Naval Architecture, Ocean and Marine Engineering Department

Professor Bruce C. Nehrling
Chair

All three disciplines in the Department of Naval Architecture, Ocean and Marine Engineering were active in scholarly research and professional development during the 1999-2000 Academic Year. As faculty members and midshipmen undertook both funded and unfunded research activities, significant use was made of the Academy's outstanding experimental, computational, and library facilities. The department sponsored a Trident Scholar and nine independent research projects during this academic year.

The department's faculty continues to participate actively in professional meetings and conferences, both nationally and internationally. They published in professional journals and other technical publications and presented research results at national and international symposia. An energized and current academic environment for both core and major courses is but one outcome of this department's broad and significant involvement in research.

The broad spectrum of research themes reflects the varied specialties of the department's three technical areas of concentration.

Naval Architecture topics included the study and experimental testing of compressive loads on composite panels - ncluding ultimate strength and failure characteristics, the durability of marine composites, and keel and hull laminate design studies for the proposed Navy 44 sail training vessel. In addition, experiments for predicting the powering performance of unconventional planing hulls were conducted in the Hydromechanics Laboratory.

Ocean Engineering topics included the study of wave groups, modeling of ship generated surface waves, experimental testing of a mobile offshore base module, driver propulsion vehicle testing, and developing flood-borne debris loading standards for fixed structures. In materials and structures, research projects dealt with the analysis of adhesively bonded composite joints, fiber steering techniques for lightweight affordable composite structures, and investigations into using composite materials to fabricate pressure vessels. Other research, resulting in five Navy Patent Disclosures, involved the thermal protection of divers, underwater life support, and experiments on passively-controlled underwater rebreather apparatus. Additional projects included an analysis of shipping trends, safety, and engineering aspects associated with the design and maintenance of navigable channels, the analysis of toxin transfer in near shore sediments, and the use of Geographical Information Systems to map long term shoreline erosion.

Marine engineering topics included reliability centered maintenance, manpower and technology issues for future submarines, advanