$ with CH_4, O_2 and N_2O," *Journal of Physical Chemistry*, 101 (1997), 9377-9381.

The gas phase reactivity of ground state $Ir(a^4F_{9/2})$with CH_4, O_2 and N_2O is reported. Iridium atoms were produced by the photodissociation of $[Ir(CO)_2(acac)]$ and detected by laser-induced fluorescence. The reaction rate of the $a^4F_{9/2}$ state with CH_4 is very slow and temperature dependent. The methane reaction is pressure independent indicating a bimolecular reaction. The bimolecular rate constant from 398 - 498 K is described in Arrhenius form by $(7\pm5)\times10^{-11}\exp(-37\pm3$ kJ/mole/RT) molecule^{-1}cm^{3}s^{-1} where the uncertainties represent ±2 . The reaction rates of the $a^4F_{9/2}$ state with O_2 and N_2O are pressure dependent indicating adduct formation. The limiting low pressure third-order, k_o, and limiting high-pressure second-order, k_∞, room temperature rate constants with O_2 in nitrogen buffer are $(4.8\pm1.6)\times10^{-30}$ molecule^{-2}cm^{6}s^{-1} and $(3.6\pm0.4)\times10^{-12}$ molecule^{-1}cm^{3}s^{-1}, respectively. For N_2O, k_o and k_∞ are $(2.2\pm0.5)\times10^{-33}$ molecule^{-2}cm^{6}s^{-1} and $(5.9\pm0.8)\times10^{-15}$ molecule^{-1}cm^{3}s^{-1}, respectively. A lower limit for the activation energy for the abstraction of an oxygen atom from N_2O to produce IrO is estimated at 45 kJ/mole.

CAMPBELL, Mark L., Associate Professor, "Kinetic Study of the Reaction of $Re(a^6S_{5/2})$ with O_2, NO, N_2O and CH_4," *Journal of Physical Chemistry*, 102 (1998), 892-896.

The gas phase reactivity of ground state $Re(a^6S_{5/2})$ with O_2, NO, N_2O and CH_4 is reported. Rhenium atoms were produced by the photodissociation of $Re(CO)_5Cl$ and detected by laser-induced fluorescence. The reaction rate of the $a^6S_{5/2}$ state with O_2 is slow and temperature dependent. The reaction is pressure independent indicating a bimolecular abstraction reaction. The bimolecular rate constant from 296 - 548 K is described in Arrhenius form by $(2.1\pm0.3)\times10^{-11}\exp(-11.6\pm0.6$ kJ/mole/RT) molecule^{-1}cm^{3}s^{-1} where the uncertainties represent ±2 . The reaction rate of the $a^6S_{5/2}$ state with NO is pressure dependent indicating adduct formation. The limiting low pressure third-order, k_o, and limiting high-pressure second-order, k_∞, room temperature rate constants with NO in nitrogen buffer are $(3.7\pm0.8)\times10^{-30}$ molecule^{-2}cm^{6}s^{-1} and $(7.0\pm0.8)\times10^{-12}$ molecule^{-1}cm^{3}s^{-1}, respectively. There is no evidence of chemical reaction for the ground state of rhenium with N_2O or CH_4 up to a temperature of 548 K.

CAMPBELL, Mark L., Associate Professor, "Gas Phase Kinetics of Ground State Platinum with O_2, NO, N_2O and CH_4," *Journal of the Chemical Society, Faraday Transactions*," 94 (1998), 353-358.

The gas phase reactivity of ground state platinum with O_2, NO, N_2O and CH_4 is reported. Platinum atoms were produced by the photodissociation of $[Pt(CH_3)_3(C_5H_4CH_3)]$ and detected by laser-induced fluorescence. The reaction rates of platinum with all the reactants are pressure dependent indicating adduct formation; however, the reaction with N_2O has a bimolecular component. The room temperature limiting low pressure third-order rate constants in argon buffer are $(2.3\pm0.2)\times10^{-31}$ molecule^{-2}cm^{6}s^{-1}, $(4.3\pm0.4)\times10^{-31}$ molecule^{-2}cm^{6}s^{-1}, $(3.7\pm0.5)\times10^{-31}$ molecule^{-2}cm^{6}s^{-1} and $(2.1\pm0.9)\times10^{-28}$ molecule^{-2}cm^{6}s^{-1} for O_2, NO, N_2O and CH_4, respectively, where the uncertainties are ±2 . The limiting high pressure second-order rate constants are $(2.5\pm0.5)\times10^{-12}$ molecule^{-1}cm^{3}s^{-1}, $(2.3\pm0.8)\times10^{-11}$ molecule^{-1}cm^{3}s^{-1}, $(2.3\pm0.3)\times10^{-12}$ molecule^{-1}cm^{3}s^{-1} and $(6.3\pm0.3)\times10^{-12}$ molecule^{-1}cm^{3}s^{-1} for O_2, NO, N_2O and CH_4, respectively. The second-order rate constant for the abstraction channel for the reaction with N_2O at 296 K is approximately 1×10^{-13} molecule^{-1}cm^{3}s^{-1}.

CHEEK, Graham T., Professor, "Electrodeposition of Tantalum and Niobium from Room-Temperature Chloroaluminate Molten Salt Systems," *Proceedings of the Electrochemical Society*, Volume 97-27, 1998.

The electrochemical reduction of $NbCl_5$ and $TaCl_5$ has been studied in the room-temperature aluminum chloride : 1-ethyl-3-methylimidazolium chloride molten salt system. In contrast to the rather simple behavior seen in the basic melt, reduction in the acidic melts occurs by a complex series of partially-resolved steps. Under conditions in which $Al_2Cl_7^-$ is reduced (acidic melts), niobium and tantalum can be co-deposited with aluminum, although in relatively small amounts (<5% of Al). The effect of fluoride addition on niobium reduction has been briefly investigated.

COPPER, Christine L., Assistant Professor and KOUBEK, Edward, Professor "A Kinetics Experiment to Demonstrate the Role of a Catalyst in a Chemical Reaction: A Versatile Exercise for General or Physical Chemistry Students," *J. Chem. Educ.*, 1998, *75*, 87-90.

A kinetics experiment for general or physical chemistry students is presented. The common iodine clock reaction is modified and the initial rate method is used to observe the role of a catalyst in the reaction through activation energy calculations. An experimental procedure is designed such that students can determine the order with respect to each reactant and evaluate the mechanism that has been previously reported for this reaction. Furthermore, students use experimental results to calculate the rate constants of the uncatalyzed and catalyzed (independent of the uncatalyzed) reactions.

COPPER, Christine L., Assistant Professor, "Capillary Electrophoresis: Part I: Theoretical and Experimental Background," *J. Chem. Educ.*, 1998, *75*, 343-347.

Separation is the cornerstone of many areas of chemistry. Quite often, the goal of a chemical experiment is to isolate and analyze a particular compound. Capillary electrophoresis (CE) is emerging as a powerful separation tool.

Separation in CE is based on differences in solute mobilities when an electric field is applied across a separation buffer solution. Compared to conventional liquid chromatographic methods, CE offers advantages of high efficiency, short analysis time, simple apparatus, small sample and separation buffer volumes, and ease in changing separation buffer. Additionally, selectivity in CE separations can be easily altered through the use of various separation buffer additives.

COPPER, Christine L., Assistant Professor, Whitaker, K.W. "Capillary Electrophoresis: Part II: Applications," *J. Chem. Educ.*, 1998, *75*, 347-351.

Since its advent, capillary electrophoresis (CE) has been used to solve many chemical separation problems. Isolation and identification of components in samples ranging from human cells to shale oil have been achieved using CE.

A wide variety of applications of CE have appeared in the literature. Many of these applications are presented in this article so as to demonstrate the power and versatility of CE. Separations of ionizable species including numerous small anions, proteins, and biopolymers are presented. Packed capillary and affinity CE methods are also discussed. Examples of the selectivity and resolving power of additives such as micelles and cyclodextrins are provided. Finally, the "future" of CE, including a examples of "CE on a chip," is discussed.

DURKIN, D.P., Midshipman First Class, USN and COPPER, Christine L., Assistant Professor, "Developing Methods in Capillary Electrophoresis for the Detection of Carbon Monoxide Poisoning," USNA Trident Scholar Project Report #255, 1998.

This project demonstrates the use of capillary electrophoresis as an improvement to existing methods of analysis for carbon monoxide (CO) in human hemoglobin (Hb).

Current methods for CO analysis are CO-oximetry and tonometry/gas chromatography, which involve lengthy sample manipulation followed by spectroscopic or gas displacement measurements. These methods are time-consuming and technically difficult because of the many manipulations they require. Capillary electrophoresis (CE), a modern analytical technique, is presented as a faster and easier method to quantify CO in Hb.

Several steps towards the development of a CE procedure to detect CO in blood have been completed. The first step of this analysis involved isolating heme, the CO binding site in Hb, from the Hb molecule. Initially, mixtures of reduced heme and heme-CO were successfully isolated from Hb standards and separated using CE. Finally, reduced heme and heme-CO were

isolated from three blood samples of CO-related accident victims and analyzed using CE. Differences in the heme-CO signals from blood samples known to contain fatal and non-fatal levels of CO were observed. These differences were quantified by measuring the areas under the peaks representative of reduced heme and heme-CO. Results indicate that an improvement was made to the current methods of CO analysis.

ELERT, Mark L., Professor, co-author, "Investigation of Detonation Properties by Molecular Dynamics Simulations," *(Russian) Chem. Phys. Reports*, 17 (1998) 185-190.

During the past few years, molecular dynamics simulations have been shown to provide a unique method for studying the behavior of condensed matter at the atomic scale in the presence of shock waves. In particular, a model diatomic system employing a Reactive Empirical Bond Order (REBO) potential energy function has been developed which produces reasonable values for shock wave velocity, peak temperature and density, and other properties of a chemically sustained shock wave. This model system provides an excellent mechanism for exploring the effect of specific changes in the properties of an energetic material undergoing shock-induced initiation. In particular, the potential energy function can be modified to systematically vary the amount of energy released in the model. The results of such a study are presented here. The minimum energy release necessary to support a chemically sustained shock wave is reported, as well as the dependence of front velocity, reaction zone temperature, and density on the magnitude of the energy release.

FITZGERALD, Jeffrey P., Associate Professor, coauthor, "Canted Ferromagnetism and Other Magnetic Phenomena in Square-Planar, Neutral Manganese(II) and Iron(II) Octaethyltetraazaporphyrins," *Journal of the American Chemical Society*, *120*,1998, 4662-4670.

Iron(II) octaethyltetraazaporphyrin has been discovered to exist as two polymorphs at room temperature, α- and β-Fe(OETAP). This has been established by X-ray powder diffraction and scanning electron microscopy. Both ac and dc SQUID magnetometry show that the α phase is a soft ferromagnet with T_{curie} = 2.8 K. The β phase possesses the same number of unpaired spins and a similar g value, but it does not order above ~1 K. Zero-field splitting is likely competing with ferromagnetic coupling in this compound. ^{57}Fe Mossbauer spectroscopy has been used to support the local structural similarity between the two phases and to study the ferromagnetic transition. The isomorphous manganese analogue of α-Fe(OETAP), α-Mn(OETAP), expected to be a ferromagnet with a higher T_{curie}, exhibits many characteristics of ferromagnetism, notably hysteresis at 1.8 K with H_{coer} = 2.5 kG and M_{rem} = 4 kemu-G/mol. However, in contrast to ferromagnetic α-Fe(OETAP), α-MnETAP) shows strongly frequency-dependent ac susceptibility in the range from 1 to 1000 Hz, indicating that it exists in a spin-glass-like state. This result underscores the need for frequency-dependent ac magnetometry to fully characterize ferromagnetic molecular materials.

HARRISON, Judith A., Associate Professor, "Properties of Capped Nanotubes When Used as SPM Tips", *Journal of Physical Chemistry B*, 101 (1997), 9682-9685.

The utility of hemispherically capped single-wall carbon nanotubes for use as scanning force microscope tips is investigated for the first time using molecular dynamics. These simulations show that [10,10] armchair nanotubes recover reversibly after interaction with a hydrogen-terminated diamond (111) substrate. The [10,10] tube exhibits two mechanisms for releasing stresses induced by indentation: a marked inversion of the capped end, from concave to convex, and finning along the tube's axis.

HARRISON, Judith A., Associate Professor, "Atomistic Simulations of the Nanometer-Scale Indentation of Amorphous-Carbon Thin Films", *J. Vac. Sci. Tech A.*, 15 (1997) 936-940.

Molecular dynamics simulations are used to examine the nanometer-scale indentation of a thin film of amorphous carbon with a nonrigid sp^3-bonded carbon tip. The simulations show in detail the atomic-scale mechanism of the indentation process and compare the bonding character of the film before and after indentation. The computationally determined elastic modulus of the amorphous-carbon film is found to be 243 GPa, in good agreement with experiment.

HARTMAN, JudithAnn R., Assistant Professor, US Patent 5,741,358, "Corrosion Inhibiting Composition for Treating Asbestos Containing Materials."

A composition for transforming a chrysotile asbestos-containing material into a non-asbestos material is

disclosed, wherein the composition comprises water, at least about 30% by weight of an acid component, optionally a source of fluoride ions, and a corrosion inhibiting amount of thiourea, a lower alkylthiourea, a C_8-C_{15} alkylpyridinium halide or mixtures thereof. A method of transforming an asbestos-containing building material, while part of a building structure, into a non-asbestos material by using the present composition also is disclosed.

KOUBEK, Edward, Professor, "Acid Base Chemistry of the Aluminum Ion in Aqueous Solution", *Journal of Chemical Education* 75, 1998, 60.

This article describes a new classroom demonstration which can be used to illustrate the amorphoteric behavior of ions in aqueous solution. A discussion of the acid-base chemistry of the process is also given.

COPPER, Christine L. Assistant Professor and KOUBEK, Edward, Professor "A Kinetics Experiment To Demonstrate the Role of a Catalyst in a Chemical Reaction", *Journal of Chemical Education* 75, 1998, 87-90.

Most general and physical chemistry texts explain that a catalyst significantly speeds up a chemical reaction by lowering the activation energy of the reaction (typically by providing an alternate pathway from reactants to products). Although this statement seems reasonable, students rarely have a chance to experimentally test its validity. We find that by modifying the common iodine clock reaction, students can use the initial rate method to observe the role of a catalyst in a chemical reaction via activation energy calculations, and evaluate a proposed mechanism. Furthermore, they can determine the order with respect to each reactant and the rate constants of the noncatalyzed and catalyzed (independent of the noncatalyzed) reactions.

O'SULLIVAN, D. W., Assistant Professor, " The Distribution and Redox Chemistry of Iron Across an Oxic/Anoxic interface in the Pettaquamscutt Estuary", *Estuarine and Coastal Shelf Science*, 45,(December, 1997), 769-788.

A series of high resolution (10 cm) vertical profiles of iron were determined across the oxic/anoxic boundary in the Lower Pond of the Pettaquamscutt Estuary. Selective chemical treatments and multiple analytical methods were used to detemine the oxidation state and lability of iron across the oxic/anoxic boundary. The vertical distributions of dissolved and total iron were determined by atomic absorption spectroscopy, and dissolved Fe(II) and reducible iron were determined using a modified Ferrozine spectrophotometric method. Well developed maxima of total dissolved iron $\approx$ 7.5 μM occurred within the oxic/anoxic transition zone. Analysis of Fe(II) by the FZ method indicates that more than 95% of the dissolved iron determined by atomic absorption spectroscopy within the maximum is in the form of Fe(II). The concentration of dissolved Fe(II) ranged from $<$ 4 nM in oxygenated surface waters to between 7 and 8 μM at the total dissolved iron maximum.

Both dissolved and total iron samples were treated with Ascorbic acid to quantify the fraction of iron that was reducible in this system. Dissolved iron is quantitatively reduced to Fe(II) by 3.5 m, and particulate iron was almost completely dissolved by 6 m. Thermodynamic speciation calculations indicate that the dominant species of Fe(II) in the anoxic waters is the $Fe(HS)^+$ complex. In addition the concentration of Fe(II) in the anoxic zone appears to be controlled by precipitation of a sulfide phase, the ion activity product for waters below 7 m is in good agreement with the solubility product of mackinawite.

The vertical distribution of oxidation states of the metals indicates non-equilibrium conditions due to microbiological and chemical processes occurring in the redox transition zone. A one-dimensional vertical, eddy diffusion model is presented that incorporates redox reactions of iron, sulfide, and oxygen. The modeling suggests the maximum in Fe(II) can be achieved through inorganic oxidation and reduction reactions, however the depth at which the maximum occurs is sensitive to sulfide oxidation which appears to be dominated by biological oxidation. The magnitude of the Fe(II) maximum depends on the flux of iron into the basin, and reductive dissolution of particulate iron.

O'SULLIVAN, D. W., Assistant Professor, Co-Author, Invited , "The Carbon Dioxide System in the Arabian Sea", *EOS-ABSTRACT*, 79(1), (January, 1998), pg. OS51.

In 1995 we participated on a number of research cruises in the Arabian Sea as part of the Joint Global Ocean Flux Study sponsored by the National Science Foundation. This paper gives the results of our total inorganic carbon dioxide (TCO_2), total alkalinity (TA) and potentiometric pH measurements made on Arabian Sea water samples during these cruises. Measurements made on Certified Reference Material indicate that the reproducibility of the measurements was $\pm$ 0.007 in pH,

3.2 mol kg^{-1} in TA, and ± 1.2 mol kg^{-1} in TCO_2 (N = 180). The surface measurements of pH and normalized TCO_2 and TA were quite uniform throughout the year (pH = 8.0 ± 0.05, $NTCO_2$ = 2200 ± 20 mol kg^{-1} and NTA = 2300 ± 8 mol kg^{-1}). The larger variations in $NTCO_2$ in the surface waters are related to changes due to primary production and the upwelling in the coastal waters. The depth profiles of pH, pCO_2, TA, and TCO_2 were similar to those in the Indian Ocean. The components of the carbonate system (CO_2, HCO_3^-, CO_3^{2-}) and the saturation state ( ) for calcite and aragonite were determined from the measurements of TA and TCO_2. The waters below 600 m and 3400 m in the Arabian Sea were undersaturated (< 1.0), respectively, for aragonite and calcite. The CO_2 measurements have been combined with the nutrient data to examine the stoichiometric ratios of C/N, C/P, C/O_2, and C/SiO_2 of the waters. Marked differences were found for the waters above and below the oxygen minimum zone. The surface waters results have been used to develop the following equation for the production of phytoplankton in the Arabian Sea.

$$126\ CO_2 + 140\ H_2O + 14\ HNO_3 + H_3PO_4 + 13\ SiO_2 \rightarrow (CH_2O)_{116}(CH_2)_{10}(NH_3)_{14}(H_3PO_4)(SiO_2)_{13} + 159\ O_2$$

These results, together with the organic material data collected from the sediment traps, should be useful in characterizing the formation and degradation of plant material in the Arabian Sea.

O'SULLIVAN, D. W., Assistant Professor, "Continuous Determination of the Total Inorganic Carbon in Surface Seawater", *Marine Chemistry*, 60, (February, 1998), 75-83.

An automated sampling and analysis system was developed to determine the total inorganic carbon (TCO_2) in seawater. Measurements are performed on subsamples taken from the shipboard flowing seawater line. The flowing TCO_2 system ($FTCO_2$) automatically acidifies and strips the CO_2 out of a know volume of sea water and determines the concentration by integrating the infra red (IR) absorbance. Laboratory results have demonstrated an analytical precision of 2 - 5 µM in TCO_2 for this system. Intercomparison of TCO_2 measurements with the $FTCO_2$ system and the SOMMA(Single Operator Multimetabolic Analyzer) agreed within their respective uncertainties. The TCO_2 in surface seawater was determined continually on the flowing seawater line aboard the R/V Thompson in the Arabian Sea. The average difference between the TCO_2 determined on surface seawater with the flowing system and the SOMMA was 6.5 ± 8.7 µM. Measurements made with the flowing system on CRMs agreed to ± 3 µM with the assigned value. TCO_2 in surface waters in the Arabian Sea varied by as much as 40 µM on short spatial and temporal scales. Although the accuracy of the present design of the $FTCO_2$ system is not as good as the SOMMA, the surface TCO_2 variability with time and space is captured with the $FTCO_2$ system and is completely missed by discrete measurements made on CTD casts. Continual measurements of TCO_2 will be valuable in characterizing the temporal and spatial changes in the carbon dioxide system in surface ocean waters.

SCHROEDER, Maria J., Assistant Professor, co-author, "Intrinsic Defect Effects on Natural Rubber Permeability," *Rubber & Plastics News*, 27(11), (January 1998), 14-15.

Recent evidence of viral-sized particles passing through ostensibly intact latex rubber films calls into question the ability of latex rubber products to function effectively as protective barriers. The origin of this permeability is presently unknown but all materials can be considered to possess "intrinsic" flaws. By utilizing both fatigue life and tensile strength measurements, intrinsic flaw sizes were deduced for natural rubber of varying grades (DPNR, SMR-L, SMR-10) and guayule rubber (GR). The results indicated that the rubber materials contaminated with less debris had smaller intrinsic flaws supporting previous studies of carbon black and compounding ingredient additions to natural rubber. Preliminary evidence of the permeation of viral-sized particles through intact natural rubber films is also reported.

SHADE, Joyce E., Professor, co-author "Ligand Exchange Photochemistry of $M_2(CO)_4(\mu\text{-}\eta^5,\eta^5\text{-}C_5H_4CH_2C_5H_4)$ (M = Fe or Ru) and Thermal Acetylene Exchange of $Ru_2(CO)(\mu\text{-}CO)[\mu\text{-}\eta^1\text{:}\eta^1\text{-}(C_6H_5)_2C_2](\mu\text{-}\eta^5,\eta^5\text{-}C_5H_4CH_2C_5H_4)$. The Molecular Structures of $Ru_2(CO)(\ \text{-}C_6H_5)(\mu\text{-}CO)[\mu\text{-}P(C_6H_5)_2](\mu\text{-}\eta^5,\eta^5\text{-}C_5H_4CH_2C_5H_4)$ and $Ru_2(CO)(\mu\text{-}CO)[\mu\text{-}\eta^1\text{:}\eta^3\text{-}(C_6H_5C{=}C(C_6H_5)O](\mu\text{-}\eta^5,\eta^5\text{-}C_5H_4CH_2C_5H_4)$." *Journal of Organometallic Chemistry*, 547 (1997) 23-33.

Photolysis of $Fe_2(CO)_4(\mu\text{-}\eta^5,\eta^5\text{-}C_5H_4CH_2C_5H_4)$ in the presence of phosphines or phosphites results in the

formation of simple carbonyl substitution products $Fe_2(CO)(\mu\text{-}CO)_2L(\mu\text{-}\ ^5,\ ^5\text{-}C_5H_4CH_2C_5H_4)$ or $Fe_2(\mu\text{-}CO)_2L_2(\mu\text{-}\ ^5,\ ^5\text{-}C_5H_4CH_2C_5H_4)$. Acetylenes react photochemically with the diriron compound to give vinylketone bridged derivatives of the form: $Fe_2(CO)(\mu\text{-}CO)[\mu\text{-}\ ^1:\ ^3\text{-}RC{=}C(R)CO](\mu\text{-}\ ^5,\ ^5\text{-}C_5H_4CH_2C_5H_4)$, where R = CH_3O_2C and C_6H_5. Reaction of $Ru_2(CO)_4(\mu\text{-}\ ^5,\ ^5\text{-}C_5H_4CH_2C_5H_4)$ with triphenylphosphine under photochemical conditions resulted in the loss of two carbon monoxide ligands and P-C insertion by ruthenium to yield $Ru_2(CO)(\text{-}C_6H_5)(\mu\text{-}CO)[\mu\text{-}P(C_6H_5)_2](\mu\text{-}\ ^5,\ ^5\text{-}C_5H_4CH_2C_5H_4)$. Photolysis of $Ru_2(CO)_4(\mu\text{-}\ ^5,\ ^5\text{-}C_5H_4CH_2C_5H_4)$ with diphenylacetylene gave previously reported $Ru_2(CO)_2(\mu\text{-}CO)[\mu\text{-}\ ^1:\ ^1\text{-}(C_6H_5)_2C_2](\mu\text{-}\ ^5,\ ^5\text{-}C_5H_4CH_2C_5H_4)$ and an air-oxidation product, $Ru_2(CO)_2(\mu\text{-}CO)[\mu\text{-}\ ^1:\ ^3\text{-}(C_6H_5)C{=}C(C_6H_5)O](\mu\text{-}\ ^5,\ ^5\text{-}C_5H_4CH_2C_5H_4)$. The diphenylacetylene derivative underwent acetylene exchange, but did not undergo exchange with triphenylphosphine. All compounds have been characterized by spectroscopic methods, elemental analysis and/or mass spectroscopy. The molecular structures of two ruthenium compounds were determined by X-ray crystallography. $Ru_2(CO)(\text{-}C_6H_5)(\mu\text{-}CO)[\mu\text{-}P(C_6H_5)_2](\mu\text{-}\ ^5,\ ^5\text{-}C_5H_4CH_2C_5H_4)$: monoclinic, $P2_1/c$, a = 13.902(3) Å, b = 13.283(3) Å, c = 14.426(4) Å, = 101.62(2)°, V = 2609(1) Å^3, z = 4, $R(F)$ = 3.98%. $Ru_2(CO)(\mu\text{-}CO)[\mu\text{-}\ ^1:\ ^3\text{-}(C_6H_5C{=}C(C_6H_5)O](\mu\text{-}\ ^5,\ ^5\text{-}C_5H_4CH_2C_5H_4)$: orthorhombic, $Pccn$, a = 15.000(4) Å, b = 15.662(4) Å, c = 19.053(4) Å, V = 4476(2) Å^3, z = 8, $R(F)$ = 3.05%.

TRULOVE, Paul C., Assistant Professor, co-author, "Electrodeposition and Nucleation Studies of Chromium from Ambient-Temperature Chloroaluminate Molten Salts," in Fundamental Aspects of Electrochemical Deposition and Dissolution Including Modeling, Paunovic, M.; Datta, M.; Matlosz, M.; Osaka, T.; Talbot, J. B., Eds.; The Electrochemical Society: Pennington NJ, 1997; Vol. 97-27

The electrochemical reduction of chromium (II) in acidic AlCl3:EMIC (1-ethyl-3-methylimidazolium chloride) room temperature molten salt results in codeposition of aluminum and chromium. Two reduction peaks are observed in staircase cyclic voltammetry, with the first peak significantly smaller than the second. Constant potential deposition in the region of the first reduction peak results in the formation of of Al-Cr deposits consisting of 40 to 50 a/o Cr present as Cr(0) and Cr(II). Constant potential deposition in the region of second peak results in the formation of aluminum rich Al-Cr deposits. Evaluation of the chronoamperometric transient behavior during electrodeposition shows that the codeposit proceeds via a 3D diffusion controlled progressive nucleation on platinum and tungsten with different kinetic control. Gold, as a substrate, gives a decidedly sharper progressive nucleation mechanism which is under kinetic control.

TRULOVE, Paul C., Assistant Professor, co-author, "Electrodeposition of Niobium and Tantalum from Ambient-Temperature Chloroaluminate Molten Salts," in Fundamental Aspects of Electrochemical Deposition and Dissolution Including Modeling, Paunovic, M.; Datta, M.; Matlosz, M.; Osaka, T.; Talbot, J. B., Eds.; The Electrochemical Society: Pennington NJ, 1997; Vol. 97-27.

The electrochemical reduction of $NbCl_5$ and $TaCl_5$ has been studied in the room-temperature aluminum chloride : 1-ethyl-3-methylimidazolium chloride molten salt system. In contrast to the rather simple behavior seen in the basic melt, reduction in the acidic melts occurs by a complex series of partially-resolved steps. Under conditions in which Al_2Cl_7 is reduced (acidic melts), niobium and tantalum can be co-deposited with aluminum, although in relatively small amounts (<2% of Al). The effect of fluoride addition on niobium reduction has been briefly investigated.

TRULOVE, Paul C., Assistant Professor, co-author, "Investigations of the Electrodeposition of Aluminum and Chromium from an Acidic Chloroaluminate Molten Salt," in Proceedings of the 5th International Meeting on Molten Salt Chemistry and Technology, 1997.

The electrochemical reduction of chromium (II) in acidic AlCl3:EMIC (1-ethyl-3-methylimidazolium chloride) room temperature molten salt results in codeposition of aluminum and chromium. Two reduction peaks are observed in staircase cyclic voltammetry, with the first peak significantly smaller than the second. Constant potential deposition in the region of the first reduction peak results in the deposition of chromium rich BCC chromium-aluminum alloys. Constant potential deposition in the region of second peak results in the formation of aluminum rich FCC chromium-aluminum alloys. Evaluation of the chronoamperometric transient behavior on platinum during electrodeposition of the first peak shows that the codeposition of chromium and aluminum proceeds via three-dimensional progressive nucleation with diffusion controlled growth.

TRULOVE, Paul C., Assistant Professor, co-author, "Microelectrode Evaluation of Transition Metal-

Aluminum Alloy Electrodepositions in Chloroaluminate Ionic Liquids" *Journal of the Electrochemical Society*, 145 (1998) 1598-1607.

Chronoamerometric data collected at a 250 um tungsten microelectrode were analyzed under near-steady-state conditions to determine the composition of MAlx alloys (M = Co, Ni, Fe, Cu, and Ag) electrodeposited from 1.5:1.0 AlCl3:1-ethyl-3-methylimidazolium chloride room-temperature ionic liquids. The analysis method relied on the fact that these alloys are produced by an underpotential deposition mechanism. Results were consistent with previous studies showing that CoAlx, FeAlx, and CuAlx systems tended to produce alloys with x~1. Analysis of the NiAlx data was complicated by kinetic phenomena, while data analysis of the AgAlx system was precluded by dendritic growth of the electrodeposit. All the alloy systems showed complex anodic stripping voltammetric behavior, and the nature of the oxidation processes (e.g., metal anodization, alloy anodization, or selective dealloying) are different for electrodeposits produced in specific potential regimes. Nonlinear curve fitting of the chronoamperometric data to the appropriate short-time and long-time equations gave diffusion coefficients from 3.9 x 10-7 to 8.3 x 10-7 cm2/s for the transition metal ions in the ionic liquid electrolyte at ca. 22 C.

URBAN, Joseph J., Assistant Professor, co-author, and CRONIN, Curtis W., midshipman 1/C, USN, co-author, "Conformational Preferences of 2-Phenethylamines. A Computational Study of Substituent and Solvent Effects on the Intramolecular Amine-Aryl Interactions in Charged and Neutral 2-Phenethylamines" *J. Amer. Chem. Soc.*, 119, (1997), 12292-12299.

A computational investigation of the conformational preferences of 2-phenethylamine has been carried out using a variety of techniques. In order to determine the intrinsic (in the absence of a solvent medium) conformational preferences of the 2-phenethylamine system, ab initio calculations at various levels of theory up to the MP2/6-311+G(d,p)//MP2/6-31G(d,p) level were carried out. This is the most sophisticated level of theory that has been applied to this biologically important system to date. In the absence of a solvent medium, phenethylamines prefer a folded gauche conformation for both the charged and neutral amines indicating a favorable interaction between the amino group and the aromatic ring. In order to probe the nature of this intramolecular interaction further the effect of ring substituents on the conformational preferences were studied. The results have been compared to those obtained with semiempirical and molecular mechanics force field methods. The molecular mechanics force fields employing default parameters typically performed poorly for this system, but the results were improved significantly if the electrostatic charges were replaced. The effects of aqueous solvation have also been investigated with the GB/SA and the SM2 continuum solvation models. The best agreement with experiment is obtained when the MP2/6-311+G(d,p)//MP2/6-31G(d,p) results are combined the SM2-calculated solvent effect. Results of nearly the same quality can be obtained if the solvent effect is calculated with the GB/SA solvation model using AM1-CM1A charges.

VON TERSCH, Robert L., Assistant Professor, co-author, "Preparation of Fluorinated Amino Acids with Tyrosine Phenol Lyase: Effects of Fluorination on Reaction Kinetics and Mechanism of Tyrosine Phenol Lyase and Tyrosine Protein Kinase Csk," Biomedical Frontiers of Fluorine Chemistry, Chapter 7, Ojima, I., McCarthy, J. R. and Welch, J. T. (eds),1996, ACS Symposium Series 639, 95-104.

Fluorinated analogues of L-tyrosine were synthesized enzymatically from the corresponding fluorinated phenols and ammonium pyruvate using tyrosine phenol-lyase. The isolated yields ranged from 0.5 - 2.8 g per liter (10 - 42% based on phenol added). The structure of 2,3,6-trifluoro-L-tyrosine hydrochloride hydrate was determined by x-ray crystallography. The fluorinated tyrosines are good substrates for the - elimination reaction catalysed by tyrosine phenol-lyase, except for 3,5-difluoro and the trifluorotyrosines. Fluorine at the 3-position increases the steady-state concentration of quinonoid intermediate absorbing at 500 nm compared to L-tyrosine, while fluorine at the 2-position dramatically decreases the intensity of the 500 nm absorbance peak. Reaction of tyrosine phenol-lyase with , , -trifluoroalanine and fluorophenols generates transient ring-fluorinated , -difluorotyrosines. 2,3,5-Trifluoro-L-tyrosine synthesized using tyrosine phenol-

lyase was incorporated into a peptide substrate for tyrosine protein kinase Csk, and the resultant fluorinated peptide was found to be a good substrate for phosphorylation, suggesting that general base catalysis with early deprotonation is not involved in the reaction mechanism.

VON TERSCH, Robert L., Assistant Professor, co-author, "Effects of Tyrosine Ring Fluorination on Rates and Equilibria of Formation of Intermediates in the Reactions of Carbon-Carbon Lyases," *Eur. J. Biochem.* 22, 658-663, 1997.

The interactions of ring fluorinated analogs of tyrosine with tyrosine phenol-lyase and tryptophan indole-lyase (tryptophanase) were studied by rapid-scanning stopped-flow spectrophotometry. The reaction of L-tyrosine with tyrosine phenol-lyase resulted in rapid formation of a small absorbance peak at 500 nm, attributed to a quinonoid intermediate. The reaction of 3-fluoro-L-tyrosine with tyrosine phenol-lyase resulted in a peak at 500 nm with much higher absorbance, as did the reaction of 3,5-difluoro-L-tyrosine, due to increased accumulation of quinonoid intermediates. In contrast, complexes with 2-fluoro-L-tyrosine, 2,3-difluoro-L-tyrosine, 2,5-difluoro-L-tyrosine, and 2,6-difluoro-L-tyrosine exhibited much lower absorbance intensity at 500 nm. The rate constant for quinonoid intermediate formation from 3-fluoro-L-tyrosine was comparable to that for L-tyrosine. However, 3,5-difluoro-L-tyrosine reacted to form a quinonoid intermediate at about half the rate of L-tyrosine, while 2,3-difluoro-L-tyrosine reacted at twice the rate of L-tyrosine. In addition, the 2-substituted difluorotyrosines exhibited an intermediate, which was formed rapidly, absorbing strongly at about 340 nm, which is likely due to a *gem*-diamine intermediate. Tyrosine is not a substrate for tryptophan indole-lyase; the reaction of tryptophan indole-lyase with L-tyrosine resulted in formation of external aldimine, which absorb ed at 420 nm, and a very small absorbance peak at 500 nm. 3-Fluoro-L-tyrosine reacted with tryptophan indole-lyase to produce a prominent quinonoid absorbance peak at 500 nm, whereas L-tyrosine, 2-fluoro-L-tyrosine, and all difluoro-L-tyrosines, had a much reduced intensity for this peak. Thus, the presence of ring fluorine substituents in L-tyrosine that are remote from the site of the chemical transformation has significant effects on the rates and equilibria of intermediate formation in the reactions with both tyrosine phenol-lyase and tryptophan indole-lyase. Although it is commonly thought that fluorine substitution will not result in any significant steric effects, our results suggest that the effects of fluorine substitution in the reactions of fluorinated tyrosines with tyrosine phenol-lyase and tryptophan indole-lyase are due to a combination of steric and electronic effects.

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.

In the spring of 1995 we participated in a research cruise on the Arabian Sea as part of the Joint Global Ocean Flux Study (JGOFS) sponsored by the National Science Foundation (NSF). This report gives the results of our total inorganic carbon dioxide (TCO_2), total alkalinity (TA) and potentiometric pH measurements made on Arabian Sea water samples during the cruise. All results were obtained by coulometric and/or potentiometric titration of seawater samples. Measurements made on 35 Certified Reference Material (CRM) samples from two different CRM batches using the WHOI DICE coulometry system indicate that the system has a TCO_2 measurement reproducibility of $\pm$ 1.5 mol kg^{-1}. Analysis of 88 CRM samples using two potentiometry cells at sea indicate that these systems have a reproducibility of $\pm$ 2.0 μmol kg^{-1} in TCO_2, 2.9 mol kg^{-1} in TA, and $\pm$ 0.007 in pH.

Presentations

BODNAR, John W., Assistant Professor, "Programming the Drosophila Embryo," Developmental Biology Gordon Conference, Tilton, New Hampshire, June 1997.

BODNAR, John W., Assistant Professor, "Programming the Embryo from Genotype to Phenotype," Duke University, Zoology Department, March '98

BODNAR, John W., Assistant Professor, "Programming the Embryo from Genotype to Phenotype," Center for Advanced Research in Biotechnology, April '98

CAMPBELL, Mark L., Associate Professor, "Reactions of Gas Phase Transition Metal Atoms," The Catholic University of America, 21 November 1997.

CAMPBELL, Mark L., Associate Professor, "Temperature-dependent Kinetics of $Zr(a^3F_2)$," 215th ACS National Meeting, Dallas, Texas, 1 April 1998.

CHEEK, Graham T., Professor, "Electrodeposition of Tantalum and Niobium from Room-Temperature Chloroaluminate Molten Salt Systems," (Poster Session) Gordon Conference on Molten Salts and Liquid Metals, Henniker, New Hampshire, 3 August 1997.

CHEEK, Graham T., Professor, "Electrochemical Studies of Tantalum and Niobium in Chloroaluminate Systems," (Poster Session) Gordon Conference on Electrochemistry, Ventura, California, 20 January 1998.

CHEEK, Graham T., Professor, "Electrochemical Studies of Tantalum and Niobium in Chloroaluminate Systems," 193rd Electrochemical Society Meeting, San Diego, California, 5 May 1998.

CHEEK, Graham T., Professor, "Structure of Niobium and Tantalum Complexes in Room-Temperature Chloroaluminate Molten Salts Using XAFS," 193rd Electrochemical Society Meeting, San Diego, California, 5 May 1998.

COPPER, Christine L, Assistant Professor, "Cyclodextrin-Modified Capillary Electrophoretic Separations of Environmentally Important Molecules," invited presentation at the University of Alaska, Fairbanks, Alaska, July, 1997.

COPPER, Christine L, Assistant Professor, Steele, J.K., Boyd, T.J., "Isolation and Characterization of Metabolic Intermediates from Polycyclic Aromatic Hydrocarbon Biodegradation," paper presented at the Federation of Analytical Chemistry and Spectroscopy Societies Conference, Providence, Rhode Island, October, 1997.

COPPER, Christine L, Assistant Professor, "Capillary Electrophoretic Separations of Biologically Important Molecules," invited presentation at Mary Washington College, Fredericksburg, Virginia, February, 1998.

COPPER, Christine L, Assistant Professor and DURKIN, David P.,Midshipman First Class, USN co-authors "Capillary Electrophoresis as an Improvement of Existing Methods of Analysis for Carbon Monoxide in Hemoglobin," presented at The Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, New Orleans, Louisiana, March 1998.

ELERT, Mark L., Professor, "Molecular Dynamics Investigation of the Effects of Variation in Energy

Release on Detonation Initiation," American Physical Society Conference on Shock Compression of Condensed Matter, Amherst, Massachusetts , July 27 -- August 1, 1997.

ELERT, Mark L., Professor, "Detonation Hugoniot for Ozone from Molecular Dynamics Simulation," American Physical Society Conference on Shock Compression of Condensed Matter, Amherst, Massachusetts, July 27 -- August 1, 1997.

ELERT, Mark L., Professor, "Self-Similar Behavior from Molecular Dynamics Simulations of Detonations," American Physical Society Conference on Shock Compression of Condensed Matter, Amherst, Massachusetts, July 27 -- August 1, 1997.

ELERT, Mark L., Professor, "Detonation Hugoniots from Molecular Dynamics Simulations," American Physical Society National Meeting, Los Angeles, California, 16–20 March 1998.

FERRANTE, Robert F., Associate Professor, co-author, *New Evidence for Low Temperature Crystallization on Amorphous Silicate Grains in Laboratory Cometary Analogs*, 29th Annual Meeting of the Division of Planetary Sciences, American Astronomical Society, Cambridge, Massachusetts, July 1997.

FERRANTE, Robert F., Associate Professor, co-author, *Surface Effects and the Low Temperature Crystallization of Ices*, 215th National Meeting of the American Chemical Society, Dallas, Texas, March 1998.

GOMBA, Frank J., Associate Professor, "Solubility Product Constant" (Demonstration), New England Association of Chemistry Teachers Summer Conference, Johnson State College, Johnson, Vermont, 11-14 August 1997

HARRISON, Judith A., Associate Professor, "Molecular Dynamic Investigations of the Tribology of Hydrocarbons", Air Force Office of Scientific Research/Office of Naval Research (AFOSR/ONR) Tribology Conference, Englewood, Ohio, June 24-26, 1997.

HARRISON, Judith A., Associate Professor, "Molecular Dynamic Investigations of the Tribology of Hydrocarbon Surfaces", Tribology Issues and Opportunities in Microelectromechanical Systems (MEMS), National Science Foundation (NSF) /Air Force Office of Scientific Research (AFOSR) / American Society of Mechanical Engineers (ASME) Workshop, Columbus, Ohio, 9-11 November 1997.

HARRISON, Judith A., Associate Professor, "Friction and Tribochemistry between Diamond Surfaces in Sliding Contact", World Tribology Congress, London, United Kingdom, 8-12 September 1997.

HARRISON, Judith A., Associate Professor, "Molecular Tribology of Hydrocarbon Surfaces: A Molecular Dynamics Investigation", University of Maryland at Baltimore County, Baltimore, Maryland, 8 April 1998

HARRISON, Judith A., Associate Professor, "Molecular Dynamics Investigations of the Tribology of Hydrocarbon Surfaces", Argonne National Lab, Argonne, Illinois, 21 April 1998

HARTMAN, Judithann R, Assistant Professor, co-author, "Electrospray Tandem Mass Spectrometry of Metal-cyclam and Metal-podand Complexes," presented at the 46th American Society for Mass Spectrometry National Meeting, Orlando, Florida, 30 May-4 June 1998.

LOMAX, Joseph F., Associate Professor, "Web Forms for Chemistry Lab," 215th American Chemical Society Meeting, Dallas, Texas, 1 April, 1998.

MCCLEAN, Roy, E., Assistant Professor, "Depletion Kinetics of Nickel Atoms by Sulfur Dioxide,"

presented at the American Chemical Society 215th National Meeting, Dallas, Texas, 1 April 1998.

O'SULLIVAN, Daniel W., Assistant Professor,"The distribution of hydrogen peroxide and methylhydroperoxide over the Pacific and South Atlantic Oceans: Impact on Ozone Chemistry", NASA Pacific Exploratory Mission Tropics Data Workshop, Hampton, Virginia, 15 July, 1997.

O'SULLIVAN, Daniel W., Assistant Professor,"The influence of hydrogen peroxide and methylhydroperoxide on S(IV) chemistry at Christmas Island", NASA Pacific Exploratory Mission Sulfur Chemistry Workshop, National Center for Atmospheric Research, Boulder, Colorado, 4 September, 1997.

O'SULLIVAN, Daniel W., Assistant Professor,"The distribution of hydrogen peroxide and methylhydroperoxide over the Pacific and South Atlantic Oceans: Impact on Ozone Chemistry", University of Maryland, College Park, Maryland, 23 October, 1997.

O'SULLIVAN, Daniel W., Assistant Professor, "The distribution of hydrogen peroxide and methylhydroperoxide over the Pacific and South Atlantic Oceans: Impact on Ozone Chemistry", Special Lecture, SC 485, United States Naval Academy, Annapolis Maryland, 14 November 1997.

O'SULLIVAN, Daniel W., Assistant Professor,"Influence of Deep convection on the distribution of hydrogen peroxide and methylhydroperoxide over the Pacific and South Atlantic Oceans", Chesapeake Biological Laboratory, University of Maryland, Solomons, Maryland, 3 April 1998.

SCHROEDER, Maria J., Assistant Professor, "Particle Diffusion Through Latex Rubber," Gordon Research Conference on Elastomers, New London, New Hampshire, 23 July 1997.

SCHROEDER, Maria J., Assistant Professor, "Workshop on Teaching at Small Universities," University of Wisconsin-Madison, Madison, Wisconsin, 8 April 1998.

SCHROEDER, Maria J., Assistant Professor, "Applications of Analytical Chemistry in the Navy," University of Wisconsin-Madison, Madison, Wisconsin, 9 April 1998.

TRULOVE, Paul C., Assistant Professor, co-author, "The Electrodeposition of Aluminum-Manganese Alloys from Room-Temperature Chloroaluminate Molten Salts," 11th International Symposium on Molten Salts, 193rd Meeting of The Electrochemical Society, San Diego, California, 3-8 May 1998.

TRULOVE, Paul C., Assistant Professor, "Investigation of the Underpotential Deposition of Lead on Gold in Basic and Acidic Room-Temperature Chloroaluminate Molten Salts," 11th International Symposium on Molten Salts, 193rd Meeting of The Electrochemical Society, San Diego, California, 3-8 May 1998.

TRULOVE, Paul C., Assistant Professor, co-author "Electrochemical Studies of Tantalum and Niobium in Chloroaluminate Systems," 11th International Symposium on Molten Salts, 193rd Meeting of The Electrochemical Society, San Diego, California, 3-8 May 1998.

TRULOVE, Paul C., Assistant Professor, co-author, "Structure of Niobium and Tantalum Complexes in Room-Temperature Chloroaluminate Molten Salts Using XAFS," 11th International Symposium on Molten Salts, 193rd Meeting of The Electrochemical Society, San Diego, California, 3-8 May 1998.

TRULOVE, Paul C., Assistant Professor, "Electrodeposition of Metals from Ambient-Temperature Molten Salts," The March Meeting of the National Capital Section of The Electrochemical Society, College Park, Maryland, 17 March 1998.

TRULOVE, Paul C., Assistant Professor, "Applications of Ambient-Temperature Ionic Liquids to Compact Power Sources and Electrodeposition of Advanced Aluminum Alloys," AFOSR/ONR Electrochemistry Science and Technology Review, Ventrua, California, 16-17 January 1998.

TRULOVE, Paul C., Assistant Professor, co-author, "Electrodeposition and Nucleation Studies of Chromium from Ambient-Temperature Chloroaluminate Molten Salts," Fundamental Aspects of Electrochemical Deposition and Dissolution Including Modeling, The 1997 Joint International Meeting, 192nd Meeting of the Electrochemical Society, Paris, France, 31 August – 5 September 1997.

TRULOVE, Paul C., Assistant Professor, "Electrodeposition of Niobium and Tantalum from Ambient-Temperature Chloroaluminate Molten Salts," Fundamental Aspects of Electrochemical Deposition and Dissolution Including Modeling, The 1997 Joint International Meeting, 192nd Meeting of the Electrochemical Society, Paris, France, 31 August – 5 September 1997.

TRULOVE, Paul C., Assistant Professor, co-author, "Investigations of the Electrodeposition of Aluminum and Chromium from an Acidic Chloroaluminate Molten Salt," 5th International Meeting on Molten Salt Chemistry and Technology, Dresden, Germany, 24 - 29 August 1997.

TRULOVE, Paul C., Assistant Professor, co-author, "Niobium and Tantalum deposition from Room-Temperature Chloroaluminate Molten Salts," Gordon Research Conference on Molten Salts and Liquid Metals, New England College, Henniker, New Hampshire, 3 – 8 August 1997.

URBAN, Joseph J., Assistant Professor, and CRONIN, Curtis W., Midshipman, First Class, "Conformational Analysis of the Neurotransmitter Acetylcholine" 215th National Meeting of the American Chemical Society, Dallas, Texas, 30 March, 1998.

Computer Science

Commander Joseph G. Kovalchik, USN
Chairman

During the 1997-1998 academic year, the Computer Science Department continued to conduct important research including that which solidly involved Midshipmen. Student research continued to prosper. Midshipman Eason conducted a Trident Scholar Project 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 and the National Science Foundation funded faculty members of the department. The Computer Science Department had a productive year. Overall, there were seven publications and five presentations.

Sponsored Projects

Advanced Decision Aids

Researcher: Professor Patrick R. Harrison

Sponsor: Office of Naval Research

Decision Aids (DA) are used to support information intensive tasks such as help-deck, diagnosis, training systems, distance education, non-linear tactical planning and training. In large-scale, real-time planning, strategic and tactical situation assessment and other complex domains critical to the Navy, current DA technologies needs to be extended and developed in a variety of ways. In particular, progress is needed in verification and validation, indexing information, reasoning about possible solutions, solution adaptation and the integration of varieties of representations. DA systems rarely can solve complex problems in a stand-alone mode. Rather, they must be integrated with and embedded in other tools. Therefore, DA practitioners must have access to tools that address practical issues in the course of building their applications. These include the ability to identify and consider the merits of alternative forms of solution representation and reasoning including prototyping and simulation support. This program includes building, demonstrating and eventually disseminating such next-generation capabilities.

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 environment. This case based reasoning tool is used 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 interface standards under windows has been delivered. A 32 bit Java based version of this product is now being

developed.

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.

Protein Conformations: New Methods for Global Optimization and Parameter Estimation

Researcher: Associate Professor Andrew T Phillips

Sponsor: National Partnership for Advanced Computational Infrastructure

Key problems in computational biology, including protein and RNA folding and drug docking, involve conformational searching. Current search methods — Monte Carlo, Molecular Dynamics, Simulated Annealing, and Genetic Algorithms — are to slow for protein folding by many orders of magnitude. They get stuck in kinetic traps. This project involves the development and improvement of a new and very different conformational search strategy based on a convex global underestimator (CGU). Two complementary strategies are being investigated: (1) speeding up the CGU method for fast conformational searches, and (2) potential energy function improvement by parameter estimation and by adding atomic detail to the chain representation. To speed up the method, several enhancements are being developed: (a) using a core-directed chain growth method as a front end, (b) using the Han and Baker secondary structure rules, where applicable, to reduce the number of degrees of freedom, and (c) using Appel's method to reduce the number of required energy evaluations. To improve the search method to work with better energy functions, we systematically move away from a simplified model toward more realistic protein models. First, we use multiple spheres per side chain — a united atom representation — to replace the single bead side chains of the simplified model. Second, we use a new parameter estimation method that can simultaneously adjust all the energy function parameters, so as to reduce the difference between the global minimum conformation in the model and the known native conformation for all members of a selected set of proteins.

Independent Research

Synthetic Theater of War Network Analysis

Researcher: CDR J. G. Kovalchik, USN

This research is a cooperative research program with Naval Research Lab Information Technology Divisional Communications System Branch, Integrated Communication Technology, Code 5523. This work is involved with ATM networks, Multicating, and RSVP protocols, in support of the Synthetic Theater of War (STOW) Simulation. Software applications to test commercial ATM network equipment under various qualities of service and traffic discriptors is being developed on Windows NT and LINUX platforms.

The Development of a Physics Knowledge Base for the ANDES Project

Researcher: Midshipman 1/C Damon Eason, USN

Faculty Advisor: Associate Professor Kay G. Schulze

This project is developing a cognitive model of a physicist's knowledge of angular momentum, tongue and circular motion. This model is then used to plan solutions for physics problems. The plans and knowledge are encoded in the CLIPS production language and the results are the necessary equations to solve the problems and a graph of the solution path.

Publications

Harrison, Patrick, Professor, Kovalchik, Joseph G., Assistant Professor, "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.

Needham, Donald M., Assistant Professor, co-author, "An Ada95 Basis for Propagation Modeling", Proceedings of TRI-Ada'97, St. Louis, Missouri, (November 11-14, 1997), pp 263-272.

Representing dynamic interdependencies between design objects is an essential part of modeling the critical software communications found in complex software systems. Current software development methodologies, computer aided software engineering (CSE) environments and computer aided design (CAD) systems lack the ability to represent and manipulate such interdependencies, even though the specific information needing representation is often well understood by the designer. This paper examines the modeling of propagations, which are captured using

design-level triggers for specifying dynamic behavior across object types. Propagation modeling in the industrial domain finds application within iterative design processes when rapid prototyping technologies are used for experimental verification. Designers use

topological tolerances as a tool for retaining desired design invariance during the production of successively refined prototypes. We present propagation constructs built upon the object-oriented features of the Ada95 programming language.

Needham, Donald M., Assistant Professor, co-author, "A Reusability Measurement Framework and Tool for Ada95" Proceedings of TRI-Ada'97, St. Louis, Missouri, (November 11-14, 1997), pp. 125-132.

This paper presents a framework which analysis and measures the reusability of object-oriented designs. Our approach relies on reuse-specific subjective characterizations of packages and hierarchical libraries, and on a set of metrics that objectively measures the dependencies among packages based on those characterizations. We examine our design environment which can parse Ada95 applications, measure their reuse potential according to our framework, and automatically advise software designers/developers on ways to improve their products' reusability.

PHILLIPS, Andrew T., Associate Professor, co-author, "Protein Structure and Energy Landscape Dependence on Sequence Using a Continuous Energy Function, *Journal of Computational Biology* 4(3):227-239.

We have recently described a new conformational search strategy for protein folding algorithms, called the CGU (convex global underestimator) method. Here we use a simplified protein chain representation and a differentiable form of the Sun/Thomas/Dill energy function to test the CGU method. Standard search methods, such as Monte Carlo and molecular dynamics are slowed by kinetic traps. That is the Computer time depends more strongly on the shape of the energy landscape (dictated by the amino acid sequence) than on the number of degrees of freedom (dictated by the chain length). The CGU method is not subject to this limitation, since it explores the underside of the energy landscape, not the top. We find that the CGU computer time is largely independent of the monomer sequence, for different chain folds, and scales of $\mathbf{O}(n^4)$ with chain length. By using different starting points, we show that the method appears to find global minima. Since we can currently find stable states of 36-residue chains in 2.4 hours, the method may be practical for small proteins.

SCHULZE, Kay G., Associate Professor, co-author, "A CLIPS Problem Solver for Newtonian Physics Force Problems," Expert Systems Principles and Programming, 3rd Edition & CDROM, PWS Publishing Company, 1998.

This paper describes the problem Solver component of ANDES, an intelligent tutoring system for Newtonian physics. The output of the Problem Solver is the set of equations that are sufficient to solve a given problem. The trace, facts, and set of dependencies and dependents generated by an execution are used as input to a CLIPS function that generates a solution graph for the problem. This graph for the problem. This graph is then converted into a Bayesian network which the Assessor component of ANDES uses to model the cognitive processes of the student. The Assessor does long-term knowledge assessment, plan recognition, and prediction of a student's actions during problem solving.

The CLIPS knowledge base for force problems encodes the pedagogical methods used by university physics professors by planning the solution and using these plans to generate a solution. In many force problems, students must make choices. For instance, a problem involving two blocks, one on top of the other, may be solved using either a compound body or two separate bodies. In drawing a free-body diagram, the student may choose the standard axes or an axis in the direction of the sought force as the problem axes. Our system establishes decision points, called strategy points, when these choices must be made and solves the problem for each possible choice.

Technical Reports

Harrison, Patrick, Professor, co-author, NAC: An Adaptive Case-Based Reasoning Tool for Experimenting with Retrieval and Indexing, NRL report NRL/MR/5520-98-8146, 1998.

NAC is a testbed for experimenting with concepts of retrieval and indexing in Case-Based Reasoning (CBR). The paper describes similarity functions and decision functions used for retrieval as well as methods for re-

indexing and case organization. The paper also describes methods for weighting attributes, analyzing their dependence and evaluation the importance index of a singly stored case. Methods employed for retrieval and indexing are based on mathematically sound techniques developed in classification, clustering and decision analysis. NAC includes basic functions for specifying similarity, normalizing data and evaluation. Retrieval is done using both non-parametric and parametric statistical procedures with weighted attributes.

Presentations

Harrison, Patrick R., Professor, "Advanced Concepts in Case-Based Reasoning." Presented at US Navy Space and Naval Warfare Systems Command, Software Systems Engineering and Technology, SPAR 332, Washington, DC., September 13, 1997.

Harrison, Patrick R., Professor, "The Insight CBR Environment." Presented at the Software Technology and Environments Branch, NAWCAD, Patuxent River, MD, October 16, 1997.

Needham, Donald M., Assistant Professor, "An Ada95 Basis for Propagation Modeling." TRI-Ada'97 Conference, St Louis, Missouri, November 12, 1997.

Needham, Donald M., Assistant Professor, "A Reusability Measurement Framework and Tool for Ada95", TRI-Ada'97 Conference, St. Louis, MO November 12, 1997.

Schulze, Kay G., Associate Professor, "Verbal vs. Computer Acknowledgments in High Workload Team Communications," Psychonomic Society, Philadelphia, PA , November, 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 midshipmen majors.

Professor Erik Bollt worked with midshipman Joshua Woods to initiate his Trident Scholar Project: "Error Statistics of Time-Delay Embedding Prediction of Chaotic Time-Series". Midshipman Michael Conrady's Honors Research Project: "Geodesics on Surfaces (An Exploration of Geodesics)" was guided by Professor Caroline Grant. Professor T.S. Michael mentored four midshipman projects: Paul Detar's Honors Research Project "Tic-Tac-Toe Under Auction Play: Analysis of a Richman Game" (chosen as best Mathematics Honors Project for 1998); Coleman Ruiz' "Ramsey and Turan Problems for the Cycle of Length Four"; Alexander Holston's "Bipartite Ramsey Problems"; Richard Bower's "Pythagorean Tiling Problems". Professor Charles Mylander was adviser to Titus Fortner's "Estimating Shipyard Employment Levels using Structural Modeling" and A.N. McGowan's Detecting a Patrolling Submarine". Both Major Michael Shehan and Professor Thomas Sanders worked with midshipman Jeremy Leiby's project "Reassigning Marine Corps Reservists" which was sponsored by Headquarters Marine Corps, Manpower Analysis Section. Midshipman Michael Montgomery's research project "Dynamic Markov Compression as a Tool for Comparing DNA Sequences" was guided by Professor Els Withers.

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 two dozen articles appeared as applications of mathematics or as pure mathematical research. Topics that Mathematics Department faculty researched include: mathematics pedagogy, chaos and dynamical systems, mathematical physics and cosmology, parallel computer applications, cardiac arrhythmias, automated fingerprint identification, algorithms for computers, computerized tomography, wavelets, cryptology, ocean acoustics, navy ship degaussing, antenna design, and basic mathematical research in areas such as algebra, differential equations, combinatorics, matrices, operator theory, and number theory.

In addition to over a dozen independent research projects, another fifteen research projects were sponsored in whole or part 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

Naval Research Laboratory

National Science Foundation

National Security Agency

During the past year, members of the USNA Mathematics Department presented the results of their scholarly activities 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

Applications and Theory of Controlling Symbol Dynamics: Communicating with Chaos

Researcher: Assistant Professor Erik M. Bollt
Sponsor: Army Research Laboratories, Information Sciences Directorate (NSF)

This project addresses problems in controlling chaos and controlling symbol dynamics with small perturbations. Recent work has demonstrated the utilization of symbolic dynamics representation of controlled chaotic orbits for communications with chaotic signal generators. The evolution of trajectories of a chaotic dynamical system is equivalent to symbolic dynamics in an appropriate symbol space. The recent advent of controlling chaos using the OGY (Ott, Grebogi, and Yorke) technique and a variety of targeting algorithms, with physical applications, has demonstrated that chaos can be mastered, and inherent instabilities can be used as an advantage in allowing small deliberate perturbations to cause large signal variations. Coupling control of chaos through small perturbations with learning the grammar of the corresponding symbol dynamics means that the control perturbations are actually a coding scheme on the original dynamics. Controlling symbol dynamics using a map based description of the dynamics requires resolution of the following issues: learning the response of map iterates to variations in the control parameters, learning the semi-conjugacy, or coding function, between the dynamics of the map on the attractor and the grammar of the corresponding symbol dynamics, and finding the minimal grammar which is dependent on the appropriate choice of the partition in phase space. In particular, extensions include on-going work on communicating in higher dimensional dynamical systems. Investigations include issues of practical noisy environment control versus bandwidth trade-off and issues of ergodicity, learning system response to controls, and symbol dynamics of a chaotic dynamical system which is known only by time-series embedding of experimental data, and the further development of practical grammar learning algorithms.

This new field of nonlinear communication theory promises to develop into a useful new paradigm offering a generally usable information transmission technique, useful to both electronic and optical media, which should find wide applications in civil and military communications infrastructure. A great deal of recent research in applied and theoretical dynamical systems has been focused on taking advantage of the fact that a chaotic dynamical system can be controlled. The sensitive dependence characteristic of chaos is actually advantageous to building a highly agile control system in which a small deliberate system variations can cause a large response; the so called ``butterfly effect" allows us to steer the system responses with extremely small powered controls. Regicide theory tells us that a chaotic system can be considered as an unlimited information source; and control of chaos allows us to manipulate this information flow with extremely low-powered controls. An example application is a high-power signal generator (e.g. an electronic circuit), which operates intentionally in the chaotic regime, so that a small-scale piggy-back controller, on the micro-chip scale, has the ability to accurately manipulate high-powered message bearing signals. This method is in contrast to standard linear communication techniques, in which a high powered electronic circuit requires an equally large-scaled switching device to affect the large power variations required to transmit a high powered message. Not only is communicating through control of chaos applicable to one-dimensional dynamics, as previously demonstrated, but also applies to the more widely typical class of higher dimensional chaotic dynamics found in nature. Communicating by control of chaos promises numerous applications included in the engineering of new and simple electronic communications devices, new and simple optical communications devices, and modeling phenomena in biology, chemistry, and cognitive science.

Shallow Ocean Acoustics

Researcher: Professor James L. Buchanan
Sponsor: National Science Foundation, Faculty Recognition Grant

In order to realistically model 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, a dense fluid, or an elastic slab. A more realistic model needs to admit the porous nature of most surficial sediments. In a poroelastic sediment model the seabed is taken to consist of a viscoelastic frame with an

interstitial pore fluid. For the last five years the researcher and his collaborators have 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 acoustic pressure in an ocean with depth-varying sound speed, computing pressure in the far field over a two layer seabed using a modal 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 determination of 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. The solutions of the two problems described above are components of the solution of an important practical problem in ocean acoustics, that of recognizing the shape and /or composition of an object in the water or lying on the seabed.

Incorporating Remedial, Interactive Software Technology into Existing MathLab Resource Center

Researcher: Professor Carol G. Crawford
Sponsor: Curriculum Development Committee

The goal of this four week Curriculum Development Project was to conduct the research necessary to incorporate state-of-the-art software technology into the existing MathLab program. In prior years the MathLab has provided tutorial instruction to answer any and all midshipmen questions. A large portion of the difficulties experienced by midshipmen occurs in topics which are remedial-algebraic and trigonometric topics, especially. In addition, there has been an increasing demand for help in these areas. Thus, the results of this project will allow for the implementation of interactive, software programs into the MathLab, enabling the Mathematics Department to handle larger numbers of students. In addition, these self-help programs will free up instructors to handle higher level questions.

Closed-loop Degaussing Using Both Naval Vessels and Scale

Researcher: Associate Professor Gary O. Fowler
Sponsor: Naval Surface Warfare Center, Annapolis Laboratory

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.

Formations and Model Theory

Researcher: Professor Anthony M. Gaglione
Sponsor: Naval Academy Research Council (O&M,N)

A nonempty class X of finite groups which is closed under taking homomorphic images and subdirect products of two (and, therefore, inductively, finitely many) factors is a formation of groups. In the presence of closure under homomorphic images the second condition above is equivalent to the following: If G is a finite group (not necessarily in X) and K_1 and K_2 are subgroups normal in G and such that G/K_i lies in X, i = 1,2 , then $G/G/(K_1 \cap K_2)$ also lies in X. If, in addition, $H \in X$ if and only if H/ (H) $\in$ X , where (H) is the Frattini subgroup of H, then the formation is saturated. These concepts first introduced by W. Gasch tz in 1963 within the class of finite solvable groups, especially that of saturation, provoked an interest over the next thirty years that resulted in a tremendous output in contributions to the literature and a proliferation of associated ideas that still attract attention today. Since the underlying theme of the initial concepts relates to properties imposed on well-defined subsets of chief factors in a group, H. Bechtell examined this relationship as a basis for extending the formation concept into other algebraic systems. With an eye toward his nascent generalization, Professor Bechtell posed the following questions to the researcher and his

colleague Dr. Dennis Spellman:
Question 1: Which properties of groups give rise to formations?
Because of the broadness of Question 1, the researchers have chosen to attack the more modest
Question 2: Which first-order properties give rise to formations?
Although formations were nestled in the cradle of finite groups, first-order axiomatizability is in general incompatible with finiteness conditions because of the Compactness Theorem and L wenheim-Skolem type results. (A set of first-order sentences having arbitrarily large finite models will have models of arbitrarily large infinite powers.) For that reason, the researchers have chosen to modify the classical definition to suit their purposes to the extent that they no longer insist that our structures in a formation need be finite. Hence, they now define: A nonempty class X of groups to be a formation of groups provided X is closed under taking homomorphic images and whenever G is a group (not necessarily in X) and K_1, K_2 are subgroups each normal in G and such that $G/K_i \in X$, $i = 1, 2$, one must have $G/G/(K_1 \cap K_2) \in X$ .They also generalize this notion to other algebraic structures. Since most of the results go through in the context of universal algebra, they have chosen to consider this material in a universal algebraic setting. It would appear that at no point was there an effort to re-examine the fundamentals of the theory of formations through Model Theory-even though the work of R. C. Lyndon on properties preserved under homomorphisms and subdirect products was well-known. It is the purpose of this research project to do just that.

Aspects of the Theory of Free Groups

Researcher: Professor Anthony M. Gaglione
Sponsor: Naval Academy Research Council (O&M,N)

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

Researchers: Associate Professor Sonia M. F. Garcia and
Rafael Santos
Sponsors: Naval Academy Research Council (Faculty Recognition Grant) and Universidade do Algarve, Portugal

The researchers are defining and analyzing mixed finite element methods for solving time dependent partial differential equations. Their methods are based on a previous paper, "Analysis of Some Moving Space-Time Finite Element Methods," by R. Bank 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. It seems that 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: Naval Academy Research Council (Faculty Recognition Grant)

The idea here is to take different meshes and subspaces for different time levels. The approximation to the solution using this type of technique is obtained by taking the finite element solution at the current time is projected on the next (time) finite element space and then it adopting the Crank-Nicolson scheme to evaluate the next finite element approximation.

Using Pulsars for Orbital Velocity and Position Determination

Researchers: Assoc. Professor Sonia Garcia & Professor William J. Bagaria (Aerospace Dept.)
Sponsor: Naval Space Command
Naval Research Laboratory

Pulsars that are in the Milky Way Galaxy can be used for orbital velocity and position determination. However, the pulsar signal is about 100 orders of magnitude lower than the background noise. Vibration techniques, such as cross-correlation, are being used to detect the pulsar signal, and the Doppler shift in near real time. Once the signals from three or more pulsars are measured, the velocity and position of an object, like the earth, can be determined.

Stability, Bifurcation and Fracture in Continuum Mechanics

Researchers: Professor Reza Malek-Madani
Sponsor: Office of Naval Research

The Principal Investigator continued his research into the behavior of solutions of thesystem of partial differential equations that govern motions of plastic materials undergoing high-rate of shearing.

Ultrawide Band Electromagnetics: Improved Antenna Design

Researchers: Professor Peter A. McCoy, S. N. Sammaddar, and E. L. Mokole
Sponsor: Naval Academy Research Council (NRL/ONR)

The infinite biconical antenna is an idea pulse radiator that is characterized by frequency dependence when a point source is located at the apex of the cone. When the voltage is applied at the apex, the surface charges, currents and electromagnetic fields are associated with spherical waves of the form

$(,)e^{-jkr}/r$

where the radiation pattern (,) is a function that depends strictly on latitude and longitude (,). Conformal mapping techniques are utilized to improve known closed form solutions for the antenna's fields, currents and relevant characteristic parameters. Numerical examples are provided to support the validity of the theoretically derived formulae.

Solution of Linear and Polynomial Systems

Researchers: Professors George C. Nakos and Peter R. Turner
Sponsor: Naval Air Warfare Center-AD, Warminster and
Naval Academy Research Council (ONR)

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 with 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.

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 George 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.

Cruise Missile/TACAIR Effectiveness Assessment Software

Researcher: Professor Thomas J. Sanders
Sponsor: The Johns 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 Joint Warfare Analysis Department of the Johns 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 1997, the researcher 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. Enhancements included custom output formats for saved trajectory files, look-ahead capability on vehicle flight path generation, ballistic trajectory flight path generation, optimization option for the command altitudes used in a vehicle's flight path generation, an option to have site names displayed, and an option to calculated the hand-off distance for intercepts.

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: David Taylor Reseach Center (NSWC/A), Code 851

In October-November 1997, a major sea trial took place for this project. The objective was to take measurements on the platform at depth. Algorithms were developed for use onboard, given that topside communications were unreliable. Data has been collected and preliminary analysis looks promising.

The researchers have become involved in another facet of this project, the application of these results to new United States platforms. This has entailed visits to NAVSEA and subcontractors to discuss the design of the new system.

Residue Polynomial Systems

Researcher: Professor Peter R. Turner
Sponsor: Naval Air Warfare Center-AD, Naval Academy Research Council (ONR)

This project grew out of earlier work on using Residue Number Systems to solve adaptive beamforming problems and the more recent work for NAWC on solving systems of polynomial equations.

The fundamental idea is for a new system of representation of polynomials within Computer Algebra Systems. The basic idea is not new but it has never been regarded as practicable largely because of the problem of obtaining a satisfactory division algorithm. However, that problem is solved in this work.

The idea is to represent a polynomial by its residues at a set of nodes and to perform polynomial arithmetic and manipulation in terms of these residues rather than using the conventional coefficient representation. The basic ideas and properties of the Residue Polynomial System are presented. The basics of the representation are manifestations of standard results in polynomial interpolation. The biggest problem with residue representations is performing

division. In a polynomial ring, however, this turns out to be a tractable problem. An algorithm for division is presented. This is then extended to other polynomial algorithms which render RPS a potentially practical system for polynomial manipulation within Computer Algebra Systems.

Solution of Linear and Polynomial Systems

Researchers: Professors Peter R. Turner and George C. Nakos
Sponsor: Naval Air Warfare Center-AD, Warminster and
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Also with 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.

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Implementation and Applications of Level-Index Arithmetic

Researcher: Professor Peter R. Turner
Sponsor: Naval Academy Research Council (ONR)

This project continues the development of possible schemes for the eventual hardware implementation of SLI arithmetic and the analysis of the algorithms used. The researcher also is gaining more computational experience and evidence of the potential practical value of the system using software implementations of the symmetric level-idix, SLI arithmetic system. This is 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 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-indix 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.

Independent Research

ITPFI Factors of the Gauge and Rotation Invariant CAR Algebras

Researchers: Professor B. Mitchell Baker

The researchers obtained results which characterize the S and T - set invariants of Araki, Woods, and Connes, and generalized them to the non-UHF case. They also have a result on "approximate transitivity" which proves that the invariant AF type algebras are ITPFI in most cases. A final subcase needs to be dealt with in order to get the sharpest possible result.

A Dynamical Systems Approach to Membrane Phenomena Underlying Cardiac Arrhythmias II

Researchers: Professor B. Mitchell Baker, Professor Mark E. Kidwell

In this sequel, the researchers present (1) proofs for dynamical systems results used in the original paper, and (2) extend some important results to the higher-dimensional analogs which are considered to be "more realistic" versions of the model. Only some computer graphics work remains to be done.

Applications of Graph Theory to Automated Fingerprint Identification

Researcher: Professor Carol G. Crawford

This ongoing investigation applies the theories and algorithms of graph theory to the design of neural networks for an important computer vision problem. In particular, this research extends the work of earlier research to the design of fully automated programs for fingerprint identification. Special emphasis is being given to the exploration of more efficient graph models and matching algorithms. 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

Researcher: Associate Professor Caroline G. Grant

This project is a continuation of joint work with Professor P. Milman of the University of Toronto. The paper contains a simple and explicit construction of complete Kahler metrics of modified Saper type. It also contains a generalized Chow's Theorem for ideals, proved using the Direct Image Theorem, and a proof that a sequence of blow-ups of a compact complex manifold along smooth centers is equivalent to a single blow-up of the 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. Another result included in the paper is an explicit local formula 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

This primer is a set of notes, and eventually, the researcher hopes, a textbook for an introductory course for mathematics majors such as 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 proof of mathematical truths. The text begins with an introduction to basic mathematical concepts--sets, logic, number, function, 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.

General Relativity and Contrary Predictions

Researcher: Professor Robert A. Herrmann

An electrically neutral (non-rotating) Schwarzschild configuration and the associated static Schwarzschild metric is considered. A new coordinate transformation is introduced and analyzed using accepted methods from which physical behavior can be gleaned. Analyzing the Riemann-curvature tensor components in geodesic coordinates, and the photon and particle geodesic paths yields, among others, the predictions that there is an infinite redshift surface that is not an event horizon and that in terms of proper time a particle in radial free-fall will never reach the D-type physical singularity where the Riemann curvature tensor components all diverge.

Multiple Harmonic Series, Euler Sums, and Quasi-Shuffle Hopf Algebras

Researcher: Associate Professor Michael E. Hoffman

Let $i_1,i_2,\ldots,i_k$ be positive integers, and let $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_k$ be r th roots of unity. The Euler sum (of level r) determined by these data is the k-fold infinite series

$$(i_1,i_2,\cdots,i_k;\varepsilon_1,\varepsilon_2,\cdots,\varepsilon_k)=\sum_{n_1>n_2>\cdots>n_k\geq 1}\frac{\varepsilon_1^{n_1}\varepsilon_2^{n_2}\cdots\varepsilon_k^{n_2}}{n_1^{i_1}n_2^{i_2}\cdots n_k^{i}}$$

which converges unless $i_1 = 1$. These sums generalize the multiple harmonic series (also known as multiple zeta values), which are the case r = 1. Multiple harmonic series arise in knot theory in connection with Kontsevich's invariant, and more general Euler sums (including the cases r = 1 and r = 6) occur in the work of D. Broadhurst on perturbative quantum field theory. Two outstanding questions concerning these sums are: (1) describe the set of identities they satisfy; and (2) find, for each r, a set of "irreducible" sums of level r. The author introduced (for each level r) the "Euler algebra" to formalize the multiplicative structure on the set of Euler sums of level 4, generalizing his earlier construction of "harmonic algebra" for multiple harmonic series. This algebra turns out to be a free polynomial algebra on an appropriate basis. The Euler sums can then be regarded as images of elements of this algebra under a homomorphism into the complex numbers. From this point of view question (1) above asks for a characterization of the kernel of this homomorphism, while question (2) asks for a description of the quotient algebra by this kernel. Neither question has a definitive answer at this point, but the algebraic point of view provides a natural description of many known relations and suggests some promising conjectures. The Euler algebra can also be given the structure of a Hopf algebra in a natural way

A Constructive Algorithm for Determining Branching Rules of Lie Group Representations

Researchers: Associate Professor W. David Joyner and Roland Martin.

The researchers proved a branching rule for crystal graphs. They also determined a simple condition in terms of the crystal graph for when a tensor product (modeling a collision between two elementary particles) is "observable."

Generalized Hecke Algebras for SL(2) and Its N-fold Metaplectic Cover Over a P-adic Field

Researcher: Associate Professor W. David Joyner

The researcher proved, using a technique developed for GL(n) by Roger Howe, a bijection between generalized Hecke algebras of G and those of $\overline{G}$. This result implies that there is a canonical correspondence between irreducible admissible representations of G and genuine irreducible admissible representations of $\overline{G}$ of "sufficiently large level" (depending on n,p.)

A Correspondence of Supercuspidal Representations for SL(2) and Its N-fold Metaplectic Cover over a P-adic Field

Researcher: Associate Professor W. David Joyner

The researcher describes the supercuspidal representations of the n-fold metaplectic cover SL(2,F), where F is a p-adic field with (p,2n) = 1. The parameterization of the supervuspidals for the correspondence which was used is a modification of that of D. Manderscheid. Finally, he extended Kutzko's "Frobeius formula" for the character of a supercuspidal representation, giving a different, slightly simpler, proof. These will be applied to obtaining character relations which will define the correspondence mentioned above.

Image Reconstruction Algorithms for Computerized Tomography

Researcher: Associate Professor Thomas J. Mahar

This work dealt with a discrete model of tomography that has seen clinical use. The model leads to a system of linear algebraic equations which determine an image of a cross-section of the specimen. A traditional method used to solve the resulting linear system is known as Kaczmarz's algorithm. This algorithm is rooted in convex analysis and has the properties that it is insensitive to rank deficiency and redundancy of the coefficient matrix and it always converges. The draw back is that it converges very slowly. Clearly, the images reconstructed from a linear system with a rank deficient coefficient matrix are not as good as those constructed from a linear system with full rank. The researcher studied several algorithms for solving the linear system which were based on the application of the pseudo-inverse of the coefficient matrix. These algorithms execute much more quickly than Kaczmarz's and also work with redundant/rank deficient matrices. One of these algorithms was clearly best for full rank coefficient matrices, while a different one was clearly best for rank deficient matrices. Redundant equations did not seem to degrade the performance of these algorithms to any extent.

Serrin's Swirling Vortex

Researcher: Professor Reza Malek-Madani

The Navier-Stokes equations in half-space are studied. The fluid motion is influenced by a line vortex along the z-axis and constrained by a rigid boundary in the xy plane. The tornadic flow is visualized by solving the ensuing dynanical systems.

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 and Maple programs which determine prime numbers and compute the class numbers of certain algebraic number fields. She is also continuing her work on Mathematica and Maple programs which compute invariants associated to quadratic mappings.

SM230 Textbook

Researchers: Professor John C. Turner and Associate Professor Gary O. Fowler

The researchers have written a textbook for course SM230. This book has been published by Wiley Custom Publishing and was used for AY97-98. 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 Erlang 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. Revisions are underway f or AY98-99 that will add considerable statistical content.

Matrix Completions over Commutative Rings

Researchers: Professor William P. Wardlaw and R. Bruce Richter

The researchers have shown that if A is a k x n matrix over a principal ideal ring R, with k < n, and if d is an element of the ideal generated by the k x k minors of A, then A forms the top k rows of an n x n matrix of determinant d. This parallels a 1981 result of Gustafson, Moore, and Reiner, and continues a program initiated by Hermite in 1849. Then the researchers used these results to obtain an extension of their 1997 result for good matrices.

They are now trying to find more general commutative rings for which these results hold.

Research Course Projects

Error Statistics of Time-Delay Embedding Prediction of Chaotic Time-Series

Researcher: Midshipman 2/C Joshua T. Woods, USN
Adviser: Assistant Professor Erik M. Bollt
Sponsor: Trident Scholar Program

Many sciences share a common goal. That goal is to be able to accurately predict the outcome of an experiment. Imagine that there exists an experiment which is generating a list of numbers by using a specific rule. Take for example the list 1, 2, 4, 8, 16. Most people would suspect that this sequence is being generated by a geometric sequence and that the next number is 32. What about the sequence 1, 1, 2, 3, 5, 8, 13, 21? After a little scrutiny it becomes clear that the next number in the sequence is the sum of the previous two (this is the famous Fibonacci sequence.) But what if we had a rule which generated numbers which appeared random? Is it obvious what rule (there is one) is generating the sequence 0.4, 0.96, 0.15, 0.52, 1.00? This is a problem addressed by the study of chaos. Chaotic systems produce data which appear random, yet they do have rules which govern the data stream. Amazingly enough, a method known as time-delay embedding makes it possible to predict the next data point in a chaotic data set without determining the rule governing the output of data.

The method of time-delay embedding prediction is useful in many fields, including medicine, economics, and several other sciences. In the field of medicine, time-series embedding is useful in analyzing two of the body's most complex organs: the brain and the heart. Both the heart and the brain have the potential to be highly chaotic organs. By looking at the data series generated by an EKG (a time series from the heart), erratic heart rhythms, a condition known as arrhythmia, can be detected, diagnosed, and classified. While chaos is a symptom of disease in the heart, it is necessary in a healthy brain! Epileptic seizures are known to be caused by periodic orbits, i.e. repeating rhythms in the brain. Time-series embedding has recently been used to monitor these brain rhythms and diagnose disorders.

The method of time-series embedding is also useful in making economic predictions. Mathematicians currently model several economic markets. The typical economist's model of a market or economy usually tries to determine the reasons behind changes in the system. This type of model is useful only in predicting large-scale trends, but it is not capable of making sense out of the seemingly random fluctuations most economic systems experience. The chaotic dynamical systems model does not take into account the factors which drive the system; it only looks at the time-series of the desired observation variable. The interesting result is that this single time-series contains within it information describing the dynamics of the entire system. While most economic systems are too complex to make accurate predictions with this information, there are times when the dimension (the number of pertinent factors) of a system will collapse, making prediction and analysis possible.

Time-series embedding prediction is also used to analyze chaotic data which arise from many physical

systems, such as chaotic lasers, chemical reactions, and electronic circuits, and other basic systems of scientific disciplines. Scientists in each respective discipline have long known of systems which seemed to behave erratically in an almost random way. Looking at some of these systems through the lens of a chaos-trained mathematician enables many of these systems to be better understood and controlled. The method of time-series embedding often turns out to be the only applicable method for making predictions on these physical systems.

Geodesics on Surfaces (An Exploration of Geodesics)

Researcher: Midshipman 1/C Michael Conrady, USN
Adviser: Associate Professor Caroline G. Grant

This project is the Honors Research Project of Midshipman 1/C Michael Conrady. The goal of the project was to understand the geometry and fundamental properties of geodesics and to write a MAPLE program which would calculate and plot geodesics on surfaces. A geodesic is a curve which is locally distance-minimizing. For example, geodesics on a sphere are great circles and geodesics on a plane are lines. The project includes derivation of the differential equations determining geodesics, proof of the existence and uniqueness of a geodesic through any given point in a surface in any given direction, and a proof that geodesics are locally distance-minimizing. The project also contains numerous graphs of geodesics on surfaces showing some of the interesting and unexpected behavior of geodesics.

Tic-Tac-Toe Under Auction Play: Analysis of a Richman Game

Researcher: Midshipmen 1/C Paul Detar, USN
Advisor: Associate Professor T.S. Michael

This was Midshipman Detar's Honors project. It was based on a problem in mathematical economics suggested by a speaker in a USNA Mathematics Department Colloquium given in the Fall of 1997. Midshipman Detar's written project was deemed the best of the three submitted by Honors mathematics students in the Class of 1998. There is a continuing look at a "probabilistic" version of the problem.

Ramsey and Turan Problems for the Cycle of Length Four

Researcher: Midshipman 1/C Coleman Ruiz, USN
Advisor: Associate Professor T. S. Michael

In this research project Midshipman Ruiz and his advisor attempted to compute the smallest unknown Ramsey numbers associated with the cycle of length four. They were able to show that the 4-color Ramsey number was either 18 or 19. They also obtained some strong structural information in the case that the answer was 19.

Bipartite Ramsey Problems

Researcher: Midshipman 2/C Alexander Holston, USN
Advisor: Associate Professor T. S. Michael

The researcher and his advisor are studying multi-chromatic bipartite Ramsey sets for the complete bipartite graph K(2,2). The two- and three-color sets have been determined and they are attacking the four-colors set. They have found about half the pairs in the set. A complete solution to this problem would be a publishable result.

Pythagorean Tiling Problems

Researcher: Midshipman 2/C Richard Bower, USN

Advisor: Associate Professor T. S. Michael

Let (a,b,c) be a Pythagorean triple. The researchers seek sets of rectangular tiles with total area c^2 that can be used to tile either (i) a square of side c ; or (ii) two disjoint squares of sides a and b. Such a tiling gives a "combinatorial" proof of the Pythagorean Theorem.

Estimating Shipyard Employment Levels Using Structural Modeling

Researcher: Midshipman 1/C Titus Fortner, USN
Advisor: Professor W. Charles Mylander

Currently NAVSEA uses an econometric model to predict the employment at a shipyard resulting from the awarding of a ship building contract. The current model predicts more variation over time in employment levels than are observed. It is believed the current model does not take into account the costs associated with changes in employment levels, nor does it take into account the fungibility of workers among contracts the shipyard is working on. The researchers are building a linear programming (LP) model that reflects the structure of the process of controlling employment levels at a shipyard. The data for the model is being estimated using data collected and analyzed during the internship of the researcher at IDA.

Detecting a Patrolling Submarine

Researcher: Midshipman 1/C A. N. McGowan, USN
Advisor: Professor W. Charles Mylander

Submarine tactics often involve the assignment of a single submarine to a patrol region. This project is to determine the distribution of times required to detect a submarine moving about in its patrol region as a function of the number of detection devices used and their detection range. The analysis assumes the submarine moves about at constant speed and making periodic, but random course changes. In conducting the analysis both an analytic model and a simulation model, coded in Visual Basic for Excel, have to be constructed. Both models assume a cookie-cutter detection device; using such a device detection occurs for sure if the target comes within range and fails to detect otherwise. The analytic model assumes the detection devices are randomly placed about the patrol region. Thus the simulation model is more versatile in that it can be used to study the impact of placing the detection devices in patterns. The results of the two models are compared and contrasted.

Reassigning Marine Corps Reservists

Researcher: Midshipman 1/C Jeremy Leiby, USN
Advisors: Major Michael Shehan and Professor Thomas J. Sanders

In this project a linear model, using an assignment approach, was used to propose a method that could improve the operational readiness of United States Marine Corps reserve units through a personnel assignment process within a geographical area. This project focused on 28 of Southern California's 30 Marine Corps reserve units. A transportation model was developed which reduced instances of unit over- and under-manning, through the reassignment and/or retraining of the current reserve population. The model indicates, without regard to cost analysis, that overall operational readiness can (potentially) be realized. This work was sponsored by Headquarters Marine Corps, Manpower Analysis Section.

Dynamic Markov Compression as a Tool for Comparing DNA Sequences

Researcher: Midshipman 1/C J. Michael Montgomery, USN
Advisor: Professor W. Douglas Withers

The researchers' goal was to apply the technique of Dynamic Markov Compression to the problem of

locating dissimilarities between DNA sequences. DNA sequences can be considered as strings of characters (A,C,G,T). Dynamic Markov Compression is a compression technique which dynamically constructs finite state machine describing frequently-observed patterns in a string to be compressed. The efficacy of compression can be used as a measure of the state machine's success in predicting patterns in the string. They modified a C program (written by Tong Lai Yu of the Department of Computer Science at California State University, San Bernadino) to fit the needs of this project. This program uses Dynamic Markov Compression to compress large binary files. The researchers made several changes to the program to fit the task of comparing DNA sequences: adding the capability to save the state machine derived from a given string, to read a pre-existing state machine and compress statically, and to report on compression efficacy for portions of a string. This report will show the results of the testing done on both simple artificial strings, as well as naturally-occurring DNA sequences.

Publications

BOLLT, Erik M., Assistant Professor, (co-author), "Analysis of the Topological Entropy versus Noise Resistance Trade-Off when Communicating with Chaos," *Physical Review Letters,* **79** 19 3787-3790, 1997.

BOLLT, Erik M., Assistant Professor, (co-author), "Encoding Information in Chemical Chaos by Controlling Symbolic Dynamics," *Physical Review E,* June, 1997.

BOLLT, Erik M., Assistant Professor, (co-author), "Learning the Grammar of a Chaotic Dynamical System in a Format Suitable for Controlling Symbol Dynamics and Communications," refereed conference proc., *Proc. First International Conference on Controlling Chaotic Oscillations, St. Petersburg, Russia,* pp 573, August, 1997.

BOLLT, Erik M., Assistant Professor "Channel Capacity of A Noise Resistant Chaotic Communication Device," *Proc. 5th Annual US Army Research Lab Technical Symposium,* October, 1997.

HERRMANN, Robert A., Professor, "Deriving Vardiman's Sedimentation Equation," CRS Quarterly, 34(2) (September 1997), 103.

The Vardiman sedimentation equation for the ocean floor sediment is obtained from empirical evidence and data matching. In this paper, a derivation from first principles of this equation is obtained by considering a homogeneous mixing problem with relaxation time incorporated in order to smooth out discontinuous mixing. The differential equation obtained has a unique solution which is the Vardiman sedimentation equation.

HOFFMAN, Michael E., Associate Professor, "The Algebra of Multiple Harmonic Series," Journal of Algebra 194 (1997), 477-495.

Recently there has been much interest in multiple harmonic series

$$\zeta(i_1,i_2,\cdots,i_k)=\sum_{n_1>n_2>\cdots>n_k\geq 1}\frac{1}{n_1^{i_1}n_2^{i_2}\cdots n_k^{i_k}}$$

(which converge when the exponents i_j are positive integers and $i_1 > 1$), also known as multiple zeta values or Euler/Zagier sums. Starting with the noncommutative polynomial algebra Q<x,y>, the author defines a second multiplication which is commutative and associative, and calls the resulting structure the harmonic algebra H . As a graded commutative algebra, H turns out to be a free polynomial algebra with the number of generators in degree n given by the Witt formulas for the N(n) of basis elements in degree n in the free Lie algebra on two generators. Multiple harmonic series can be thought of as images under a map :H^0 → R, which is a homomorphism with respect to the commutative multiplication, where H^0 is an appropriate subalgebra of H. If we call $i_1 + \cdots + i_k$ the weight of the series $(i_1, \ldots, i_k)$, then (for $n > 1$) there are at most N(n) series of weight n that are irreducible in the sense that they are not rational multiples of products of multiple harmonic series of lower weight. In fact, this approach gives an explicit set of "algebraically" irreducible multiple harmonic series. The author also shows that there is a subalgebra $H^0 \subset H^1 \subset H$ related to the shuffle algebra which contains the algebra Sym of symmetric functions: in fact, maps the elements of Sym $\cap$ H^0 to algebraic combinations of zeta values (i) , for integer $i > 1$. The map is not injective; shows how several results about multiple harmonic series can be recast as statements about the kernel of , and the author proposes some conjectures on the structure of the algebra H^0 / ker .

HOFFMAN, Michael E., Associate Professor, "The Bull and the Silo: An Application of Curvature," American Mathematical Monthly 105 (1998) 55-58.

This note presents a solution to the following problem: suppose a bull is tethered to a silo whose horizontal cross-section is a smooth convex curve C by a leash whose length is less than half the circumference of C. How large an area can the bull graze?

HOFFMAN, Michael E., Associate Professor, Solution to Problem 10536, American Mathematical Monthly 105 (1998) 76-77.

JOYNER, W. David, Associate Professor, "Decomposing Lie Algebra Representations Using

Crystal Graphs," SAC Newsletter no. 2, 1997.

KONKOWSKI, Deborah A., Professor, (co-author), "Applying a Stability Conjecture to Plane-Wave Cauchy Horizons," Internal Structure of Black Holes and Spacetime Singularities," Annals of the Israel Physical Society, Vol. 13, ed. L. M. Burko and A. Ori (published jointly by (1) Institute of Physics Publishing, Bristol, U.K., and (2) The Israel Physical Society, Jerusalem, Israel, 1997) 131-140.

Plane-wave Cauchy horizons are reviewed and their stability discussed in terms of a previously-developed stability conjecture. Many examples are considered and two stability theorems are stated.

KONKOWSKI, Deborah A., Professor, (co-author), "Encounter of a Stability Conjecturewith Black-hole Cauchy Horizons," Internal Structure of Black Holes and Spacetime Singularities," Annals of the Israel Physical Society, Vol. 13, ed. L. M. Burko and A. Ori (published jointly by (1) Institute of Physics Publishing, Bristol, U.K., and (2) The Israel Physical Society, Jerusalem, Israel, 1997) 114-130.

The stability of various black-hole Cauchy horizons is reviewed in the context of a previously-developed stability conjecture. Reissner-Nordstrom, Kerr, Reissner-Nordstrom-deSitter, and lower-dimensional black holes are considered. In addition to successes, challenges to the conjecture are presented. These include shell-focusing singularities and a resulting "improved" conjecture along with Weyl tensor singularities from null dust incident on an impulsive gravitational wave and Reissner-Nordstrom with impulsive outgoing null dust. Future lines of inquiry are discussed.

KONKOWSKI, Deborah A., Professor, (co-author), Some Thoughts about S. Chrandrasekhar," Newsletter of the Calcutta Mathematical Society, April 1998, p.1.

A review of the life and work of the Nobel-prize-winning mathematical physicist S. Chrandrasekhar is given along with personal encounters.

KONKOWSKI, Deborah A., Professor, "Stability of Plane-Wave Cauchy Horizons," Abstracts of Plenary Lectures and Contributed Papers," ed., N. Dadhich (Pune, Inter-University Centre for Astronomy and Astrophysics, 1997) p. 53.

A summary of the work by T. M. Helliwell and D. A. Konkowski on plane-wave Cauchy horizons is given.

MALEK-MADANI, Reza, Professor, "Advanced Engineering Mathematics with Mathematica and MATLAB", Addison-Wesley-Longman, 1998.

This two-volume book introduces the fundamental concepts of vector calculus, linear algebra and partial differential equations in the context of fluid dynamics. Numerous examples are presented in how one may use Mathematica and MATLAB to solve the basic initial boundary value problems that arise in fluid mechanics.

MCCOY, Peter A., Professor, "Sampling Theorems for Higher Order Elliptic Boundary Value Problems," Applicable Analysis, vol. 61 (1996) 149-161.

Theorems analogous to C. E. Shannon's classical result provide solutions of regular interior elliptic boundary value problems of order two or more from samples of mixed type boundary data. Equivalent problems are obtained by transmuting the partial differential operators or by varying the domains. Function theoretic applications follow.

MCCOY, Peter A., Professor, "The Singularities of Legendre Series in C^N," Complex Variables, vol. 34 (1997) 231-245.

Z. Nehari's theorem identifies the precise geometric connection between the singularities of analytic Legendre series on C_z and those of associated Taylor's series in C_t. Recent generalizations consider the singularity problem for analytic series of products or triple products of Legendre polynomials. This paper completes the analysis by developing the analogous theorems for analytic series of products of N Legendre polynomials in $C_{z_1} x \ldots x C_{z_n}$ for n = 4,5, ... (N fixed).

MEYERSON, Mark D., Professor, "The TI-92 Calculator," Mathematica Militaris, vol. 7, Issue 3, Fall/Winter 1997, pp. 12-15.

This is a "lessons learned" summary of the U.S. Naval Academy Mathematics Department use of the (TI-92) calculator in the Fall 1997. Several concerns are addressed-pedagogical questions, practical questions, examples of usage, hints, and errors discovered.

MICHAEL, T. S., Associate Professor, (co-author), "Skew Hadamard Matrices and the Smith Normal Form," Designs, Codes and Cryptography, 13 (1998), 173-176.

The Smith normal form has been used to study matrices of combinatorial interest, e.g. Hadamard matrices. Indeed, there is a small number of results that show that the Smith normal forms of special classes of Hadamard matrices are uniquely determined. In this joint paper, the authors show that all Skew-Hadamard matrices of a given order have the same Smith normal form.

NAKOS, George, Professor, (co-author), "Elimination with the Dixon Resultant," Mathematica for Education and Research, Vol. 6, No. 3, Summer 1997 pp 11-21.

The Dixon resultant can be used to eliminate a number of unknowns from a system of polynomial equations in

one step. To the Mathematica user the code complements and greatly enhances the command Eliminate. The 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 over 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 authors offer 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.

NAKOS, George, Professor, (co-author), "Fraction-Free Algorithms for Linear and Polynomial Equations," SIGSAM Bulletin, ACM, Vol 31, No 1, December 1997, Issue 122, pp 11-19.

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.

PRICE, Geoffrey L., Professor, "Cocycle Conjugacy of Shifts on the Hyperfinite II_1 Factor, II," Journal of Operator Theory 39 (1998) 1-19.

Let u_0,u_1, ... be a sequence of hermitian unitary operators in a von Neumann algebra which are assumed pairwise either to commute or to anticommute, and which satisfy the further property that for any positive integer k the pair of operators u_{i+k},u_{j+k} have the same commutation relations as do the pair u_i,u_j. If the commutation relations are sufficiently chaotic the weakly closed algebra generated by these operators is isomorphic to the hyperfinite II_1 factor R. Due to the translation invariance of the commutation relations one can define a shift endomorphism on R which satisfies $(u_i) = u_{i+1}$ for all non-negative integers i. Endomorphisms of R defined in this way are called Powers shifts. The commutant index of is defined to be the first positive integer k such that the von Neumann subalgebra $^k(R)$ of R has non-trivial relative commutant in R. In this paper the author shows that any pair of Powers shifts of relative commutant index 2 are cocycle equivalent.

PRICE, Geoffrey L., Professor, "The Entropy of Rational Powers Shifts," Proceedings of the American Mathematical Society, 1998.

Let $u_0,u_1,...$ be a sequence of hermitian unitary operators in a von Neumann algebra which are assumed pairwise either to commute to anticommute, and which satisfy the further property that for any positive integer k the pair of operators u_{i+k},u_{j+k} have the same commutation relations as do the pair u_i,u_j. If the commutation relations are sufficiently chaotic the weakly closed algebra generated by these operators is isomorphic to the hyperfinite II_1 factor R. Due to the translation invariance of the commutation relations one can define a shift endomorphism on R which satisfies $(u_i) = u_{i+1}$ for all non-negative integers i. Endomorphisms of R defined in this way are called Powers shifts.

The Connes-Stormer entropy for automorphisms of the hyperfinite II_1 factor R is modeled on the classical entropy defined for commutative dynamical systems. The Connes-Stormer entropy may also be defined for Powers shifts. Narnhofer, Stormer and Thirring have published results of Powers shifts which have Connes-Stormer entropy 0. In the paper above, the author shows that all Powers shifts of finite relative commutant index have Connes-Stormer entropy $\frac{1}{2}\log 2$. It is an outstanding problem to try to determine whether there are Powers shifts whose entropy is other than 0 or $\frac{1}{2}\log 2$.

TURNER, Peter R., Professor, (co-author), "Fraction-Free Algorithms for Linear and Polynomial Equations," SIGSAM Bulletin (ACM) September 1997.

This paper extends the ideas behind Bareiss' fraction-free Gauss elimination algorithm in a number of direction. 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.

WARDLAW, William P., Professor, (co-author), "Good Matrices: Matrices that Preserve Ideals," American Mathematics Monthly 104 (December 1997), 932-938.

An r x n matrix A with entries from a commutative ring R with identity is said to be left-

good if and only if, for every r-tuple $\mathbf{x}$ of elements of R, the ideal $\mathbf{x}A$ generated by the elements of $\mathbf{x}A$ is equal to the ideal $\mathbf{x}$ generated by the elements of $\mathbf{x}$. The paper presents a number of properties of good matrices and establishes the following:
Main Theorem. Consider the following statements about an $r \times n$ matrix A over the commutative ring with unit R.
(1) The rows of A extend to a basis of R^{1xn}.
(2) A can be enlarged to an $n \times n$ matrix invertible over R.
(3) A has a right inverse over R.
(4) The ideal generated by all $r \times r$ subdeterminants of A is R.
(5) A is left good.
Then (i) (1) $\Leftrightarrow$ (2) $\Rightarrow$ (3) $\Rightarrow$ (4) $\Rightarrow$ (5).
(ii) If R is a principal ideal ring, then each of (1) - (5) is equivalent to
(6) A has Smith Normal Form $[I_r\ 0]$.

WARDLAW, William P., Professor (co-author), "Q873 and A873," Mathematics Magazine, 70-5 (December 1997), 382 and 389.

Q873. Suppose that A, B, C, and D are $n \times n$ matrices over a commutative ring such that AC-CA. Show that

$$\det\begin{pmatrix} A & B \\ C & D \end{pmatrix} = \det(AD - CB).$$

(A873 is the solution to this problem.)

Technical Reports

MARUSZEWSKI, Richard F., Professor, "Wavelets and MATLAB," Department of Defense Technical Report, May 1998.

TURNER, Peter R., Professor, (co-author), "Fraction-Free Algorithms for Linear and Polynomial Equations," Technical Report 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.

TURNER, Peter R., Professor, "Residue Polynomial Systems," Technical Report NAWCADPAX, 1998.

In this report the basic ideas and properties of the Residue Polynomial System are presented. This system is an analog of the Residue Number System for integer representation and arithmetic. The basics of the representation are manifestations of standard results in polynomial interpolation. The biggest problem with residue representations is performing division. In a polynomial ring, however, this turns out to be a tractable problem. An algorithm for polynomial division is presented. This is then extended to other polynomial algorithms which render RPS a potentially practical system for polynomial manipulation within Computer Algebra System.

Presentations

BAILEY, Craig K., Professor, "Teaching Differential Equations with the TI-92," Poster Session East Coast Computer Algebra Day, Annapolis, MD., 25 April 1998.

BAKER, B. Mitchell, Professor, "A Dynamical Systems Approach to Cardiac Rhythms," invited colloquium, University of Southwestern Louisiana, Louisiana, 14 October 1997.

BAKER, B. Mitchell, Professor, "A Dynamical Systems Approach to Cardiac Rhythms," invited colloquium, University of New Orleans, New Orleans, Louisiana, 15 October 1997.

BAKER, B. Mitchell, Professor, "Coin Flipping and Permutations: A Beginners Guide to Operator Algebras," Mathematics Department Colloquium, , U.S. Naval Academy, Annapolis, MD., 14 January 1998.

BOLLT, Erik M., Assistant Professor, "Coding, Channel Capacity, and Noise Resistance in Communicating with Chaos," University of Maryland, Chaos Hour, College Park, MD., 9 October 1997.

BOLLT, Erik M., Assistant Professor, "Controlling Hamiltonian Chaos: Finding a Low-Energy Orbit to the Moon," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, MD., 7 May 1998.

BOLLT, Erik M., Assistant Professor, "Optimizing Chaos," University of Maryland, Chaos Hour, College Park, MD., 7 May 1998.

CRAWFORD, Carol G., Professor, Panel Member, "National Science Foundation Grants Review for Undergraduate Course and Curriculum Development Program," Washington DC., 21-24 July 1997.

CRAWFORD, Carol G., Professor, Conference Chair, "Maryland-DC-Virginia Regional Meeting Introductory Remarks," Mount Saint Mary's College, Emmittsburg, MD., 21-22 November 1997.

CRAWFORD, Carol G., Professor, Conference Chair, "Maryland-DC-Virginia Regional Meeting Introductory Remarks," Virginia State University, Petersburg, VA., 18-19 April 1998.

GAGLIONE, Anthony M., Professor, "Lyndon's Free Exponential Groups and their Applications," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, MD., 8 October 1997.

GAGLIONE, Anthony M., Professor, "Is Every Axiomatic Formation of Groups a Variety?" State University of New York at Albany Group Theory Conference, Albany, NY., 15 October 1997.

GAGLIONE, Anthony M., Professor, "Residual Properties of Groups and Rings," New York Group Theory Conference, CUNY Graduate Center, New York, NY., 13 February 1998.

GAGLIONE, Anthony M., Professor, "On Some Algorithmic Questions Easily Handled Using Group Theory," Fairfield University, 18 April 1998.

GAGLIONE, Anthony M., Professor, "On Varieties and Axiomatic Formations," International Conference on Algorithmic Problems in Groups and Semi-Groups, University of Nebraska, Lincoln, NE., 10-17 May 1998.

GAGLIONE, Anthony M., Professor, "Is Every Axiomatic Formation of Groups a Variety?" Ohio-Denison Group Theory Conference, 22-24 May 1998.

GARCIA, Sonia M. F., Associate Professor, "Moving Space - Time Mixed Finite Element Methods," NMDE98-2nd International Meeting on Numerical Methods, University of Coimbra, Portugal, 25-27 February 1998.

GRANT, Caroline G., Associate Professor, "Complete Kahler Metrics for Singular Algebraic Varieties," Midwest Algebraic Geometry Conference, University of Notre Dame, South Bend, IN., 9 November 1997.

GRANT, Caroline G., Associate Professor, "Parametrizing Algebraic Plane Curves," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, MD., 3 December 1997.

HOFFMAN, Michael E., Associate Professor, "A Hopf Algebra Construction Motivated by Euler Sums," topology seminar, Ohio State University, OH, 12 August 1997.

HOFFMAN, Michael E., Associate Professor, "Boustrophedonic Triangles, Snakes, and Derivative Polynomials," Mathematics Colloquium, USNA, Annapolis, MD., 3 September 1997.

HOFFMAN, Michael E., Associate Professor, "Multiple Harmonic Series and Kontsevich's Invariant," Special Session of the American Mathematical Society Winter Meeting, 9 January 1998.

HOFFMAN, Michael E., Associate Professor, "Kontsevich's Invariant, Mysterious Numbers and Hopf Algebras," topology seminar, Johns Hopkins University, Baltimore, MD., 2 February 1998.

HOFFMAN, Michael E., Associate Professor, "Algebras of multiple zeta values, quasi-symmetric functions, and Euler sums," seminaire de combinatoire, Universite du Quebec a Montreal, 1 May 1998.

HOFFMAN, Michael E., Associate Professor, "Mysterious Numbers from Knot Theory and Hopf Algebras," Lehigh University Geometry and Topology Conference, 11 June 1998.

KAPLAN, Harold M., Professor, "Smaller Alpha Sizes for Monte-Carlo Tests," Mid-Atlantic Regional Probability and Statistics Day, The Johns Hopkins University Applied Physics Laboratory, Laurel, MD., 18 October 1997.

KONKOWSKI, Deborah A., Professor, "Stability of Cauchy Horizons in Plane-Wave Spacetimes," 8th

Marcel Grossman Meeting on General Relativity, Jerusalem, Israel, 22-27 June 1997.

KONKOWSKI, Deborah A., Professor, "Applying a Stability Conjecture to Plane-Wave Cauchy Horizons," Workshop on the Internal Structure of Black Holes and Spacetime Singularities, Haifa, Israel, 29 June - 4 July 1997.

KONKOWSKI, Deborah A., Professor, "Stability of Cauchy Horizons in Plane-Wave Spacetimes," 15th International Conference on General Relativity and Gravitation, Pune, India, 16-21 December 1997.

KONKOWSKI, Deborah A., Professor, "Some Thoughts about S. Chrandrasekhar," Address as Guest of Honor at Inaugural Ceremony, International Symposium on Mathematical Physics, Calcutta, India, 28 December 1997.

KONKOWSKI, Deborah A., Professor, "The Strengths and Limitations of a Stability Conjecture for Cauchy Horizons," International Symposium on Mathematical Physics, Calcutta, India, 28 December 1997 - 1 January 1998.

MARUSZEWSKI, Richard F., Professor, "Introduction to the Mathematics Department Computer Systems," USNA, Mathematics Department Computer Seminar, Fall 1997.

MARUSZEWSKI, Richard F., Professor, "Uploading/Downloading," USNA Mathematics Department Computer Seminar, Fall 1997.

MARUSZEWSKI, Richard F., Professor, "Using Spreadsheets In and Out of Class," USNA Mathematics Department Computer Seminar, Fall 1997.

MCCOY, Peter A., Professor, "Initial Value Problems for Fractional PDE's," Special Session on Analysis with Wavelets, (Invited) American Mathematical Society Central Section Meeting, University of Wisconsin-Milwaukee, 24 October 1997.

MCCOY, Peter A., Professor, "Multivariable Multipower Sampling Theorems," Session on Analysis, American Mathematical Society annual meeting, Baltimore, MD., 7 January 1998.

STANFORD, Theodore B., Assistant Professor, "Vassiliev Invariants and the Lower Central Series of the Pure Braid Group," Knots in Washington miniconference, University of Maryland, College Park, MD., 22 November 1997.

STANFORD, Theodore B., Assistant Professor, "Extending the Gassner Representation from Pure Braids to Tangles, and Some Rational Functions that Generate Milnor Invariants," Special session on knot theory and quantum topology, AMS Winter meeting, Baltimore, MD., 10 January 1998.

STANFORD, Theodore B., Assistant Professor, "Knots, Surfaces, and Matrices," USNA Mathematics Department Colloquium, Annapolis, MD., 21 January 1998.

STANFORD, Theodore B., Assistant Professor, "A Generalized Magnus Expansion with Applications to String Links," Knots in Washington miniconference, U.S. Naval Academy, Annapolis, MD., 8 February 1998.

STANFORD, Theodore B., Assistant Professor, "Vassiliev Invariants and the Lower Central Series of Pure Braid Groups," Columbia University Topology Seminar, 13 March 1998.

STANFORD, Theodore B., Assistant Professor, "Vassiliev's Knot Invariants and the Lower Central Series of the Pure Braid Groups," Special session on quantum topology, AMS sectional meeting, Manhattan, KS., 27 March 1998.

TURNER, John C., Professor, "Using Spreadsheets to Calculate Prob (X+Y=W)," Probability and Statistics Day, Johns Hopkins University/Applied Physics Laboratory, Laurel, MD., 18 October 1997.

TURNER, John C., Professor, "Conditional Probability and the Monty Hall Problem," Broadneck Senior High School, Annapolis, MD., 14 October 1997.

TURNER, Peter R., Professor, George C. NAKOS, and R. M. WILLIAMS, "Fraction-Free Algorithms for Linear and Polynomial Equations," 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.

TURNER, Peter R., Professor, "Residue Polynomial Systems," East Coast Computer Algebra Day, Annapolis, MD., April 1998.

TURNER, Peter R., Professor, "Residue Polynomial Systems," Highlighted Presentation, RNC3 (3rd Conference on Real Numbers and Computers), Paris, France, April 1998.

WARDLAW, William P., Professor, "Rings of Polynomial Functions," Fall meeting of the MD-DC-VA Section of the Mathematical Association of America, Mount St. Mary's College, Emmitsburg, MD., 22 November 1997.

WARDLAW, William P., Professor, "Rings of Polynomial Functions," Annual meeting of the AMS-MAA, Baltimore, MD., 9 January 1998.

WARDLAW, William P., Professor, "Matrix Completion over Principal Ideal Rings and Good Matrices," Spring meeting of the MD-DC-VA section of the Mathematical Association of America at Virginia State University, Petersburg, VA., 18 April 1998.

WITHERS, W. Douglas, Professor, "The ELS-Coder: A Rapid Entropy Coder," JPEG 2000 Conference, Scottsdale, AZ., 9 September 1997.

DEPARTMENT OF

Oceanography

Captain Dennis J. Whitford, USN

Chairman

Academic Year 1997-1998 was particularly productive in terms of U.S. Naval Academy meteorology and oceanography (METOC) research. With only five 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 1997 with a focus on pedagogical research. The department held its fourth Maury Project summer workshop, hosting twenty-six science teachers from across the country and 18 teachers who returned from previous summer workshops for advanced training. Enhancing the scientific foundations and teaching methodology for K-12 teachers in the area of physical oceanography continued as the project's primary focus.

Fifteen 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. In addition, the department was fortunate to have another Trident Scholar this year. His research was entitled "A Sub-Bottom Profiler and Side Scan Sonar Study, Chesapeake Bay."

Two faculty members conducted research while on sabbatical leave resulting in one faculty member receiving an approved patent with a second patent under consideration.

The annual Oceanographic YP Summer Cruise aboard YP686 was not conducted in June 1998 because the vessel was undergoing an overhaul.

Our externally-funded research faculty continued their strong research efforts with multiple scientific articles submitted for publication.

Sponsored Research

Measuring Copper in the Marine Environment

Researcher: Professor John W. Foerster

Sponsor: Naval Research Laboratory

A major source of trace metal contamination in the marine environment is the copper containing anti-foulant paints on ship hulls. An anti-fouling paint containing copper (I) presents a challenge to the environment because its design is to leach continuously over a period of time. This study tests the hypothesis that the organic molecule, 2,9-dimethyl-4, 7-diphenyl-1,10-phenanthrolinedisulfonic acid (Bathycuproinedisulfonic acid=BCS) is a reliable chemical to use in developing a sensor capable of measuring copper (I) in seawater. The purpose is to acquaint environmental users and managers with a system easily used to determine levels of copper contamination. A sensor system that will measure trace

metal contamination quickly will help in the deployment of remedial methods to avert an environmental problem. The sensor must have

- parts per billion (ppb) detection limits,
- environmental immersion capability, and
- the ability to detect the copper (I) oxidation state.

Results of this study show copper one leaching at a rate of 1.2 ppb/hour. After 2 hours Cu (I) begins to convert to copper (II). Both ions are toxic above very low ppb concentrations (<5.0 ppb). Initially for the first 2 hours you have 100% copper (I) leaching into the water and by 20 hours the ratio is 38% copper (I) to 62% copper (II). The BCS chemical is a quick and relatively easy way to determine the concentration of copper (I) in marine and estuarine waters.

A Sub-Bottom Profiler and Side Scan Sonar Study of the Chesapeake Bay

Researcher: 1/C Midshipman Dewey A. Lopes, USN

Advisor: Associate Professor Peter L. Guth

Sponsor: Trident Scholar Program

This study focused on very shallow features of the most recent Holocene channels in the mid Chesapeake Bay near Annapolis, MD and west of Kent Island. The study used two sonar systems, a side-scan sonar to create a mosaic showing bottom topography and surface sediment characteristics, and a chirped subbottom profiler which penetrated up to 10 m into the sediments to reveal the distribution and characteristics of sediment laying.

Several different Channels have north-south orientations, at depths between 1.5 m and 10 m below the sediment/water interface. Two strong sub-bottom returns separate three main layers. Shallow layer A has an average thickness of 2 m, and is characterized by smooth regular returns indicative of homogenous sediment.

Intermediate layer B has an average thickness of 9 m, and contains many faint sub-bottom layers. Deep layer C extends below the strong return that marks the bottom of layer of B. It also contains several strong returns, but is not well imaged due to limited return strength.

Analysis of the side-scan data indicates the orientation of the subbottom layering tends to follow the general bottom surface bathymetry and orientation of the present channel. Both side-scan and subbottom data reflect recent sediment deposition. This location and orientation of the subbottom layers show areas of sedimentation, while side-scan sonar data mosaics over the area help illustrate sediment fluxes.

Sedimentation in the study area is approximately 0.05 cm/yr to 0.075 cm/yr. This assumes the deepest subbottom return separating layers B and C represents the Cape Charles palechannel (18ka) and uses the measured layer thicknesses.

TerraBase II: Computerized Terrain Analysis Training System

Researcher: Associate Professor Peter L. Guth

Sponsor: U.S. Army Engineer School

TerraBase II is a training system to expose soldiers to the nature and types of digital terrain data, procedures for visualizing terrain, and integrating terrain into tactical planning. The program runs on standard desktop, laptop, and notebook computers with the Windows 95 or NT operating system, and uses standard terrain data from the National Imagery and Mapping Agency. The program provide base maps for tracking situation, terrain computations (e.g. line of sight, slope for cross country mobility, sunrise/sunset), and 3D visualizations. The program integrates digital elevation models and satellite imagery.

The Influence of Boundary Layer Dynamics and Thermodynamics on the Diagnosis of Near-Surface Wind Speed by Synthetic Aperture Radar

Researcher: Assistant Professor Todd. D. Sikora

Sponsor: The Office of Naval Research

Convection in the marine atmospheric boundary layer (MABL) manifests itself into distinct coherent structures, such as kilometer-scale three-dimensional thermals. Momentum transfer from the convective MABL to the sea surface results in centimeter-scale sea surface roughening beneath and down-mean-wind of thermal downdrafts. In contrast, the sea surface beneath and down-mean-wind of thermal updrafts is less perturbed on the centimeter-scale. Microwave radar imagery of the sea surface, such as synthetic aperture radar (SAR), can reveal the existence of the convective MABL via a characteristic kilometer-scale mottled backscatter pattern which is tied to the above given sea surface roughening arguments.

The ability of SAR to reveal the existence of convection via the mottling is, among other things, a function of the MABL static stability and mean wind speed. In the presence of MABL convection, it is reasonable to expect that as the static stability and mean wind speed change, mottling variability will also change. An increase or decrease in MABL static stability will cause a corresponding decrease or increase in mottling variability, all else being equal. An increase or decrease in mean wind speed will cause a corresponding decrease or increase in mottling variability, all else being equal. It is therefore reasonable to expect that there is a static stability/mean wind speed limit in SAR's ability to detect the presence of MABL convection. This limit is when the mottling variability approaches zero but the MABL is still convective, not neutral. In short, it is hypothesized that SAR is not a perfect convection finder. This poses a potentially serious problem when employing SAR to deduce the near-surface wind speed in a convective MABL because this deduction is based on mottling variability and its relation to convective variability. The proposed research will investigate how the variability of kilometer-scale mottled SAR backscatter varies with both MABL static stability and mean wind speed so that this potential problem can be accounted for.

The Maury Project - Exploring The Physical Foundations of Oceanography

Researcher: Associate Professor David R. Smith

Sponsor: National Science Foundation and Commander,

Naval Meteorology and Oceanography Command

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 oceanographic 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. This year I was heavily involved in writing proposals to fund a distance learning program for teachers on topics in physical oceanography - still awaiting word on proposal to the National Science Foundation.

Research Course Projects

A Theoretical Approach to Estuarine Optics

Researcher: Midshipman 2/C James E. Coleman, Jr., USN

Advisers: Adjunct Associate Professor Richard W. Spinrad and Associate Professor David R. Smith

This research project is an in-depth study into the causes of optical variability in the northern Chesapeake Bay during the Fall destratification period. The purpose is to contribute a data base of optical characteristics of the Bay by periodically making in situ measurements using sensors on-board YP-686. Drawing upon knowledge of the biogeochemical characteristics of the Bay during the destratification period and using various statistical techniques to filter the data, we are able to account for the sources of optical variability in the northern Chesapeake Bay. This knowledge will be later used to develop an optical model to predict the optical characteristics within an estuarine environment.

Optical Variability in the Northern Chesapeake Bay

Researcher: Midshipman 2/C James E. Coleman, Jr., USN

Advisers: Adjunct Associate Professor Richard W. Spinrad and Associate Professor David R. Smith

This research project is a continuation of the study into the causes of optical variability in the northern Chesapeake Bay begun during the Fall 1997 semester. The purpose is to enhance the data base collected during the fall destratification period with additional in situ measurements collected during the spring season. These data will provide conditions to constrast with the destratified state that might serve as a baseline for the optical state of the Bay. Radiative transfer theory will be applied to the data to develop the predictive optical model for an estuary.

Analyzing Atmospheric Conditions that Cause Heavy Precipitation

Researcher: Midshipman 1/C Christopher J. Domencic, USN

Adviser: Associate Professor David R. Smith

Heavy precipitation and flash flooding is the single largest weather contributor to death in the United States. The National Weather Service and the Office of Hydrology are very interested in techniques to improve quantitative precipitation forecasting. This study examines an intense rainfall event that occurred in July 1997 over Kentucky and Tennessee. The study utilizes PC-GRIDDS, a software package developed by the National Weather Service to analyze model output data. This project is being done in conjunction with the National Weather Service Forecast Office in Coraopolis, PA.

Teleconnections between the El Nino and La Nina Phenomenon and Hurricane Frequency and Intensity in the North Atlantic, Caribbean Sea, and Gulf of Mexico

Researcher: Midshipman 1/C Danny Garcia, USN

Advisers: Associate Professor David R. Smith and

Adjunct Associate Professor Alan E. Strong

This paper examines the connection between El Nino and its impact on the tropical Pacific waters and the frequency and intensity of tropical storms over the North Atlantic Ocean, the Caribbean Sea and the Gulf of Mexico. This concept, called teleconnections, demonstrates the magnitude of this interannual atmospheric-oceanic event. The El Nino of 1997-98 is generally accepted as the strongest such phenomenon in recorded history. An analysis of Sea Surface Temperatures (actual and anomalies) is performed to determine the strength of the event. Previous El Nino events and the corresponding tropical storm occurrences are correlated to determine the strength of the teleconnection. The opposite event, called La Nina, are also examined to determine its relationship to tropical storm occurrence. The expected result is that El Nino is followed by low frequency of tropical storms, and La Nina by higher occurrences.

Skylight Polarization at Sunset

Researcher: Midshipman 1/C Jeannette Gaudry, USN

Adviser: Adjunct Assistant Professor Raymond L. Lee, Jr.

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 image analysis of color slides, occasionally corroborated by spectroradiometry, to explore the photometric, polarimetric, 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 Prof. Lee's assistance, Midn. 1/C Gaudry took several sequences of 4-image polarization photographs in October 1997; subsequent image analysis was the basis for Gaudry's well-received December 1997 and May 1998 research presentations.

Global Warming: A Study in a Hotly Debated Phenomenon

Researcher: Midshipman 1/c Kenji K. Gjovig, USN

Advisers: Associate Professor David R. Smith and

Adjunct Associate Professor Alan E. Strong

A century ago, the Swedish scientist Svante Arrhenius argued that the burning of fossil fuels could heat the climate because the magnitude of carbon emissions from the burning is significant enough to have an impact on the atmospheric carbon dioxide concentration (Weart, 1997). Little did he know that this phenomenon would grow into one of today's most hotly debated topics in the media. Scientists and journalists alike throw their opinions into the chais in what is often a mostly futile attempt to clear up the confusion. Isa anyone much closer to the truth about global warming? Unfortunately, at the moment the short answer to this question is "no," and for two reasons. First of all, there is a lack of understanding about the physical processes and feedbacks which are involved in global warming well enough to predict long-term climate responses to forcing mechanisms. Second, there is insufficient global data to accurately represent the long term climate variability of the planet. However, based on limited data collected on global warming, the threat of runaway warming seems very far away.

Toxic Algae: Are Phosphates and Nitrates the Real Cause?

Researcher: Midshipman 1/C Ashley Harrison, USN

Advisers: Professor John Foerster, Professor Doug Edsall,

Adjunct Associate Professor Alan Strong

An estuary is an interface, a region where the salt water of the sea mixes with the freshwater of the river. Because of unique biological production, this natural interface area is vulnerable to environmental changes. In this interface, biological production is high and any changes are noticeable; noticeable whether it is the reduction of harvestable resources, the loss of wetlands, or the development of toxic algal blooms. It matters not that these changes are naturally or anthropogenically induced. The overall problem is not laying the blame but understanding the effects of changes on a dynamic system. In the case of toxic algal blooms, like pathogens, the disease develops because of factors no longer controlled by the host environment. The "pathogen" develops because it is an opportunistic species and the conditions are good for its growth. The only control on this species is to enhance the environment so it can regain ecological equilibrium. With toxic algae, the assumption, based on laboratory and field data, is that increased loading of coastal marine environments with nitrates and phosphates creates a condition suitable for excessive growth. With dinoflagellates like Pfeisteria, it seems that the nutrients, plus warm water temperatures and runoff after a storm triggers explosive growth. Is this the whole story? Could it be the runoff creating a different chemical environment more conducive to growth that initially has nothing to do with nitrates and phosphates? In our zeal to seek a simple solution to a complex problem, have we not overlooked the runoff and what it contributes besides nutrients? What of the humic substances and their chelation capabilities?

What of the particulate matter and the absorptive and adsorptive capacities? Our purpose in presenting this paper is to stimulate thinking and research into what we feel is the actual underlying cause of the "epidemics." We present initial studies into what we believe really underlies these episodic events and that is the trace metals. To answer these questions we test the hypothesis that after rainfall, the runoff carries compounds that remove growth inhibiting trace metals. Once the trace metals temporarily disappear, the toxic algae bloom appears. For this study we target copper because it is both beneficial and toxic and has the possibility of being used for remedial treatments. Preliminary laboratory studies show that particulate organic matter removes ionic copper from estuarine water (10 - 14ppt) within 48 hours. Our work is in progress. However, based on preliminary analysis and literature searches, we become more certain that the driving force behind the chaotic bloom patterns is the absence of trace metals. The nutrients are only the food whose high concentrations exacerbate the problem.

Stratification Effects on Water Quality in the Severn River Estuary

Researcher: Midshipman 1/C Brendan Higgins, USN

Adviser: Associate Professor Mario Vieira

Time series of temperature, salinity and dissolved oxygen were taken between 15 September and 7 October 1997 at two locations in the Severn River estuary. Two YSI6000 instruments were attached to the same fixed structure, one close to the bottom and the other close to the surface. It is determine that the density is influenced mostly by the temperature and not so much by the salinity; the fall cooling of the atmosphere determining the observed increasing trend in water density. The column is seen to oscillate between stratified and unstable conditions as a result of the surface cooling. The consequences of these fluctuations in the stability of the column can be best seen in the resulting time series of oxygen concentration. The dissolved oxygen on the bottom of the column is negatively correlated with the strength of the column static stability, while the concentration at the surface is essentially independent of the stability. These data demonstrate clearly how strong stratification of the water column prevents the oxygenation of the bottom environment, leading to hypoxic conditions.

Examination of the Development of an Extratropical Cyclone over the Eastern United States (6-9 Jan 1996)

Researcher: Ensign 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 March 1993 case, the moisture maximum appeared to be displaced further from the storm center, hence it was less efficient in producing snow.

A Study of Extratropical Cyclone Tracks during an El Nino winter (DEC 1997 - MAR 1998)

Researcher: Midshipman 1/C Matthew J. Ledridge, USN

Adviser: Associate Professor David R. Smith

This study examines the tracks of extratropical cyclones entering the West Coast of the United States, across the country and exiting the East Coast during the period 1 DEC 1997 - 31 MAR 1998. This period is generally considered the most intense El Nino period to date, so the purpose is to compare cyclone tracks during the period and compare against climatological records to determine the impact of El Nino on winter storms. Cyclones will be counted over the period of interest for areas (5 deg by 5 deg) along the West Coast, Central U.S. and East Coast to determine if the frequency of cyclones differs from climatological normals. Weather parameters (temperatures and precipitation amounts) will be examined to see if there are significant departures from typical winter conditions.

The Automated Weather Source System: A Useful Research Tool

Researcher: Midshipman 1/C Matthew J. Marcuson, USN

Adviser: Assocociate 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. Michael'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 Study of the Dynamics of the Severn RiverWater Column

Researcher: Midshipman 1/C Jennifer Marino, USN

Adviser: Associate Professor Mario E. C. Vieira

In late September and early October of 1997, a study was conducted of the vertical and lateral gradients of various hydrodynamical variables of the Severn River water column. In order to create a cross-sectional picture of the tendencies of density, salinity, temperature, and dissolved oxygen, transects across the river were made at two points: west to east from Triton Light to the David Taylor Research Center, and east to west beginning at Channel Marker Four, just south of Brewer Point. Data was collected using a conductivity-temperature-depth meter (CTD) at evenly spaced stations across the river. Using a computer profiling program, two dimensional plots were generated of the four variables studied. Comparing the direction of the density gradients with actual data from an acoustic doppler current profiler (ADCP) showed parallels between current flow in the Severn River and actual geostrophic flow.

A Study of the Circulation in the Lower Reaches of the Severn River Estuary

Researcher: Midshipman 1/C Stephen N. McClune, USN

Adviser: Associate Professor Mario E. C. Vieira

The purpose of this experiment was to document and study the lateral structure of circulation in the Severn River Estuary under different tidal regimes as related to tide and meteorological forcing. The researchers obtained data from YSI6000, CTD, and Acoustic Current Doppler Profiler (ADCP). The data from the ADCP is the focus of this study. The frequency which is reflected off of "sound scatterers" in the water column such as sediment or plankton. It also records the relative backscatter of the signal in dB to determine the concentration of these "sound scatterers" within the water column. The researchers performed the experiment in the late afternoon on three different days, making three to four transects each day. A flood current occurred on two of these days and the third was an ebb. From this data, the researchers obtained profiles of current projected on the axis of the river and relative backscatter. They also made plots of wind projection on the river, as they observed it having a significant affect on the surface currents. From the plots, they concluded that there is a core of the fastest currents in the channel. Slower current speeds existed in the shallower waters near shore. Also, profiles also indicated that the wind played a significant role in the currents. During a maximum flood of the river, the surface currents were being blown in the ebb direction down to a depth of approximately 2 m. High concentrations of "sound scatterers," most likely sediment, were found to be at the bottom of the channel. A large void often existed in the middle of the water column and channel, extending to the surface many times. Sometimes, there were large "patches" of high concentrations of "sound scatters," most likely photoplankton, or zooplankton.

Knowledge of current patterns within an estuary are important to the Navy because they determine the placement of docks, piers, and dredging operations, and also play a factor in underwater SCUBA exercises.

The Gulf Stream: The Development of an Educational Web Page

Researcher: 1/C Midshipman Pamela. J. Phillips, USN

Adviser: Assistant Professor Todd. D. Sikora

An educational web page has been developed by Midshipman 1/C Pamela J. Phillips, with the support of the Ocean Remote Sensing Group of The Johns Hopkins University Applied Physics Laboratory. The web page consists of a time-line history of the Gulf Stream and is in a format such that it can be employed by schools for teaching purposes.

Observations and Analysis of a Warm-Fresh Oceanic Front Coupled with a Cool-Moist Atmospheric Front at Duck, North Carolina

Researcher: Midshipman 1/C Michael D. Wisecup, USN

Adviser: Assistant Professor Todd D. Sikora

In May of 1996 the Ocean Remote Sensing Group of the Johns Hopkins University Applied Physics Laboratory led an effort to investigate radar scattering from the ocean at a pier near Duck, NC. The experiment employed meteorological instruments, ocean current meters, CTDs, and pier and land based radars.

On the afternoon of May 12, 1996 a clearly defined oceanographic front approached the pier from the east. Before the front's arrival the ocean was colder and more saline, with a 10-20 cm/s current to the southeast. After the front's arrival, the ocean was warmer and fresher, with a 40 cm/s current to the northwest. The arrival of the oceanographic front was associated with the arrival of a cold, humid air mass with characteristics similar to that of a sea breeze.

Observations and theory support the hypothesis that the forcing behind this form of air-sea interaction was the relaxation of coastal upwelling, and subsequent Ekman transport of warm-fresh surface water shoreward. This warm-fresh water mass was convectively coupled with the overlying airmass. Therefore, as the warm-fresh water mass propagated towards shore, so to did the overlying airmass.

Publications

FOERSTER, John W., Professor, "Sentinel Species: Trace Metal Ecotoxicology in The Oyster Toadfish *(Opsanus tau)*, U.S.E.P.A. Marine and Estuarine Shallow Water Science and management Conference Proceedings, pp. 119-129.

Oyster toadfish (*Opsanus tau*) are a resident, non-migratory part of the estuarine benthic food web along the U.S. eastern coast. They are a sentinel species with the potential to extract toxic environmental trace metals. To test this hypothesis, we are studying toadfish resident in the Chesapeake Bay near Annapolis, Maryland. This area is away from any direct industrial or commercial effluents carrying trace metals but has concentrations of trace metals in the benthic sediments. Using a proton induced x-ray emissions (PIXE) system, this study concentrates on trace metals found in the liver. The PIXE system allows us a rapid method to determine trace metal types, concentrations and an archiving method for samples. Present analyses of various size toadfish show that the livers contained concentrations of chromium (5.9-51.7 mg/L), copper (3.3-26.0 mg/L), and zinc (8.6-29.9 mg/L). The trace metal amounts vary as a function of the size, age, and sex of the fish. Copper and chromium concentrations deplete with age after the reproductive phase, while zinc concentrations increase. Generally, the trace metals have an accumulation pattern of chromium>zinc>copper. Thus the life history of the animal appears as an important factor in trace metal accumulation, and leads us to accept the hypothesis.

FOERSTER, John W., Professor, "American Shad:

Pattern of change in the Northern Chesapeake Bay," Charting the Future of Coastal Zone Management, pp. 882-884, 1997.

In the northern Chesapeake Bay, the American shad (Alosa sapidissima) is a useful sentinel for environmental change and harvesting (Figure 1). This is an anadromous fish returning from the ocean to spawn in the freshwater rivers entering the Bay. Using this fish as an enviromarker allows a view of the changes in the northern Chesapeake Bay habitat over the past 120 years. These changes include modifications to the animals' environment (loss of spawning ground, habitat modifications from tropical storms, introduced species, sedimentation) and increased harvesting pressure (Mansuetti and Kold 1953, Foerster and Reagan 1977). Many of the changes are permanent so it is important to study this animal to see if and how it survives (Figure 2). Commercial catch (down 98% in the last 55 years) reflects not only the harvesting pressure but the survivability of the American shad. Much of the catch reduction is a result of recruitment overfishing. To further accentuate the commercial catch statistics is the level of recruitment to the population in the form of juveniles. As the commercial catch increases and habitat changes, the juveniles become less abundant. Therefore, the American shad reflects the environment of the northern Chesapeake Bay and is an enviromarker for change.

GUTH, Peter L., Associate Professor, 1997, "Teaching Plate Tectonics and Marine Geophysics to Introductory Students with a Microcomputer": Journal of Geoscience Education, vol.45, no.5, pp. 451-455.

The Marine Geophysics Trainer program allows students to manipulate and visualize bathymetric, gravity anomaly, and magnetic anomaly grids.

Labs using data sets cover key plate tectonic features and key concepts like the appearance of the sea floor at regional scales, the age-depth relationship for ocean crust, the pattern of marine magnetic anomalies, and the patterns of gravity anomalies and the geoid. This interactive lab for an introductory oceanography or geology class serves four functions: teach or reinforce key concepts from lecture; show variability in nature; practice critical thinking/problem solving; and reinforce computer skills. Advanced options of the program would be suitable for other courses.

GUTH, Peter L., Associate Professor, (co-author), 1997, "A Realistic Microcomputer Exercise to Teach Geologic Reasoning: Journal of Geoscience Education", vol.45, no.4, pp. 349-353.

The DRILLBIT computer program simulates geology so that introductory geology students can learn the logical processes used by geologists to develop the history of a region. Designed to function as an end of semester project, the exercise shows students how scientific research would support a problem in the "real" world. Starting with knowing the surface geology, students simulate drilling holes and staying within a finite budget to unravel the subsurface geology. The computer handles

details of budget and provides a drill log at any desired location, allows multiple ways to visualize the drill log data, and automates tedious work so that students can concentrate on understanding concepts. The exercise integrates the topics covered in a first semester physical geology course, provides an interesting challenge for students of all ability levels, and can be used to develop team skills.

GUTH, Peter L., Associate Professor, 1997, "George Montague Wheeler": in Sterling, K.B., Harmond, R.P., Cevasco, G.A., and Hammond, L.F., eds., Biographical Dictionary of American and Canadian Naturalists and Environmentalists, Greenwood Press, pp. 817-820.

George Montague Wheeler was the last Army explorer of the American west, attempting to continue the work and traditions of the Corps of Topographical Engineers which merged with the Corps of Engineers during the Civil War. He viewed the goal of mapping to "furnish all the practical topographical information required by the Government and people in these thinly settled areas. With the necessary revisions, as slowly-increasing settlement shall demand, it becomes of permanent value." But the frontier was fading and with it the need for exploration; working scientists no longer needed Army escorts and the rising scientific class chafed under the leadership of junior military officers. Wheeler was left lamenting the shift in government mapping from providing practical final

products to providing a base for scientific studies.

GUTH, Peter L., Associate Professor, 1997, "TerraBase II [computer program]", Terrain Visualization [CD-ROM], U.S. Army Engineer School, Version 1.0, Sept. 1997.

TerraBase II is a training system to expose soldiers to the nature and types of digital terrain data, procedures for visualizing terrain, and integrating terrain into tactical planning. The program runs on standard desktop, laptop, and notebook computers with the Windows 95 or NT operating system, and uses standard terrain data from the National Imagery and Mapping Agency. The program provide base maps for tracking situation, terrain computations (e.g. line of sight, slope for cross country mobility, sunrise/sunset), and 3D visualizations. The program integrates digital elevation models and satellite imagery.

GUTH, Peter L., Associate Professor, 1997, "Tectonic geomorphology of the White Mountains, eastern California": Geological Society of America Abstracts with Programs, vol. 29, no. 6, pp. A-235.

Analysis of Landsat TM imagery, digital elevation models (DEMs), and published geologic maps supports an overview classification of the White Mountains. They form a northward tapering block bounded to the west by the White Mountains and Owens Valley fault zones, to the southeast by the Deep Springs fault zone (DSFZ), and to the east by the Fish Lake Valley fault zone. The asymmetrical range has steeper slopes to the west facing Owens Valley, suggesting eastward tilting of the entire block on the normal DSFZ. White Mountain Peak, the highest point in the range, marks a major geomorphic break. To the north both eastern and western flanks exhibit much greater dissection than to south. South of White Mountain Peak, a gently-sloping, low relief region forms the wide apex of the range northwest of the Deep Springs fault; I will refer to this as the Blanco Mountain wedge (BMW). Dissected by several major streams (Cottonwood, Wyman, and Birch Creeks), the BMW may represent a Miocene erosional surface. Gravel clast compositions suggest Miocene drainage westward from the current Last Chance Range.

GUTH, Peter L., Associate Professor, 1998, "Letter to the editor, comment on The influence of timescales in basin modeling calculations, by R.O. Thomsen and I. Lerche, Computers & Geosciences, 23, 33-44": Computers & Geosciences, vol.24, no.1, pp. 101-103.

The recent paper by Thomsen and Lerche presented the intriguing

postulate that refinements to the geologic time scale tend to home in on the mean of recent estimates, and that we have reached a limit in our ability to resolve the timing of boundaries. Unfortunately, several procedural flaws underlie the work and considerably weaken the argument. This letter presented the following flaws in their analysis: insufficient data to define any statistical distribution, inability to differentiate a normal distribution from a log-normal, errors in applying the statistics of a log-normal distribution, and examples of several age horizons whose dating does not support the model.

GUTH, Peter L., Associate Professor, 1998, "Structural analysis of digital topography": EOS, EOS, vol.79, no.17, pp. S339.

Quantitative studies of the earth's surface topography have been hampered by the limited availability of digital elevation models (DEMs) and the lack of algorithms to deal with huge data sets. The increasing availability of digital data and the increasing power of microcomputers promise to revolutionize the quantitative study of geomorphology on a variety of scales. This work continues the structural geology analogy for topographic analysis and presents eigenvector analysis of the normal vectors computed at each internal point in the DEM and a resulting landform classification. The classification considers both the steepness of the terrain and the degree of organization of its grain or orientation.

GUTH, Peter L., Associate Professor, 1998, MICRODEM: in Poloni, C., ed., GRIPS-98 [Government Raster Image Processing Seminar] at SIGCAT-98 [Special Interest Group on Cd Applications & Technology] Demonstration CD-ROM, Baltimore, MD, May 1998.

This CD-ROM contains samples of government mapping and image processing software. The MICRODEM portion contains the program, sample data, sample data including terrain fly bys, and links to

additional sites on the World Wide Web.

LEE, Raymond L. Jr., Visiting Assistant Professor, "Digital imaging of clear-sky polarization," Applied Optics, v. 37 (1998), pp. 1465-1476.

If digital images of clear daytime or twilight skies are acquired through a linear polarizing filter, they can be combined to produce high-resolution maps of skylight polarization. Here polarization P and normalized Stokes parameter Q are measured near sunset at one inland and two coastal sites. Maps that include the principal plane consistently show that the familiar Arago and Babinet neutral points are part of broader areas in which skylight polarization is often indistinguishably different from zero. A simple multiple-scattering model helps explain some of these polarization patterns.

LEE, Raymond L., Jr., Visiting Assistant Professor, "Mie theory, Airy theory, and the natural rainbow," Applied Optics, v. 37 (1998), pp. 1506-1519.

Compared with Mie scattering theory, Airy rainbow theory clearly miscalculates some monochromatic details of scattering by small water drops. Yet when monodisperse Airy theory is measured by perceptual (rather than purely physical) standards such as chromaticity and luminance contrast, it differs very little from Mie theory. Considering only the angular positions of luminance extrema, Airy theoryUs errors are largest for small droplets such as those that dominate cloudbows and fogbows. However, integrating over a realistic drop-size distribution for these bows eliminates most perceptible color and luminance difference between the two theories.

ROBICHAUD, Raymond, Lieutenant Commander, USN, (co-author), (1998): "The Maury Project - A Look to the Future." Preprints of the 7th AMS Symposium on Education, American Meteorological Society, Boston MA, J5-8.

See David R. Smith's input.

SALTZMAN, Jennifer, Adjunct Assistant Professor, "Zooplankton ecology in the eastern tropical Pacific oxygen minimum zone above a seamount: 1. General trends, Deep-Sea ResearchI, Vol. 44, No 6, pp. 907-930, 1997.

The distribution of zooplankton in the oxygen minimum zone (OMZ) of the eastern tropical Pacific and near a seamount was investigated. The oxygen minimum layer appeared to be an important factor influencing the vertical distribution of zooplankton taxa below the thermocline. The maximum zooplankton in terms of biomass and numbers was in the thermocline zone, with a secondary maximum in the depth zone that included the lower OMZ interface (600-1000 m). Most taxonomic groups showed this secondary peak in abundance in the lower OMZ interface depth zone and minimum abundances above it. The secondary maximum in zooplankton at the lower OMZ interface seems to be unique to OMZ regions. Only lavaceans and mollusks did not appear to be strongly influenced by the minimum concentrations of oxygen. Four vertical distribution patterns characteristic of different taxonomic groups may be indicative of their different tolerances to minimum oxygen concentrations. The physical intrusion of the seamount (summit at 730 m depth) did not cause major changes in the distribution of pelagic zooplankton. Significant biological and physical differences between locations above and away from the seamount were found only within the upper OMZ (100-300m).

SALTZMAN, Jennifer, Adjunct Assistant Professor, "Zooplankton ecology in the eastern tropical Pacific oxygen minimum zone above a seamount: 1. General trends," Deep-sea Research I, Vol. 44, No. 6, pp. 931-954, 1997.

The abundance and vertical distribution (0-1230 m) of copepods were studied in the eastern tropical Pacific near the seamount Volcano 7 to examine the influence of the extreme oxygen minimum zone (OMZ). Maximum zooplankton biomass and copepod abundance were in the thermocline zone. A secondary peak in biomass and copepod abundance was evident between 600 and 1000 m, which included the depth of the lower interface of the OMZ. This prominent secondary peak in zooplankton is a feature unique to OMZ regions.

There were four general trends of vertical distribution of copepod abundance. These trends appeared to be related to the oxygen concentration and gradients. The most common vertical distribution was a pattern of maximum abundance in the mixed layer and thermocline zones, with a secondary maximum in the zone of the lower OMZ interface (600-1000m). Clausocalanus spp., Oncaea, spp., Euchaeta spp. Oithona spp. and Corycaeus spp. showed this trend. Low oxygen concentration did not appear to restrict these groups, since they were present throughout the OMZ. The second vertical distributional pattern was vertical migration between the thermocline and the OMZ. Pleuromamma robusta showed this pattern, with maximum abundance at night in the thermocline zone and during the day in the core of the OMZ. In addition, there was a secondary maximum of abundance at the lower OMZ and at the lower OMZ interface zones. Eucalanus inermis, Haloptilus paralongicicccus and Heterostylites longicornis were dominant copepod species that exhibited this pattern. They were either

absent from the mixed layer or at similar abundances in the mixed layer and upper OMZ. The fourth pattern was shown by copepod species that live primarily above the OMZ day and night.

The majority of the species appeared to be tolerant of the extreme low oxygen concentrations. Rhincalanus spp. Was the dominant copepod that was excluded by low oxygen concentrations. In general, species also found in other OMZ regions showed similar distributions in this study, indicating that low oxygen is a major controlling factor. Some vertical niche separation among congeneric species was indicated for Eucalanidae, Metridiidae and Augaptilidae.

SALTZMAN, Jennifer, Adjunct Visiting Professor, (co-author), (1998): "The Maury Project - A Look to the Future." Preprints of the 7th AMS Symposium on Education, American Meteorological Society, Boston MA, J5-8.

See David R. Smith's input.

SIKORA, Todd D., Assistant Professor, (co-author), 1997, "Stability Correction of Surface Winds Derived from Synthetic Aperture Radar," Preprints, Twelfth Symposium on Boundary Layers and Turbulence, AMS, Vancover, British Columbia, Canada, 28 July - 1 August 1997, pp. 486-487.

Satellite-borne scatterometry provides a means of estimating the wind speed in the atmospheric surface layer via measurements of backscatter from the ocean surface. A scatterometer equation is first used to relate the observed backscatter intensity to the surface stress. The surface stress is then related to the surface wind speed via a drag-law type similarity relationship. The stability dependence of the drag coefficient has generally been ignored because of the difficulty in ascertaining the surface layer stability. Because this stability correction can easily exceed 10%, a method is needed for estimating the surface layer stability from remote sensing measurements. Such an estimate is possible using synthetic aperture radar because its 10-m scale resolution is considerably finer than that of scatterometers. This capability provides the foundation for the stability estimation and correction described in the current research.

SIKORA, Todd D., Assistant Professor, (co-author), 1997: "Kilometer-scale Patterns on Synthetic Aperture Radar Imagery of the Sea Surface caused by Marine Atmopshere Boundary Layer Convective Eddies," Preprints, Twelfth Symposium on Boundary Layers and Turbulence, AMS Vancover, British Columbia, Canada, 28 July - 1 August, 1997, pp. 182-183.

In order to study efficiently the stress variability at the sea surface produced by boundary layer spanning convection (BLSC), such as those evident on synthetic aperture radar imagery of the sea surface, we develop a three-dimensional, nonlinear dynamical system. The BLSC are modeled using the shallow Boussinesq equations, in which a height-dependent mean wind is included. We assume that the BLSC scale with the boundary layer depth and interact with the ocean surface via transfers of momentum and heat through the surface layer; these transfers occur via eddies on order 1 - 10 m.

SIKORA, Todd D., Assistant Professor, (co-author) 1997: Estimating convective atmospheric boundary layer depth from microwave radar imagery of the sea surface. J. Appl. Meteorol., pp. 36, 833-845.

Kilometer-scale mottling seen on real and synthetic aperture radar imagery of the sea surface can be linked to the presence of microscale cellular convection(thermals)spanning the marine atmospheric boundary layer. In the current study, it is hypothesized that the typical scale of the mottling, found via standard Fourier spectral analysis, can be used to estimate the depth of the convective marine atmospheric boundary layer (z_i) using a modified form of traditional mixed-layer similarity theory for these thermals aspect ratio. The hypothesis linking the typical scale of mottling to z_i is substantiated using previously published boundary layer results and supporting meteorological and oceanographic data from a number of case studies.

SIKORA, Todd D., Assistant Professor (co-author) 1997: Satellite imagery of sea surface temperature cooling in the wake of Hurricane Edouard (1996). Mon. Wea. Rev., 125, pp. 2716-2721.

A series of Advanced Very High Resolution Radiometer images are presented as evidence of sea surface temperature (SST) reduction in the wake of Hurricane Edouard. Edouard traversed northward off the east coast of the United States during late August and early September, 1996. The images show a swath of 4°C SST reduction in the region which was centered slightly east of the track of Edouard s eye. This SST reduction is attributed to mixing and upwelling in response to the Edouard s circulation.

SIKORA, Todd D., Assistant Professor, (co-author), 1998: "Observations and Analysis of a Warm Fresh Ocean Front Coupled with a Cool Moist Atmosphere Front at Duck, North Carolina," Preprints, Second Conference on Coastal Atmosphere and Oceanic Prediction and Processes, AMS, Phoenix, Arizona, 11-16 January, 1998, pp. 249-252.

During the period from 2 may 1996 to 22 May 1996,

an experiment was conducted at the United States Army Corps of Engineers Field Research Facility pier at Duck, North Carolina. This experiment to study the surface effects of submerged objects was supported by remote sensing and in situ instrumentation. During the experiment, a strong oceanic front passed by the instrumentation moving towards shore. A simultaneous change in atmospheric boundary layer structure was observed as the oceanic front passed the instrumentation.

This research presents data associated with the above described event and proposes hypotheses for its forcing.

SIKORA, Todd, D., (co-author), 1998: "Air-sea Interaction Associated with the Relaxation of an Upwelling Event off the Coast of Duck, North Carolina," 1998 Ocean Sciences Meeting, AGU, San Diego, California, 9-13 February 1998.

Off the outer coast of Duck, NC, during the afternoon of May 12, 1996, a clearly defined ocean front approached the coast from the east. It was parallel to the beach and stretched from horizon to horizon. Before the front arrived, the entire water column was 13° C, it had a Sigma T value of 24, and it was flowing to the southeast along the coast at approximately 10-20 cm/s. Within minutes of the front's arrival, the top 4 m warmed to 14.5°C, the Sigma T fell to 22, and the current flow was 20 cm/s toward shore at the surface and up to 12 cm/s off shore at the bottom. Ten minutes after the front's arrival, the entire water column flowed to the northwest at over 40 cm/s. The arrival of the oceanic front was associated with an air temperature drop of 4°C and a rise in relative humidity of 20%. The oceanic front appears to be associated with the relaxation of an upwelling event. It appears that the atmospheric front is driven by air-sea interaction associated with the discontinuities in the water mass temperature.

SMITH, David R., Associate Professor, (co-author) (1997): "The Maury Project - An Educational Partnership in Oceanography". *Bulletin of the American Meteorological Society*, 78(7), pp. 1497-1502.

The education program of the American Meteorological Society established a unique partnership in 1994 with the United States Naval Academy and oceanographic agencies of both NOAA and the Navy. This partnership, called the Maury Project, was formed to promote the study of the physical foundations of oceanography for precollege teachers. The primary activity of the Maury Project has been two-week summer programs for teachers hosted by the Oceanography Department at the Naval Academy. In addition, a variety of educational materials have been developed to provide participating teachers with topics to conduct workshops for their colleagues in their home states. In the two years since the first Maury Project summer workshop, Maury peer-trainers have conducted approximately 200 workshops reaching some 3600 teachers at a variety of conferences and other in-service training sessions.

This paper focuses on the partnership aspect of the Maury Project. The combination of a variety of organizations involved in both the operational and research activities of physical oceanography provides a network of individuals and resources which can greatly enhance teaching about this discipline. The overall characteristics of the program are described and major outcomes from the first three years are outlined.

SMITH, D.R. Associate Professor, (co-author) (1998): "The Maury Project - A Look to the Future". *Preprints of the 7th AMS Symposium on Education*, Amer. Meteor. Soc., Boston, MA, J5-8.

The Maury Project was established in 1994 as a joint venture of the American Meteorological Society (AMS) and the United States Naval Academy, with funding from the National Science Foundation, as a pre-college teacher enhancement program on the physical foundations of oceanography. Since its initiation both the Navy (Naval Meteorology and Oceanography Command and the Office of Naval Research) and NOAA (National Environmental Satellite, Data, and Information Service and the National Ocean Service) have become full members in this unique educational partnership. The primary activity of the Maury Project has been annual two-week summer workshops for teachers on various aspects of physical oceanography. The participant teachers then become peer-trainers, conducting workshops for their colleagues, normally at statewide science teachers conferences, using teacher guides on various topics on the physical aspects of oceanography as the subject matter area of the workshops. These workshops have reached thousands of teachers nationwide over the past four years.

The presentation will focus on the accomplishments of the Maury Project over the past four years. Additionally, there will be a look to the future directions of the Maury Project. In particular, the Maury Project is exploring the development of a distance learning course using web-based instruction and activities utilizing actual oceanographic data bases to enhance teachers' background on the physical foundations of oceanography. Such an approach would enable the Maury Project to reach even greater numbers of teachers with the power and versatility of the Internet.

SMITH, David R., Associate Professor, (co-author), (1998): "Meeting Report on the Sixth AMS Symposium on Education", *Bulletin of the American Meteorological Society*, 79(3), pp. 457-466.

The American Meteorological Society held its Sixth Symposiumon Education in conjunction with the 77th Annual Meeting in Long Beach, California. The theme of this year's Symposium was "Atmospheric and Oceanographic Education: Teaching about the Global Environment". Thirty-eight oral presentations and 37 poster presentations summarized a variety of educational programs or examined educational issues for both the precollege and university levels. There was also a joint session with the Eighth Symposium on Global Change Studies and a special session on "homepages" to promote popular meteorological education. 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 teaching about the global environment.

SMITH, David R., Associate Professor, (co-author), (1998): "Report on the Fourth International Conference on School and Popular Meteorlogical and Oceanographic Education". *Bulletin of the American Meteorological Society*, 79(7), pp. 1387-1395.

The Fourth International Conference on School and Popular Meteorological and Oceanographic Education was held 22-26 July 1996 in Edinburgh, Scotland. Conference attendees included 125 educators, meteorologists, oceanographers, and government officials representing 19 nations. The themes of the conference were the roles of meteorology and oceanography in science education and the benefits derived from improved environmental awareness and scientific literacy, particularly weather awareness, meteorological literacy, and understanding of the ocean. Formal presentations, workshops, poster sessions, and demonstrations provided information on programs for teacher enhancement, computer-aided instruction, and classroom access to real-time weather information though the World Wide Web.

SMITH, David R., Associate Professor, (co-author), (1998). "A Comparitive Study of Two Winter Coastal Storms: 6-9 Jan 1996 and 12-15 Mar 1993", *Preprints of the 16th Conference on Weather Analysis and Forecasting*, Amer. Meteor. Soc., Boston, MA, pp. 424-427.

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 March 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 March 1993 case, the moisture maximum appeared to be displaced further from the storm center, hence it was less efficient in producing snow.

SMITH, David R., Associate Professor, (co-author), (1998). "A Study of a Coastal Extratropical Cyclone Using an Automated Observation System", *Preprints of the 10th Symposium on Meteorological Observations and Instruments*, Amer. Meteor. Soc., Boston, MA, pp. J26-29.

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. Michael'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.

VIEIRA, Mario, E. C., Associate Professor, (co-author), (1998): "The Maury Project - A Look to the Future." Preprints of the 7th AMS Symposium on Education, American Meteorological Society, Boston MA, J5-8.

See David R. Smith's input.

WHITFORD, Dennis J., Captain, USN (co-author)(1997): "Making Science Come Alive, Bucking the Declining Science Major Enrollment Trend at Annapolis." *Journal of College Science Teaching*, Vol. XXVII, No. 2, 109-113. (cover page

article)

In recent years, national enrollments in Mathematics and Science majors have declined significantly. Between 1966 and 1988, the percentages of college freshman planning to major in mathematics and physical sciences fell by half, from 11.5% to 5.8% (Green, 1989). Specifically, bachelor degrees conferred in the physical sciences have significantly decreased by 40%, that is, from 2.5% to 1.5% of all bachelor degrees conferred in the U.S., from 1970 to 1993 (U. S. Department of Education, 1995).

This national trend has also been observed at the U.S. Naval Academy (USNA). However, the USNA Oceanography major has "bucked this trend" and experienced increasing enrollment over the past 17 years. The purpose of this paper is to share some departmental initiatives which may contribute to the popularity of the major. Additionally, a survey of academic institutions offering an undergraduate degree in oceanography was conducted. The survey's first purpose was to determine whether other undergraduate oceanography programs were experiencing increasing enrollments. The survey's second purpose was to determine if the same types of initiatives addressed in this paper were correlated to their increasing enrollments. Results of the survey will be discussed. The paper will close with a focus on a non-academic credit, oceanography "at sea" cruise which occurs before the major even begins, and which is felt to contribute to increasing enrollment.

WHITFORD, Dennis J., Captain, USN, (co-author), (1998): "The Maury Project - A Look to the Future." Preprints of the 7th AMS Symposium on Education, American Meteorological Society, Boston MA, J5-8.

See David R. Smith's input.

WHITFORD, Dennis J., Captain, USN, (co-author), (1998): "Environmental Science Education at the United States Naval Academy." Invited paper and presentation at *Third International Symposium on Technology and the Mine Problem*, CD-ROM, Monterey CA, April 98.

An understanding of the battlespace environment, specifically the sciences of meteorology and oceanography (METOC), is essential to understanding the naval mine and other warfare problems. For U.S. Naval and Marine Corps officers, this METOC education should begin at the undergraduate level. Unfortunately, our nation has experienced declining mathematics and science undergraduate enrollments for the last two decades.

The U.S. Naval Academy (USNA) currently educates 33% of all U.S. Navy unrestricted line officer accessions and 11% of Marine Corps officer accessions. USNA provides a core technical education coupled with an emphasis on one of eighteen undergraduate majors. USNA has also experienced a significant decline in mathematics and science enrollments; however, the USNA Oceanography major has "bucked" that national and USNA trend with steady enrollments. Approximately 75 USNA midshipmen graduate each year with a Bachelor of Science degree in Oceanography, representing 8% of the graduating class--the nation's largest single source of undergraduate physical oceanography majors. USNA's Oceanography major provides a superb undergraduate environmental education for the conduct of naval warfare.

WHITFORD, Dennis J., Captain, USN, (1998): "How Weather and Water Affect Littoral Operations." Invited article in *All Hands* magazine, Naval Media Center, Washington, D.C., No. 972, p. 34-35.

The littoral zone is that area extending from coastal water inland along the shore. Although deep water operations remain important, it is critical that Sailors and Marines learn how to operate in this rather unique environment. In the littoral, there are a number of weather and oceanographic factors which can affect our ability to fight. Here, we present only a few of the more prominent.

WRIGHT, W. A., Commander, USN, (co-author), (1998): "The Maury Project - A Look to the Future." Preprints of the 7th AMS Symposium on Education, American Meteorological Society, Boston MA, J5-8.

See David R. Smith's input.

Presentations

FOERSTER, John W., Professor, "American Shad: Pattern of Change in the Northern Chesapeake Bay," Coastal Zone 97 conference, Boston, Massachusetts, 16 July 1997.

FOERSTER, John W., Professor, "American Shad: Enviromarker for Change in the Northern Chesapeake Bay," Estuarine Research Federation conference, Providence, Rhode Island, 22 October 1997.

FOERSTER, John W., Professor, "Sentinel Species: Biotic and Xenobiotic Trace Metal Distribution in the Northern Chesapeake Bay," Western Society of Naturalists, Monterey, California, 27 December 1997.

FOERSTER, John W., Professor, "Optical Measurement of Copper in the Marine Environment, San Diego, California, 11 Feb 98.

FOERSTER, John W., Professor, "Detecting Copper in the Marine Environment," Environmental Protection Agency, Shallow Water Conference, Atlantic City, New Jersey, 16 March 1998.

FOERSTER, John W., Professor, "Toxic Algal Blooms: Are Phosphates and Nitrates the Real Cause?," Atlantic Estuarine Research Society, Beaufort, North Carolina, 21 March 1998.

FOERSTER, John W., Professor, "Runoff Induced Toxic Algal Blooms," American Geophysical Union, Boston, Massachusetts, 28 May 1998.

GUTH, Peter L., Associate Professor, "Experiences with SDTS DEM profile", SDTS Spatial Data Transfer Standard Implementor's Workshop, hosted by U.S. Geological Survey, Rolla, Missouri, 15-18 Sept 1997.

GUTH, Peter L., Associate Professor, "Tectonic Geomorphology of the White Mountains, eastern California", Geological Society of America national meeting, Salt Lake City, Utah, 20-23 Oct, 1997.

GUTH, Peter L., Associate Professor, "Structural Analysis of Digital Topography": American Geophysical Union spring meeting, Boston, Massachusetts, May 1998.

SALTZMAN, Jennifer, Adjunct Assistant Professor, "Zooplankton in Low Oxygen Water," Monterey Bay Aquarium Research Institute, Monterey, California, 11 May 1998.

SIKORA, Todd, D., Assistant Professor, (co-author), 1997: Stability Correction of Surface Winds Derived from Synthetic Aperture Radar. Preprints, Twelfth Symposium on Boundary Layers and Turbulence, AMS, Vancouver, British Columbia, Canada, 28 July-1 August 1997.

SIKORA, Todd D., Assistant Professor, (co-author), 1997: "Kilometer-scale Patterns on Synthetic Aperture Radar Imagery of the Sea Surface Caused by Marine Atmospheric Boundary Layer Convective Eddies," Preprints, Twelfth Symposium on Boundary Layers and Turbulence, AMS, Vancouver, British Columbia, Canada, 28 July-1 August 1997.

SIKORA, Todd D., Assistant Professor, (co-author) 1998: "Observations and Analysis of a Warm-fresh Ocean Front Coupled with a Cool-moist Atmospheric Front at Duck, North Carolina," Preprints, Second Conference on Coastal Atmospheric and Oceanic Prediction and Processes, American Meteorological Society, Phoenix, Arizona, 11-16 January 1998.

SIKORA, Todd D., Assistant Professor, (co-author), 1998: "Air-sea Interaction Associated with the Relaxation of an Upwelling Event off the Coast of Duck, North Carolina." 1998 Ocean Sciences Meeting, American Geophysics Union, San Diego, California, 9-13 February 1998.

VIEIRA, Mario E. C., Associate Professor, "Dynamics of Destratification in the Severn River Estuary," Fall 97 Meeting of the Estuarine Research Federation, Providence, Rhode Island, November 1997.

VIEIRA, Mario, E. C., Associate Professor, "Aspects of Fall Circulation in the Severn River Estuary," Spring Meeting of the Atlantic Estuarine Research Society, Beaufort, North Carolina, 19-21 March 1998.

VIEIRA, Mario, E. C., Associate Professor, "Being a Midshipman at the U.S. Naval Academy," Portuguese Naval Academy, Alfeite, Portugal, 24 April 1998.

WHITFORD, Dennis J., Captain, USN, (1997): "Proposal for the Permanent Military Professor Program," Multiple presentations to senior DoN officials, Washington, D.C., June - Aug 1997.

WHITFORD, Dennis J., Captain, USN, (1998): "Observations of Horizontal and Vertical Tidal Current Velocity Variability across the Mouth of the Chesapeake Bay." *1998 American Geophysical Union Ocean Sciences Meeting*, San Diego, California.

WHITFORD, Dennis J., Captain, USN, (1998): "Environmental Science Education at the United States Naval Academy." Invited presentation at *Third International Symposium on Technology and the Mine*

Problem, Monterey, California, April 98.

WHITFORD, Dennis J., Captain, USN, (1998): "METOC and MC&G Criticality for an Arleigh Burke-Class Guided Missile Destroyer Engaged in Littoral Expeditionary Warfare." Poster presentation. Third International Technical Symposium, Technology and the Mine Problem, Monterey, California.

WHITFORD, Dennis J., Captain, USN, (1998): "Littoral METOC Factors and Impact on Expeditionary Warfare." Poster presentation. *Third International Technical Symposium, Technology and the Mine Problem*, Monterey, California.

Technical Reports

FOERSTER, John W., Professor, "Measurement of Copper," Unattended Marine Operations, NRL Report 6120-98-8131, 49pp, 1997.

A major source of trace metal contamination in the marine environment is the copper containing anti-foulant paints on ship hulls. An anti-fouling paint containing copper (I) presents a challenge to the environment because its design is to leach continuously over a period of time. This study tests the hypothesis that the organic molecules, 2,9-dimethyl-4, 7-diphenyl-1,10-phenanthroline (Bathocuproine=BCP) and 2,9-dimethyl-4,7-diphenyl-1,10-phenanthrolinedisulfonic acid (Bathocuproinedisulfonic acid=BCS) are reliable chemicals to use in developing a standard analysis procedure (BCS) and testing an optical fiber sensor (BCP) capable of measuring copper (I) in seawater. The sensor must have

- parts per billion (ppb) detection limits,
- marine environmental immersion capability, and
- the ability to detect the copper (I) oxidation state.

Results of this study show copper (I) leaching at a rate of 1.2ppb/hour from a copper containing anti-fouling paint (Interviron anti-fouling red paint-Product No. BRA640, Batch No. UUA11176E). After 2 hours Cu (I) begins to convert to copper (II). Initially for the first 2 hours you have 100% copper (I) leaching into the water and by 20 hours the ratio is 38% copper (I) to 62% copper (II). The BCS chemical provides a quick and relatively easy way to determine the concentration of copper (I) in marine and estuarine waters due to its water soluability. Bathocuproine (BCP), once attached to optical fibers allows for a rapid electronic measurement to detect quickly the amount and pattern of copper(I) released into the marine environment.

DEPARTMENT OF

Physics

Professor D. J. Treacy

Chair

During the 1997-1998 academic year the Physics Department was actively engaged in a wide variety of research. It is significant that many of these were interdisciplinary collaborations. Interdisciplinary work extended into the fields of medicine, archeology, ecology and cognitive science. More traditional areas included cosmology, planetary physics, nuclear structure, nonlinear acoustics, applied acoustics, accelerator physics, applied magnetism, condensed matter and optical processing. The results of these investigations were presented at local, notional and international meetings by midshipmen and faculty. This research was made possible by the excellent facilities in the Physics Department as well as by collaborations with other laboratories.

The Physics Department has been successful in attracting external funding from the Office of Naval Research, the Naval Research Laboratory, the Naval Surface Weapons Center, the National Science Foundation, the Delaware State Museums and a Kinnear Grant. The department received internal support from the Naval Academy Research Council, the Trident Scholar Program and the Curriculum Development Committee.

Midshipmen were involved in many of the research programs. Of the three midshipmen doing Trident Scholar research touching on physics one was from the Physics Department and two others were visitors from other departments. Within the Physics Department there were fourteen midshipmen doing research. These midshipmen represent four different majors. All of this activity naturally led to numerous presentations by the midshipmen at national and international meetings.

The faculty had a prolific year. The fifteen sponsored and fourteen independent topics of research in which they were involved led to the publication of twenty-one papers and thirty-eight presentations. This is representative of the level of scholarly pursuit enjoyed by the Physics Department. The topics are far-ranging, the investigations are exciting and the results are gratifying.

Sponsored Research

Speckle Photography

Researchers: Assistant Professor Philip R. Battle, Rita Mahon, Naval Research Laboratory,

Will Rabinovich, Naval Research Laboratory

Sponsor: Naval Research Laboratory

Speckle photography is a well known and widely used non-destructive evaluation tool. Because it is a remote, non contact, whole field technique it has found particular use in metrology. In this work a multiple quantum well structure was used to record the displaced speckle image. Our technique replaces a step in the electronic processing, which will lead to a significant increase in speed and promises to be sensitive to very small displacements.

We demonstrated the use of speckle photography using optically addressed multiple quantum well spatial light modulators to measure small displacements.

Infrared Studies

Researcher: Professor Donald W. Brill

Sponsor: Naval Surface Warfare Center, Carderock, MD

The Naval Surface Warfare Center is developing a Bi-Directional Reflectometer (BDR) facility at Carderock. The BDR measures the electormagnetic scattering characteristics of molecular targets. An analysis of the physics of the BDR was performed with emphasis on the general problem of radiation from an oscillating dipole. A report was submitted at the end of the summer.

Andes: A Tutoring System For Classical Physics

Researchers: Professors F.D. Correll, R.N. Shelby, M.C. Wintersgill, Associate Professor

K. G. Schulze

Sponsor: Office of Naval Research, Cognitive Sciences Division

Classical physics is a prerequisite for virtually all university level study 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 is being developed by Professors Correll, Wintersgill and Shelby of the USNA Physics Department, and knowledge base construction, coding, and coordination is being done by Prof. Schulze of the USNA Computer Science Department. This year Professor Schulze and the project were assisted by the work of a Trident Scholar, Midshipman 1/c Damon Eason, USN.

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 system's 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 internal validity of the assessments using artificial students. We will evaluate the external validity using real students and verbal protocols.

The project is currently in its third year and will include a 5 section trial of the current system in the fall 98 semester. Questions on appropriate difficulty of problems, adequacy of the help system and planning are currently being studied. Appropriate answers to these questions will undoubtedly determine future student use of the system.

Structure and Composition of Metal Fittings from *H.M.S. DeBraak*

Researchers: Professors F.D. Correll, Angela L. Moran, Mechanical Engineering Department

Sponsor: Delaware State Museums

The goal of this project is to provide new perspectives on 18th-century naval production methods and metallurgy using modern ion-beam analysis, scanning-electron microscopy, and metallographic imaging.

H.M.S. DeBraak was a 16-gun English warship that sank on May 25, 1798, off Cape Henlopen, near Lewes, Delaware. Apparently, the hull became covered with silt shortly after it sank. After many attempts to locate it, *DeBraak* was finally found and salvaged in 1984. Among the recovered items are a large collection of well-preserved copper-alloy bolts, fasteners, sheathing, and sheathing nails. They constitute a valuable record of the materials and techniques used in the construction of naval vessels in the late 18th century.

We have agreed to be part of a large, multi-disciplinary team that will study DeBraak's hull. We will analyze the structure and composition of a representative sample of *DeBraak's* metal fittings in order to determine fabrication techniques and document important phases in the development of alloys for shipboard use. We have made several preliminary measurements and are awaiting final notification of funding approval.

A Review of Critical Sea Test (CST) Contributions to Low Frequency Active Acoutics (LFAA) with Applications to the Littoral Warfare Advanced Development Program (LWAD) (U)

Researcher: Professor Douglas W. Edsall

Sponsor: Naval Research Laboratory

The CST Program has provided a wealth of information about LFAA. Over 80 unclassified and classified white papers and reports were spawned by the CST Program. The bibliography gives a complete list of the white papers and reports reviewed for this report. The CST Program has provided an insight into several issues of importance to LFAA prosecution in the littoral environment in the frequency regime 50 Hz to 1500 Hz. These initial findings must be pursued to the next level of understanding and then refined for use in the fleet.

Heavy-Ion Backscattering Analysis Using A Magnetic Spectrometer

Researcher: Associate Professor James R. Huddle

Sponsor: Naval Research Laboratory

Calculations indicated that by using a position-sensitive detector with a magnetic spectrometer, the heavy-ion back scattering technique could be pushed to a sensitivity sufficient to detect iron impurities on silicon substrates at the level of ten billion iron atoms per square centimeter. A differential nonlinearity ("scalloping") was discovered in the position-sensitive detector. It was proposed to try to correct this nonlinearlty using matrix methods, but we showed that the linear transformations which can be derived from a small number of experimental spectra from known samples are not unique. In principle, the appropriate linear transformation could be determined from a large number of spectra, but this would involve a huge number (3n, where n is the number of channels in each spectrum) of coupled equations. It may be possible to adapt this technique to measuring charge-changing cross sections for heavy-ion collisions; this possibility will be the focus of this study in 1998.

Radio Observations of Tycho Supernova Remnant

Researcher: Assistant Professor Debora Katz-Stone

Sponsor: The Naval Research Laboratory and The Office of Naval Research

As part of ongoing research, Very Large Array (VLA) observations at 332.9 and 1,375 MHz of Tycho Supernova remnant were analyzed with innovative tomography techniques. Preliminary results show several flat-spectrum filaments and a general trend such that high emissivity features correlate with a flat spectrum.

HyperText Physics Tutor (HyPT)

Researcher: Professor E. 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.

Physics of Minesweeping

Researcher: Professor Carl S. Schneider

Sponsor: Naval Surface Warfare Center, Annapolis, MD

The goal of this project was to compile the physics of minesweeping to guide future minesweeping development. The physical quantities used by mines to detect the presence of ships include the mechanical influences of sound, seismic pressure and contact as well as the electromagnetic influences of magnetic and

electric fields. This paper treats only magnetic influences, attempting to define the magnetic signature which will cause the magnetic sensor to trigger the magnetic logic and enable detonation of the mine. Mines which incorporate random inactivity such as sleeping can never be swept absolutely, and sweep duration exponentially reduces the mine threat leaving operations always subject to a finite level of risk.

Properties of Fuel Cell and Battery Materials

Researchers: Assistant Professor Phillip E. Stallworth, Professors John J. Fontanella and Mary C. Wintersgill, and LCDR C. E. Edmondson, USN

Sponsor: Office of Naval Research

The goal of the project is to study electrical transport in materials used in batteries and fuel cells. This includes electrolytes for batteries and ion-exchange membranes for use in fuel cell materials. Electrical conductivity and nuclear magnetic resonance (NMR) studies will be carried out over a wide range of temperatures and pressures. The NMR work will be carried out in collaboration with the group at Hunter College. For ion-exchange membranes, work will be carried out on acid doped polybenzimidazole (PBI), a new material recently developed by Litt and co-workers at Case Western Reserve University and the sulfonated block copolymer membranes developed by Wnek and co-workers at Virginia Commonwealth University. The relevant liquids such as phosphoric and sulfuric acids will also be studied. The battery material of initial interest is the PVDF-HFP copolymer for plastic lithium ion rechargeable cells developed at Bellcore. The relevant liquids such as propylene and ethylene carbonates containing lithium salts will be studied.

The dynamical and structural studies will be performed utilizing electrical conductivity/relaxation and NMR techniques. Both the electrical conductivity and NMR measurements will be carried out at high pressures. In addition, the complex impedance/electrical relaxation studies will be performed over a wide range of frequencies and temperatures.

Electrical transport studies are of both fundamental and applied interest. From a fundamental standpoint, it is of interest to know the electrical transport mechanism. Electrical transport is also of applied interest since it is an important factor in determining how well a fuel cell or battery operates. Complex impedance studies provide a direct measure of the electrical conductivity, and, when carried out at high pressures, gives insight into the transport mechanism, particularly when carried out in conjunction with NMR measurements.

Applied Imaging

Researcher: Lawrence L. Tankersley

Sponsor: Naval Research Laboratory

All work undertaken was in support of ongoing efforts at the Naval Research Laboratory in Code 5640. Studies are being conducted of optical detection and analysis of debris in turbine engine lubricating fluids. This involves imaging through turbid media and correlator studies using multiple quantum well devices. 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 photo refractive image correlators, and
6. Development of support electronics

Basic Nuclear Physics with the GEANIE Array at LANSCE/WNR

Researcher: Associate Professor J.R. Vanhoy

Sponsor: National Science Foundation, Los Alamos Neutron Science Center

GEANIE is a 13 element gamma-ray detector array installed at LANSCE at Los Alamos, NM. The data taken using GEANIE is driven by applied interests -- (n,xn) cross section measurements over a range of energies. Several weeks were spent examining the 1996-1997 GEANIE data to see if the techniques used in (n,n') could be applied to the GEANIE data sets. Of particular interest was spin determination with angular distributions and excitation functions and Doppler-shift lifetime measurements for nuclei populated with the (n,2n) and (n,3n) reaction channels. It was found that the existing data in a restricted energy bin tend to have poor statistics, and only a couple of their 1996-1997 data sets may have sufficient statistics. Nuclear spectroscopic studies will require acquisition times of 2-3 weeks. Work on a ^{238}U data set indicates more care must be taken in the future while calibrating detectors if any Doppler-shift attenuation measurements will be attempted. The angular distributions are also somewhat limited in many of the data sets as the GEANIE array is presently only configured with 3 unique angles with respect to the beam direction (there is azimuthal redundancy).

Permanent Waveguides in Photorefractive Ferroelectrics

Researcher: Associate Professor Steve Montgomery

Sponsor: Kinnear Foundation

Normally, when a laser beam is focused to a small spot it quickly diverges, due to diffraction, so that the laser beam is concentrated only for a small distance in the direction of propagation. A few years ago it was discovered that a beam focused on the face of a photo refractive crystal, with the proper orientation and externally applied electric field, would maintain the same beam diameter all the way to the exit face. This is due to charges made mobile by the photons in the light beam that respond to an electric field applied transverse to the direction of propagation. The charges loose mobility as they leave the light beam and get stuck in the dark regions of the crystal around the beam, with positives on one side and negatives on the other, so that a charge gradient develops. This charge gradient produces a varying electric field that produces a transversely varying index of refraction in the path of the laser beam via the linear electro optic effect. With the right combination of light intensity and electric field a waveguide is formed so that beam focusing exactly compensates beam diffraction. Waveguides formed in this manner have come to be called spatial solitons. They are an active area of optical research, not only for their inherit scientific interest, but because they are potentially useful in fiber optic communications networks where it may be become desirable to have sections of optical waveguides that can be formed and erased dynamically. While the beam power required to produce a spatial solition is only a few micro watts, beam diameters are routinely a few microns which means that very high irradiance is maintained. Such high irradiances may be used to great advantage in generation and amplification of wavelengths other than that of the incident beam.

Up to now, photo refractive spatial solitons have required a combination of external electric field and light intensity applied to the crystal or they would disappear. The objective of this study was to find a way to write a soliton waveguide that would remain after all the fields are turned off. This objective was reached by taking advantage of the Ferro electric nature of the crystal and producing Ferro electric domains in the soliton waveguide that are oriented opposite to those in the bulk of the crystal. Details of this process are being submitted in a paper to the journal, Optics Letters.

Independent Research

An Optical Survey of Large Interstellar Structures

Researchers: Professor C. Elise Albert, L. Danly and P. Lee, Space Telescope Science Institute,

C. Sneden and D. Hiltgen, U. of Texas, D. Hartmann, Center for Astrophysics,

B. Burton, Sterrewacht Leiden, and F.J. Lockman, National Radio Astronomy Observatory

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.

Electrical Properties Of Nafion Membranes Intended For Use In Methanol Fuel Cells

Researchers: Professors John J. Fontanella, Mary C. Wintersgill,

and LCDR Charles A. Edmondson, USN

The primary objective of this work is to gain insight into ion motion in the ion exchange membrane, Nafion, via complex impedance measurements. Detailed studies of the complex impedance as a function of water content and pressure have been conducted. Since these membranes are intended for use in the presence of methanol, current efforts are directed at evaluating the affect of methanol and methanol - water mixtures on the conductivity.

Investigation Of The Human Voice Mechanism

Researchers: Professor S. A. Elder, P. E. Castellanos, University of Maryland

School of Medicine, Baltimore, MD

It is generally understood that the way in which the human larynx creates sound is by the generation of a "glottic source wave" which perturbs the vocal tract and is shaped by the tract walls and cavities to form the phonemes of speech. However it is still unclear exactly how the action of the moving laryngeal surfaces on the air stream passing through them actually generates sound. The importance of this knowledge to the physician is that it holds the clues to understanding the causes of pathological conditions associated with voice abuse, the secrets of restoration of damaged laryngeal function after surgery for removal of tumors, the feasibility of complete voice reconstruction by transplantation of excised larynges, and probably many other unanticipated discoveries all of which have application to medical practice in the Navy. For the last several years this has been the goal of a collaboration between an acoustical scientist at the United States Naval academy and an otolaryngological surgeon at the University of Maryland School of Medicine. Although this work has so far been carried out on a part time basis without formal sponsorship, it has already resulted in a series of papers at professional meetings of both acoustical and medical societies, and

is currently the subject of two papers in preparation for peer review journals. Experimental methods involve the use of reflection less tubes and the USNA anechoic chamber facility for experimental investigations on in-vivo and in-vitro specimens. Measurements are being carried out in the state-of-the-art acoustical laboratory of the Naval Academy Physics Department.

Magnetospheric Physics

Researcher: Professor Irene M. Engle

Several areas of magnetospheric physics were investigated during the past year. This work includes:

1. Modeling, from first principles, a representation of the Jovian magnetosphere. 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 LTjg Todd Bode, USN ('94) has been favorably received by the editor of *Planetary and Space Science*, but the modified manuscript has not as yet been returned to the editor. Other works, generally in collaboration with European colleagues regarding the application of these results to observations of the SL9 encounter with Jupiter have been presented or are in process. One paper was published (Oct.1997) in a special dedicated issue of Planetary and Space Science. A floppy magnetodisk to replace a rigid magnetodisk is currently being incorporated into the global Jovian magneto spheric field model; the laborious task modifying the magnetopause shapes and consequent contribution of solar wind-induced currents is under ongoing investigation.

2. A new look at the Mercury magneto spheric 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 surfaces of Mercury. This work was presented at the European Space Agency (ESA) Workshop for planning a new mission to Mercury and this 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 1/C Jacob G.Scott, USN has undertaken as a special project the mapping of the boundaries of the magnetospheric models being used by ESA investigators for mission planning and made a favorably-received presentation of results in April, 1998. In summer of 1998, Ensign Scott, USN will continue the work, with a view to submitting a paper to Planetary and Space Science.

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. Establishing the relation of observed temporal variations of magneto spheric configurations to the proximate causes and consequential phenomena; investigating 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 magneto pause position.

5. The researcher 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 1/C Mark Skubis, USN (1996) 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 on details of possible size and shape configurations when a plausible range of direction of incident solar wind and solar wind pressure has been published, (December 1996) with co-authors Trident Scholar Mark Skubis, USN, 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 now-launched 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; this mission comprises the subject of the Trident Scholar project of Midshipman 2/C Jeremy J. Bruch, USN for 1998-99.

Understanding The Classroom Jumping Ring

Researchers: Professor C. S. Schneider and Associate Professor J. P. Ertel

We have studied and designed a compact alternating current jumping ring apparatus which can electromagnetically launch conducting rings across a classroom. Jump energy and height are calculated for core and thin ring length, radius, thickness and material. The effects of core saturation, permeability, hysteresis and demagnetizing field, ring shielding and convective derivative are described. Even rings with small phase lag can pass by the magnetic pole of the primary in one quarter of a cycle. Large ring size relative to skin depth delays the ring current close to the 180 degrees of Lenz's law. Contactless jump height measurement enables ring resistivity determination. Demonstrating the effects of voltage, frequency, conductivity, permeability and geometry contributes to understanding electromagnetism in the classroom.

Scattering Of Acoustical Power From Unribbed And Regularly Ribbed Panels

Researchers: Associate Professor John P. Ertel

The radiation and partial radiation efficiencies from point and line driven panels were previously defined and investigated by the authors [J. Acoust. Soc. Am. 98, 2888(A) (1995) and J. Sound Vib. 144, 71--86 (1991)]. In this paper, the mechanical power dissipated in a point driven fluid loaded panel is studied and compared to the radiated power. The interdependence of the mechanical and radiated powers is investigated, and they are related as fractions of the total input power. The dependencies of the mechanical and radiated power on frequency, fluid loading, and mechanical loss are further studied. In the present paper, the mechanical power as well as the radiation efficiency is shown to increase with increased damping in a panel while the radiated power decreases, as it must. These results again show the fallibility of the conclusion that "a higher radiation efficiency necessarily implies more radiated power." The results of computer simulations are cited in numerical examples.

A Spectral Analysis of 3C449

Researcher: Assistant Professor Debora Katz-Stone

We studied the evolution of relativistic electrons in the Fanaroff-Riley Type I (FR I) galaxy 3C449, by observing with the Very Large Array (VLA) at three frequencies (330, 1445 and 4835 MHz) and in all 4 configurations for a primary resolution of 3. 6 arcsec.

The conventional model for this type of source is that the relativistic electrons are accelerated in the core and subsequently lose energy as the jet flows outward, expands and bends downstream. We find that 3C449 is more complicated with evidence of a different type of structure, more reminiscent of higher luminosity FR II galaxies. We introduce a new analysis tool - the spectral tomography gallery, and find evidence for two spectral components that we label the "flat jet" and the "sheath." The flat jet remains fairly well collimated throughout the inner 5 arcminutes, with the sheath accounting for most of the observed widening.

The flat jet shows little steepening with distance from

the core. However, the sheath has a steeper spectral index than the jet. If the same spectral shape is appropriate for both components, there may be an evolutionary connection between the particles in the flat jet and those in the sheath. Another possibility is that the sheath has a steeper injection index than the flat jet. This may mean that the sheath and flat jet are separate spectral components.

Radio Observations Of Compact Steep-Spectrum Sources

Researcher: Assistant Professor Debora Katz-Stone

Everton Ludke (Brazil University) and I successfully applied for observing time at the Very Large Array operated by the National Radio Astronomy Observatory. This spring, we have begun to observe several Compact Steep Spectrum sources at multiple frequencies in order to apply spectral tomography analysis. Our initial findings reveal more complicated structure than previously observed. These new structures are reminiscent of larger radio galaxies. Perhaps more importantly, multiple structures must be taken into account when determining the synchrotron age of these compact sources.

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 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 was presented at the August 1997 meeting of the American Association of Physics Teachers. The ultimate intention of this research is 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) and zero field Nuclear Quadrupole Resonance (NQR) equipment 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 line shape simulation programs in analyzing solid state spectra.

Imaging of Dwarf Galaxy Candidates

Researcher: CDR Alan Whiting, USNR

Dwarf galaxies, the very lowest-mass and lowest-luminosity galaxies, are of disproportionate importance in studies of galaxy formation, star formation in different environments, total mass in the universe and the distribution and motions of mass in general. However, being so very faint they are extremely difficult to detect and relatively few are known. A systematic search for dwarf like images on sky survey plates has resulted in a list of possible nearby dwarf galaxies. Using a 60" telescope at Cerro Tololo Interamerican Observatory in Chile (telescope time awarded competitively, one week in September and one in February), most of these candidates have been examined. Several are indeed nearby dwarf galaxies; the rest are more distant, very low surface brightness galaxies (of interest in their own right) or objects within our own galaxy. The details of one of these have been published; data reduction on other observations continues.

Spectroscopy of Very Faint Planetary Nebulae

Researcher: CDR Alan Whiting, USNR

Planetary Nebulae are thin clouds of gas around old stars of medium mass, excited by the high-energy radiation of the degenerate star at the center. From the spectrum of the nebula such data as the temperature and density of the nebula as well as the radiation field of the star can be determined--they are very useful astrophysical laboratories. Of more general importance, the relative abundances of various elements can be determined, important data for reconstructing the history of our galaxy and its stars. For all these studies additional examples are useful. Several very faint objects, identified as possible dwarf galaxies in a recent survey, have in fact proven to be planetary nebulae. Very faint nebulae are either very distant (and made faint by intervening dust), probing a distant part of the galaxy, or very old. In the latter case they will be affected by interaction with the interstellar medium, an extremely dilute but important constituent of the galaxy. Using the 1.54m telescope at the European Southern Observatory in Chile (time awarded competitively, one week in December) spectra of several of these very faint nebulae have been obtained. Reduction of the data, a process requiring more than usual care due to the low brightness involved (a few percent of the night sky), is still proceeding.

Personality Characteristics Among Future Military Leaders

Researchers: LT B. R. Yatko, USN, Captain E. Holmes, USN, and LCDR R. Lall, USN,

Professional Development

Relatively little is known about the personality characteristics of military personnel, particularly those who are most successful in military careers. This study evaluated the personality characteristics of 530 third year Midshipmen at the United States Naval Academy. Participants completed the Hogan Personality Inventory (HPI) and a demographic questionnaire. Class ranking data was also obtained as an indicator of success at the Naval Academy. Results indicated that in comparison to national norms, midshipmen scored somewhat higher on scales of ambition, sociability, intelligence and school success and lower on scales of adjustment, likability and prudence. Ambition, prudence, intelligence and school success were each significantly positively correlated with class standing. Implications of these findings for understanding personality correlates of success in military leadership are discussed.

Midshipmen Research

Tunable Laser Light Source

Researcher: Midshipman 1/C Ian Schillinger, USN

Faculty Advisors: Assistant Professor Philip R. Battle, John Watkins, Systems Engineering Department

Sponsor: Trident Scholar Program

There is considerable interest in developing compact, narrow band tunable light sources. Tunable light sources can be used in a variety of applications ranging from precision spectroscopy to optical engineering. In this work we designed and constructed a tunable laser. In contrast to conventional tunable laser sources, the feedback mechanism for this laser was embedded in an optical fiber. The design may lead to a more compact and robust optical source.

The laser was constructed from a semiconductor laser diode and a modified optical fiber. The fiber has a Bragg grating embedded in the core; feedback from the grating was used to control the output of the laser. The wavelength of the laser was tunable over 5 nanometers, and centered at a wavelength of 683nm.

Trace Element Concentrations and Variability in Sulfides from Middle Valley of Bent Hill Site, 1035, ODP Leg 169

Researchers: Midshipmen 2/C Kim DaCosta, USN, 1/C M. T. Trinh, USN,

and 1/C L. S. Reinke, USN

Faculty Advisors: Professor D. W. Edsall and Associate Professor J. Vanhoy

A suite of 10 samples from ODP Leg 169, site 1035H, the Bent Hill sulfide mound, were analyzed with the

USNA Proton Induced X-Ray Emission (PIXE) instruments. All samples were recovered from depths ranging from 9.04 to 162.41 mbsf. Recognizable minerals in these samples included magnetite, hematite, pyrite, marcasite, pyrrhotite, sphalerite, and chalcopyrite. We determine trace element concentrations for two locations on each sample. A large beam spot size was used to average sample nonuniformity. The standard used was NIST Marine Mud Mag 1. Measurements of element concentrations were made in vacuum at a proton energy of 2.4 MeV. We obtained concentrations for elements between Na and Zn. These concentrations vary with depth and with matrix.

Toxic Algae: Are Phosphates and Nitrates the Real Cause?

Researcher: Midshipman 1/C Ashley Harrison, USN

Faculty Advisor: Professor Doug Edsall, Professor John Foerster, and

Adjunct Associate Professor Alan Strong, Oceanography Department

An estuary is an interface, a region where the salt water of the sea mixes with the freshwater of the river. Because of unique biological production, this natural interface area is vulnerable to environmental changes. In this interface, biological production is high and any changes are noticeable; noticeable whether it is the reduction of harvestable resources, the loss of wetlands, or the development of toxic algal blooms. It matters not that these changes are naturally or anthropogenically induced. The overall problem is not laying the blame but understanding the effects of changes on a dynamic system. In the case of toxic algal blooms, like pathogens, the disease develops because of factors no longer controlled by the host environment. The "pathogen" develops because it is an opportunistic species and the conditions are good for its growth. The only control on this species is to enhance the environment so it can regain ecological equilibrium. This toxic algae, the assumption, based on laboratory and field data, is that increased loading of the coastal marine environments with nitrates and phosphates creates a condition suitable for excessive growth. With dinoglagellates like Pfeisteria, it seems that the nutrients, plus warm water temperatures and runoff after a storm triggers explosive growth. Is this the whole story? Could it be the runoff creating a different chemical environment more conducive to growth that initially has nothing to do with nitrates and phosphates? In our zeal to seek a simple solution to a complex problem, have we not overlooked the runoff and what it contributes besides nutrients? What of the humic substances and their chelation capabilities? What of the particulate matter and the absorptive and adsorptive capacities? Our purpose in present this paper is to stimulate thinking and research into what we feel is the actual underlying cause of the "epidemics." We present initial studies into what we believe really underlies these episodic events and that is the trace metals. To answer these questions we test the hypothesis that after rainfall, the runoff carries compounds that remove growth inhibiting trace metals. Once the trace metals temporarily disappear, the toxic algae bloom appears. For this study we target copper because it is both beneficial and toxic and has the possibility of being used for remedial treatments. Preliminary laboratory studies show that particulate organic matter removes ionic copper from extuarine water (10 - 14 ppt) within 48 hours. Our work is in progress. However, based on preliminary analysis and literature searches, we become more certain that the driving force behind the chaotic bloom patters in the absence of trace metals. The nutrients are only the food whose high concentrations exacerbater the problem.

Electrical Properties of Water/Methanol Mixtures at High Pressures

Researcher: Midshipman 1/C Jeffrey Immel, USN

Faculty Advisor: Professor J. Fontanella

The objective is to study water and methanol molecular rotation at high pressure. Water molecular rotation has been extensively studied at atmospheric pressure. That is not surprising since it is the phenomenon used to

generate heat in microwave ovens. However, it turns out that the effect of pressure on water molecular rotation has not been studied. The rotation of methanol molecules at atmospheric pressure has also been studied but to a lesser extent than water. Again, the objective is to study rotations under pressure. The reason for studying water and methanol molecular rotation under pressure is to help gain insight into proton motion in liquids being used in fuel cells. High pressure electrical conductivity experiments have been carried out in ion exchange membranes containing both methanol and water. Those results have given insight into proton motion. However, the interpretation is incomplete because the liquids themselves have not been studied. The needed experiments will be carried out in the present work.

Electrical Properties of Acid and Acid Containing Polybenzimidazole (PBI)

Researcher: Midshipman 1/C Christopher Scheidler, USN

Faculty Advisor: Professor J. Fontanella

The objective is to study the effect of water on the pressure variation of the electrical conductivity of acid and acid containing polybenzimidazole (PBI). Both sulfuric and phosphoric acids will be studied. PBI is a recently developed ion exchange membrane for fuel cells. It is significant because it is stable at high temperatures and because it has low methanol crossover. As a consequence it is important to understand the ion transport mechanism. Only PBI containing standard (85%) phosphoric acid has been studied at high pressures. For comparison, the standard phosphoric acid has been studied separately. Little resemblance has been found between the two materials. As a consequence it is important to study both pure phosphoric acid, which is available, and phosphoric acid and acid containing PBI containing varying amounts of water. The idea is to determine whether ion transport in PBI is the same as for the liquid. All experiments need to be extended to high temperatures since that is the operational range for PBI.

Experiments During a Total Solar Eclipse

Researchers: Midshipman 1/C J. Tyler Webb, USN, Cadet Iain McConnell, U. S. Coast Guard Academy, C. Grace Young, Remington Middle School, Franklin, MA, Lindsay Anderberg, Damascus High School, Damascus, MD

Faculty Advisors: Associate Professor James R. Huddle, Principal Investigator, Dr. James R. Dire, U. S. Coast Guard Academy

Sponsor: Innovations in Travel, Inc.

On an expedition to Aruba to observe the total solar eclipse of 11 February 1998, we measured precise times of the eclipse's second and third contacts, and we measured the ambient light intensity as a function of obscuration of the solar disk. While we detected polarization in the sun's corona and were able to see an effect of obscuration on the ambient temperature, quantitative measurements of these effects were hampered by the broken cloud cover at our location. An attempt to record the shadow bands on videotape failed due to the bands' low contrast; the shadow bands are notoriously difficult to record. An attempt to capture the flash spectrum on videotape failed because the spectrum was much brighter than we anticipated; the brightness saturated the camcorder's CCD, even with the gain turned all the way down. While most of these experiments were primarily of pedagogical interest, the contact timing data are of interest to astronomers at the U. S. Naval Observatory and at the Johns Hopkins Applied Physics Laboratory who are studying suspected small oscillations in the sun's diameter. These oscillations, if they exist, may have a measurable effect on global warming issues.

Design and Development of PC-IMAT:

Teaching Strategies For Acoustical Oceanography

Researchers: Midshipmen 1/C Lee Anne Hurley, and Kevin M. Thomas, USN

Faculty Advisor: Professor Murray S. Korman

Sponsor: NPRDC and Office of Naval Research

The PC-IMAT (Personalized Curriculum for Interactive Multisensor Analysis Training) project is proving to be a flexible computer based training/educational platform needed to help tackle ASW and other tasks which require extensive analysis, classification and interpretational skills. Midshipmen taking SP411 (Underwater Acoustics and Sonar) are currently using PC-IMAT to help investigate effective instructional strategies which convey understanding of a complex multivariate domain (like ray trace or propagation loss models). Classroom demonstration lectures and out-of-class projects allow students to successfully interact with experimental apparatus and make actual measurements (e.g. Fourier analysis, detection theory, beam pattern functions, sound speed vs. temperature, computer ray tracing, reflection and transmission at an interface and target strength vs. angle of a scale model sub). However, a link between textbook theories, the actual physics experiments and the real world setting of tactical sonar has been missing. Usage of PC-IMAT on actual submarine training exercises shows the limitations and enhancements of tactical maneuvering when sonar systems are subject to complex surroundings. The research and development of "scientific visualization" on PC-IMAT should ultimately incorporate a strong link between both learning environments.

Scattering Of Ultrasonic Pulses From A Spherical Bubble Cloud Encapsulated By A Thin Spherical Shell

Researcher: Midshipman 3/C Kathryn McMahon, USN

Faculty Advisor: Professor Murray S. Korman

Experimental apparatus for the resonant back-scattered pressure vs. frequency from a submerged elastic shell filled with a bubbly fluid is being designed. The elastic shell (of inner radius 1.27 cm and 0.318 cm thickness) is a castable urethane which has a density of $r \sim 1.03$ g/cm^3 and longitudinal and shear speeds of $c_d \sim 1450$ m/s , $c_s \sim 70$ m/s, respectfully. The bubbly fluid is prepared by whipping up castor oil in a microblender. The mean radius of the suspended air bubbles varies from 40 - 80 mm, while the volume void fraction ß (in the cloud) varies from 0.01 to 0.001 during experimental measurements. The 24 ft wide and 16 ft deep dimensions of the U.S. Naval Academy Hydrodynamic 380 ft Tow Tank provide a suitable environment for performing scattering experiments over the desired 50 to 500 kHz frequency range. Here, the need is for a highly directional source of pulsed sound, that is active for only a few cycles - to avoid unwanted reflections from the boundaries. A circular plane radiator is used to generate this pulse. A custom made gated amplifier generates a synchronous amplitude modulated gated rf tone burst that drives a PZT transducer which ultimately controls the ultrasonic pulse shape.

Optical Spectroscopy of Upconversion Processes in Rare Earth Doped Crystalline Solids

Researchers: Midshipman 2/C Brad W. Hoff, USN

Erin W. Bonning, St. John's College

Faculty Advisor: 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.

Structure Mixing in the Mid-Shell Tellurium Nuclei

Researchers: Ensigns Brian Champine and Eric Jensen, USN, Associate Professor J.R. Vanhoy, Associate

Sponsor: National Science Foundation

There are 8 stable tellurium isotopes. This great number of isotopes allows one to examine the evolution of nuclear structure for a near continuous range of neutrons. Three different types of structure are thought to be active in these nuclei: collective, two-particle, and particle-hole excitations known as intruders. Emphasis centers on understanding the interplay between particle and collective features and on the aspects of the nuclear forces that determine the relative importance.

We have invested over six weeks of beamtime on Tellurium-122 since last June. The small sample size (5.1 gm) leads to data points of 18 hours. Excitation function data were taken up to $E_n = 3400$ keV during a two-week run in June 1997. Angular distributions and Doppler shifts were measured at $E_n = 3300$ keV in December 1997. Gamma-gamma coincidence data were taken in March to identify cascade sequences. A final 8 day run in May 1998 completed the measurements. Analysis is still in progress but the amount of information discovered at present is impressive. The multi-phonon character of the level scheme is apparent from successive spectra in excitations functions (gammas appear in groups). Approximately 38 new levels have been found. An extra 0^+ state has been identified among the two-quadrupole phonon triplet. This is undoubtly the bandhead for the intruder structures which have been missing in the tellurium nuclei.

Publications

BATTLE, P. R., Assistant Professor, Coauthor, "Speckle Photography Using Optically Addressed Multiple Quantum Well Spatial Light Modulators," Optics Express **2**, 11, 449-453 (1998).

Speckle photography is a well known and widely used non-destructive evaluation tool. Because it is a remote, non contact, whole field technique it has found particular use in metrology. In this work a multiple quantum well structure was used to record the displaced speckle image. Our technique replaces a step in the electronic processing, which will lead to

a significant increase in speed and promises to be sensitive to very small displacements.

Spatial image processing techniques were applied to a temporal imaging problem in optical coherence tomography.

We demonstrated the use of speckle photography using optically addressed multiple quantum well spatial light modulators to measure small displacements.

BATTLE, P. R., Assistant Professor, Coauthor, "Signal Processing For Improving The Field Cross-Correlation Function In Optical Coherence Tomography," Optics and Photonics News, 12, (1998).

BATTLE, P. R., Assistant Professor, Coauthor, "A Tunable Laser Light Source," Trident Scholar Report no. 258 (1998).

There is considerable interest in developing compact, narrow band tunable light sources. Tunable light sources can be used in a variety of applications ranging from precision spectroscopy to optical engineering. In this work we designed and constructed a tunable laser. In contrast to conventional tunable laser sources, the feedback mechanism for this laser was embedded in an optical fiber. The design may lead to a more compact and robust optical source.

The laser was constructed from a semi-conductor laser diode and a modified optical fiber. The fiber has a Bragg grating embedded in the core; feedback from the grating was used to control the output of the laser. The wavelength of the laser was tunable over 5 nanometers, and centered at a wavelength of 683nm.

BRILL, Donald W., Professor, Coauthor, "Signal processing of the echo signatures returned by submerged shells insonofied by dolphin 'clicks:' Active classification," Journal of the Acoustical Society of America, 103, 3, 1447-1557 (1998).

We have examined a large set of dolphin-emitted acoustic pulses ("echolocation clicks") which were reflected from various elastic shells that were suspended, underwater, 4.5 m in front of the animal in a large test site in Kaneohe Bay, Hawaii. A carefully instrumented analog-to-digital system continuously captured the emitted clicks and also the returned, backscattered echoes. Using standard conditioning techniques and food reinforces, the dolphin is taught to push an underwater paddle when the "correct" target, the one he has been trained to identify, is presented to him. He communicates to us his consistently correct identifying choices in this manner. We have examined many echoes returned by three types of cylindrical shells in both the time and frequency domains as well as in the joint time-frequency (t-f) domain, by means of Wigner-type distributions. We show how specific features observable in these displays are directly related to the physical characteristics of the shells. Our processing takes advantage of certain fundamental resonance principles to show which echo-features contain information about the size, shape, wall-thickness, and material composition of both the shell and its filler substance. In the same fashion that these resonance features give us the identifying characteristics of each shell, we believe they may also give them to the dolphin. These echo features may allow him to extract the target properties by inspection without any need for computations. We claim that this may be the fundamental physical explanation of the dolphin's amazing target-ID feats, upon which they base their recognition choices. Our claim may be substantiated by the detailed analysis of many typical echoes returned by various shells, when they are interrogated by several dolphins. Thus far, this analysis of many echoes from many shells has only been carried out for a single dolphin.

EDSALL, D. W., Professor, "Sentinel Species: Trace Metal Ecotoxicology in the Oyster Toadfish (Opsanus tau). Proceeding of the Second Marine and Estuarine Shallow," Water Science and Management Conference. 1:119-122 (December 1997).

Oyster toadfish (Opsanus tau) and the American oyster (Crassotrea virginica) are resident, non-migratory species important to the estuarine benthic food web along the eastern coast of North America. They are sentinel species with the potential to extract potentially toxic environmental trace metals. To test this hypothesis, samplings are from areas away from direct industrial or commercial effluents. Using a proton induced x-ray emissions (PIXE) system, this study concentrates on trace metals found in the liver of the oyster toadfish and the gill and muscle tissue of the oyster. The PIXE system is a rapid method to determine trace metal types, concentrations and for archiving samples. Present analyses of various size toadfish show that the livers contained concentrations of chromium (6-52 mg/L), copper (3-26 mg/L), and zinc (9-30 mg/L). For the toadfish, the trace metals vary as a function of the size, age, and sex of the fish. Generally, the trace metals have an accumulation pattern of chromium>zinc> copper. The life history stage of the toadfish is an important factor in trace

metal accumulation. Oysters tend to concentrate trace metals in the ratio of zinc>copper>selenium with varying concentrations of lead and arsenic (1-10 mg/L). The lead, arsenic and copper accumulation in these animals fit patterns of land use. Therefore, trace metal accumulation relative to life history stages, and land use practices in the northern Chesapeake Bay indicates these two species are useful sentinel species for various trace metals.

ENGLE, I. M., Professor, Coauthor, "Magnetic Mapping Of Auroral Signatures Of Comet S19 In The Jovian Magnetosphere," Planet. Space Sci., 45, 1315-1332, (October 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 unfavorable 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, J. P., Associate Professor, Coauthor, "A laboratory manual for all of Introductory Physics," General Physics Laboratory Manual, 1997-1998 Harcourt-Brace Custom Publishing, ISBN 0-03-025068-4.

ERTEL, J. P., Associate Professor, Coauthor, "Mechanical And Radiated Power And Radiation Efficiency Of Point Driven Panels," *130th Winter Meeting of the Acoustical Society of America* , San Diego, CA, 1 December 1997, 1aSA10.

The radiation and partial radiation efficiencies from point and line driven panels were previously defined and investigated by the authors [J. Acoust. Soc. Am. 98, 2888(A) (1995) and J. Sound Vib. 144, 71--86 (1991)]. In this paper, the mechanical power dissipated in a point driven fluid loaded panel is studied and compared to the radiated power. The interdependence of the mechanical and radiated powers is investigated, and they are related as fractions of the total input power. The dependencies of the mechanical and radiated power on frequency, fluid loading, and mechanical loss are further studied. In the present paper, the mechanical power as well as the radiation efficiency is shown to increase with increased damping in a panel while the radiated power decreases, as it must. These results again show the fallibility of the conclusion that "a higher radiation efficiency necessarily implies more radiated power." The results of computer experiments are cited in numerical examples.

FONTANELLA, J. J., Professor, Coauthor, "Dielectric Properties of Fluoropolymers," Ch.13, Dielectric Spectroscopy of Polymeric Materials, Fundamentals and Applications. Eds. J. R. Runt and J. J. Fitzgerald, American Chemical Society Press, 1997.

Dielectric properties have been measured for polytetrafluoroethylene (PTFE) and a number of copolymers of TFE as well as poly(perfluoropropylene oxide). Of the three dynamic mechanical relaxations in PTFE, only the low temperature g-relaxation is dielectrically active. However, the a-relaxation is seen in certain copolymers. Polymers having certain side groups exhibit an additional relaxation near 94K. Small guest molecules absorbed in PTFE also produce a relaxation at low temperatures. Other studies included the effect of pressure, which caused the g-relaxation to shift to higher temperatures and lower frequencies.

KATZ-STONE, D. M., Assistant Professor, Coauthor, "An Analysis of the Synchrotron Spectrum

in the Fanaroff-Riley Type I Galaxy 3C 449," The Astrophysical Journal, 488, 146-154, (1997).

We studied the evolution of relativistic electrons in the Fanaroff-Riley type I (FR I) galaxy 3C449, by observing with the VLA at three frequencies (330, 1445, and 4835 MHz) and in all four configurations for a primary resolution of 3."6.

The conventional model for this type of source is that the relativistic electrons are accelerated in the core and subsequently lose energy as the jet flows outward, expands and bends down stream. We find that 3C 449 is more completed than that, with evidence for a different type of structure, more reminiscent of higher luminosity FR II galaxies. We introduce a new analysis tool -- the spectral tomography gallery -- and find evidence for two spectral components that we label the "flat jet" and the "sheath." The flat jet remains fairly well collimated throughout the inner 5, with the sheath accounting for most of the observed widening.

The flat jet shows little steepening with distance from the core. However, the sheath has a steeper spectral index than the jet. If the same spectral shape is appropriate for both components, there may be an evolutionary connection between the particles in the flat jet. This may mean that the sheath and the flat jet are separate electron populations. In either case, the standard aging analyses would give incorrect answers because of confusion between the separate spectral components.

KORMAN, Murray S., Professor, "Design and development of PC-IMAT," Proceedings of the 16th International Congress on Acoustics and the 135th Meeting of the Acoustical Society of America, 2079-2080, Seattle, Washington, 20-26 June 1998.

NPRDC has been tasked to provide empirical evidence of effective instructional strategies for the acquisition of conceptual knowledge under the project name PC-IMAT (Personalized Curriculum for Interactive Multisensor Analysis Training). The domain to be investigated and demonstrated includes those concepts required for the successful planning and execution of antisubmarine warfare (ASW), specifically, the conceptual knowledge underlying the prediction of sound transmission paths and detection ranges. Navy-standard models which are used in fleet SONAR prediction systems are available to support the learners' conceptual understanding of the elements of the oceanographic environment which affect acoustic propagation. To date, these models are employed in a microcomputer based, stand-alone delivery architecture in both a linear interactive courseware (ICW) format and in modules suitable for independent exploratory learning. Midshipmen 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 trace or propagation loss models). Research on "scientific visualization" (to enhance comprehension and retention) and student feedback will also be used to help develop and evaluate other training materials including beamforming, reverberation, target motion analysis and scattering. [Work supported by ONR.]

KORMAN, Murray S., Professor, "Design and development of PC-IMAT: Teaching strategies for acoustical oceanography, part II," Proceedings of the 16th International Congress on Acoustics and the 135th Meeting of the Acoustical Society of America, 1703-1704, Seattle, Washington, 20-26 June 1998.

The PC-IMAT (Personalized Curriculum for Interactive Multisensor Analysis Training) 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. Midshipman taking SP411 (Underwater Acoustics and Sonar) are currently using PC-IMAT [J. Acoust. Soc. Am. 101, 3096A (1997)] to help investigate effective instructional strategies which convey understanding of a complex multivariate domain (like ray trace or propagation loss models). Classroom demonstration lectures and out-of-class projects allow students to successfully interact with experimental apparatus and make actual measurements (e.g. Fourier analysis, detection theory, beam pattern functions, sound speed vs. temperature, computer ray tracing, reflection and transmission at an interface and target strength vs. angle of a scale model sub). However, a link between textbook theories, the actual physics experiments and the real world setting of tactical sonar has been missing. Usage of PC-IMAT on actual submarine training exercises shows the limitations and enhancements of tactical maneuvering when sonar systems are subject to complex surroundings. The research and development of "scientific visualization" on PC-IMAT should ultimately incorporate a strong link between both learning environments. [Work supported by ONR.]

TANKERSLEY, L. L., Professor, Coauthor, "Optical Oil Debris Monitoring," Society for Machinery Failure Prevention Technology Proceedings 52, 483-

490 (30 March 1998).

The performance characteristics of the LASERNET FINES optical oil debris monitor are described. This monitor provides on-site measurements of particle size distributions and shape characteristics in lubricating, hydraulic and other fluids. It will provide information on mechanical wear of oil wetted machinery components and contamination in hydraulic systems. The features and capabilities of a portable instrument based on LASERNET FINES are described.

TANKERSLEY, L. L., Professor, Coauthor, "LASERNET Optical Oil Debris Monitor," JOAP International Condition Monitoring Conference Prodeedings, 110-116 (1998).

The LASERNET optical oil debris monitor has been developed for real time on line identification of fault type and severity through detection of size, shape and rate of production of failure related debris in critical applications such as engines and gearboxes of helicopters. Detection of failure related debris without sampling has required the development of a high resolution high speed imaging and processing capable of recording and processing images at rates up to 500 frames per second. We have designed and constructed such a system based on parallel/series CCD technology, high speed dedicated image processors and neural net classifiers for fault identification. The system has been tested on the T700 engine at the helicopter power train test cell at Naval Air Warfare Center, Trenton, NJ. The system has been tested under a variety of engine operating conditions. The first set of tests were directed at demonstrating an acceptably low false alarm rate along with the ability to identify failure related debris. The test on the T700 engine was chosen for the low debris generation rate of the engine, providing a platform on which the false alarm rate could be examined under a variety of conditions. Qualitative performance evaluation has demonstrated the ability to detect debris in real time and to distinguish and classify air bubble patterns in varying degrees of complexity. The overall false alarm rate has been shown to depend on the strategy adopted in the image processor. For a dual processor architecture the results indicate that LASERNET will be capable of operating on line in real time with a false alarm (defined as an incorrect identification of a rejectable gear box) rate of less than one every 2000 operating hours.

TANKERSLEY, L. L., Professor, Coauthor, "LASERNET Fines Optical Oil Debris Monitor," JOAP International Condition Monitoring Conference Proceedings, 117-124 (1998).

The performance characteristics of the LASERNET FINES optical oil debris monitor are described. This monitor provides on-site measurements of particle size distributions and shape characteristics in lubricating, hydraulic and other fluids. It will provide information on mechanical wear of oil wetted machinery components and contamination in hydraulic systems. The features and capabilities of a portable instrument based on LASERNET FINES are described.

VANHOY, J., Associate Professor, Coauthor, "Structural Characteristics of 144Nd through -Ray Spectroscopy Following Inelastic Neutron Scattering," Phys. Rev. C, 57, 2264-2280 (1998).

Excited levels in ^{144}Nd below 3.3 MeV have been studied using the (n,n') reaction. Electromagnetic transition probabilities, multipole-mixing and branching ratios, and level spins and parities were deduced from measured -ray excitation functions, angular distributions, and Doppler shifts. Mixed-symmetry configurations in low-lying excited states were investigated by comparing experimental electromagnetic transition rates with theoretical calculations made using the interacting boson model and with existing calculations from the quasiparticle phonon model, the cluster vibrator model, and the particle-core coupling model. Fragmentation of the 2^+ mixed-symmetry mode is clearly observed through strong $M1$ transitions into the lowest symmetric 2^+ level and through small $E2/M1$ multipole-mixing ratios. Comparisons with similar measurements on ^{142}Ce reveal that that these N = 84 isotones exhibit strong fragmentation of the mixed-symmetry mode, although it appears to be spread into more levels in ^{144}Nd. Evidence is found to support the assignment of the 2779.0-keV level as the 3^- member of the octupole-quadrupole phonon coupled quintuplet in ^{144}Nd and to propose that this excited mode is shared with the 2606.0-keV state. Two- and three-quadrupole phonon excitations, as well as other members of the quadrupole-octupole quintuplet, are also examined.

VANHOY, J., Associate Professor, Coauthor, "Nuclear Structure of the Stable Tellurium Isotopes," Proceedings: Eleventh National Conference on Undergraduate Research 1997, Edited by R.D. Yearout, Asheville: Univ North Carolina at Asheville Press, 1531-1535 (1997).

The level schemes of the even mass tellurium nuclei A=124, 126, 128, and 130 have been constructed by measuring the de-excitation gamma rays following excitation of a target nucleus by inelastic neutron scattering. Level schemes were developed by identifying gamma-ray cascades with a multiple detector arrangement. Combined with additional information obtained from gamma ray angular distribution data, the evolution of nuclear structure across an isotope chain becomes apparent. Results are compared with IBM-2 and PCM model calculations.

WHITING, Alan B., "A New Galaxy in the Local Group: The Antlia Dwarf Spheroidal Galaxy," Astronomical Journal 114, 996-1001, September 1997.

We report the discovery of new member of the Local Group in the constellation of Antlia. Optically the system appears to be a typical dwarf spheroidal galaxy of type dE3.5 with no apparent young blue stars or unusual features. A color-magnitude diagram in I, V - I shows the tip of the red giant branch, giving a distance modulus of 25.3 $\pm$ 0.2 (1.15 Mpc $\pm$ 0.1) and a metallicity of -1.6 $\pm$ 0.3. Although Antlia is in a relatively isolated part of the Local Group it is only 1.2 degrees away on the sky from the Local Group dwarf NGC3109, and may be an associated system.

WINTERSGILL, M. C., Professor, Coauthor, "Dielectric Properties of Fluoropolymers", Ch.13, Dielectric Spectroscopy of Polymeric Materials, Fundamentals and Applications. Eds. J. R. Runt and J. J. Fitzgerald, American Chemical Society Press, 1997.

Dielectric properties have been measured for polytetrafluoroethylene (PTFE) and a number of copolymers of TFE as well as poly(perfluoropropylene oxide). Of the three dynamic mechanical relaxations in PTFE, only the low temperature g-relaxation is dielectrically active. However, the a-relaxation is seen in certain copolymers. Polymers having certain side groups exhibit an additional relaxation near 94K. Small guest molecules absorbed in PTFE also produce a relaxation at low temperatures. Other studies included the effect of pressure, which caused the g-relaxation to shift to higher temperatures and lower frequencies.

Presentations

ALBERT, C. Elise, Professor, "Optical Observations of Halo Gas," NASA Goddard Spaceflight Center, 8 December 1997.

BATTLE, P., Assistant Professor, "Laser Speckle Photography Using Optically Addressed Multiple Quantum Well Spatial Light Modulators," Conference on Lasers and Electro-Optics, San Francisco, CA, 3-8 May 1998.

EDMONDSON, C. A., LCDR, USN, Coauthor, "Effect of High Pressure on the Electrical Conductivity of Ion-Exchange Membranes and Related Acids," Gordon Research Conference, Conference on Ion Containing Polymers, New London, NH, 22-27 June 1997.

EDMONDSON, C. A., LCDR, USN, Coauthor, "Properties of Fuel Cell and Battery Materials," ONR Electrochemistry Review, Ventura, CA, 15-16 January 1998.

EDMONDSON, C. A., LCDR, USN, Coauthor, "Electrical Conductivity of "Dry" PEM's at Elevated Temperatures," ONR/ARO/DARPA Workshop on Advanced Fuel Cell Membranes, Las Vegas, NV, 28 April -1 May 1998.

EDSALL, D. W., Professor, Coauthor, "Runoff Induced Toxic Algal Blooms," AGU National Meeting, Boston, MA, 26-29 May 1998.

ELDER, S. A., Professor, Coauthor, "Insights On Normal Vocal Fold Oscillation From The Acoustic Dissection Of Single Glottic Pulses In Vocal Fry," 134th Meeting of the Acoustical Society of America, 1-5 December 1997.

ELDER, S. A., Professor, Coauthor, Poster Paper presented at Session Y1, 1998 Midwinter Meeting Association for Research in Otolaryngology, St. Petersburg Beach, FL, 15-19 February 1998.

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HUDDLE, James R., Associate Professor, "Observing, Recording and Enjoying the Total Solar Eclipse of 26 February 1998," Aruba, Netherlands Antilles, 25 February 1998.

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TANKERSLEY, L. L., Professor, Coauthor, "LASERNET Optical Oil Debris Monitor," 1998 Technology Showcase, JOAP International Condition Monitoring Conference, Mobile, AL, 20-24 April 1998.

TANKERSLEY, L. L., Professor, Coauthor, "LASERNET Fines Optical Oil Debris Monitor," 1998 Technology Showcase, JOAP International Condition Monitoring Conference, Mobile, AL, 20-24 April 1998.

VANHOY, J. R., Associate Professor, Coauthor, "Nuclear Structure Trends in N=84 and Z=52," LANSCE Workshop on Nuclear Physics Applications with GEANIE, Taos, NM 22-24 June 1997.

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TECHNICAL REPORTS

EDSALL, D. W., Professor, Coauthor, "Bottom Backscattering Measured Southwest of Key West During Littoral Warfare Advance Development Focused Technology Experiment 97-2." Manuscript Report NRL/MR/7140-97-7977. Naval Research Laboratory, Washington, D.C. 20375-5350 (1997).

Measurements of ocean bottom backscattering were performed in a shallow water environment southwest of Key West, Florida, as part of the Littoral Warfare Advanced Development (LWAD) Focused Technology Experiment 97-2 (FTE 97-2). Scattering strengths were obtained at 2, 2.5, 3 and 3.5 kHz as a function of grazing angle at a single site with a sandy bottom. The scattering strengths roughly followed a Lambert's Law (dependence on the square of the sine of the grazing angle) dependence with constants ranging from -22 dB for 2000 Hz to -19 dB for 3500 Hz. This frequency dependence was consistent with the results given by the Mourad-Jackson bottom scattering model.

Division of Professional Development

CAPT Louis J. Geanuleas

Director

DEPARTMENT OF

LEADERSHIP, ETHICS AND LAW

Captain (Sel) Mark N. Clemente, USN

Chair

The 1997-1998 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 not only to the efforts 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 continued with NETC-Newport and Pensacola. Psychology papers addressing social psychology and leadership as well as eating disorders were presented by CAPT Elizabeth Holmes, while both she and LCDR Rocky Lall published an article on suicide. LCDR Leigh Lucart presented research on authoritarian personalities. David Johnson, Paul Roush, George Lucas, Aine Donovan, Shannon French, and the Distinguished Ethics Chair, Nancy Sherman, all actively pursued scholarly work within philosophy. Members of this Ethics Section continued their instruction in 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. Admiral Leon A. Edney, USN (Ret), continued as the Distinguished Professor of Leadership Studies. Finally, the department lost a pillar of a man who represented the best of Naval Academy leadership, Dr. Karel Montor, who passed away on 13 March, 1998. 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

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 Corps, and Admiral Frank Kelso, USN (Ret), the former CNO, along with a forward by the Secretary of the Navy. Additionally, an entirely new chapter on combat leadership was added, drawn from extensive interviews of combat veterans. The revised text was published in May 1998.

The Ethics of Neutrality and Isolationist Foreign Policy

Researcher: Assistant Professor Shannon E. French

Sponsor: Naval Academy Research Council (O&M,N)

Noting that much of what has been written in the area of Just War Theory in the field of military ethics focuses on the question, "Is nation X's decision to go to war for cause Y morally defensible?," this project turns the question around and focuses instead on examining the possible moral justifications for a nation's decision to refuse to enter an existing conflict. The central question thus becomes, "When, if ever, can nation X's decision to remain neutral when other nations are at war be morally condemned?" The Legalist Paradigm, formally established in Michael Walzer's ground-breaking work, Just and Unjust Wars, allows nations to be judged by the international community on essentially the same grounds that ordinary people are judged in the courts for violating the legal rights and claims of others. Nations and human beings thus are placed into the same category of "legal persons." This establishes a precedent for the accepted standards that are used to praise or condemn the behavior of individual humans and applying them to the task of judging the action and policies of nations. The first goal of this research is to study the defense for the practice of treating nations as legal persons, and then to consider arguments that they should be viewed as "moral persons," as well. The next step is to construct analogies between individual human conflicts and international conflicts and evaluate both using the same moral criteria in order to determine whether or not certain forms of national neutrality, isolationism, and non-intervention foreign policies are open to moral criticism. Groundwork for this project includes research into the notion of the "bad Samaritan," the category of supererogatory actions (actions "above and beyond the call of duty"), and the concepts of nobility and sacrifice.

Independent Research

Moral Growth Assessment Project

Researcher: Assistant Professor Aine Donovan

This project involves measuring the moral stages of military officers who have at least ten years of experience and are involved in the ethics education program at the United States Naval Academy. The officers will be assessed before they begin work with the ethics education program and, again, throughout their first year of work with the midshipmen. A significant emphasis of this research project will reside in determining the relationship between ego identity and moral reasoning - with special emphasis placed on gender distinction and how teaching is perceived as a moral practice. The significance of this project lies in the formation of appropriate pedagogy for military ethics education programs.

The Military Community as a Moral Force in Adolescent Development

Researcher: Assistant Professor Aine Donovan

The historical appeal to military service has been character-shaping; taking boys and "making men of them." With the increasing polarization of the military and civilian communities, this project examines the ethos reflected in the emerging warrior class who see themselves as socially and morally different from the larger society. For the first time in American history military personnel who are clearly aligning themselves with partisan politics and religious orientations have taken a decidedly conservative turn. What does this orientation mean for the citizen-soldier and, perhaps more significantly, for society at large? This project examines some of the significant social problems (racial tension, drug abuse, etc.) And explores the ways in which the military community addresses these concerns and what they mean for the moral

development of young men and women who enter military service.

Flag Officer Mentor Survey

Researchers: Assistant Professor Rocky Lall and Professor Elizabeth Holmes

This project included a review of literature on mentoring followed by a survey questionnaire sent to over 1200 retired Navy admirals. The survey was titled the "Navy Flag Officer Mentor Experience Survey." It was created by faculty to help provide the first comprehensive look at the nature and extent of mentoring as it had been experienced by the most successful of our Navy's career officers.

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DONOVAN, Aine, JOHNSON, David E., LUCAS, George R., and ROUSH, Paul E. "Ethics for Military Leaders," Simon and Shuster, Needham, MA, 1998.

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Presentations

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DONOVAN, Aine. Assistant Professor. "Celestial Navigation with a Moral Compass," at Association of Moral Education, Atlanta, GA, Oct 1997.

DONOVAN, Aine. Assistant Professor. "Ethics for Today's Retailers," at International Mass Retailers Association, Tampa, FL, March 1998.

DONOVAN, Aine. Assistant Professor. "The Right to Philosophy of Education: From Critique to Deconstruction," at Philosophy of Education Society, Boston, MA, March 1998.

FRENCH, Shannon E., "Mentoring 401 - The Advanced Course," at Women Officers' Professional Association Luncheon, Naval Station, Annapolis, MD, 22 April 1998.

HOLMES, Elizabeth K., Ph.D., CAPT, USN, "Social Psychology and Leadership," Surgeon General's Conference, Arlington, VA. 25 Aug 1997.

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Nimitz Library

Richard H. Werking

Director

Academic librarians are engaged primarily in professional practice, in providing a variety of services that assist the research of students, faculty, and other library users. In addition, they conduct research, publish works of scholarship, and make presentations at professional meetings.

Publications

CLEMENS, Lawrence E., Reference Librarian, Review of *The American Aero-space Industry: From Workshop to Global Enterprise*, by Roger E. Bilstein, Twayne/ Prentice Hall International, 1996, *Choice,* Vol. 35, No. 4, p. 651 (December 1997).

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Presentations

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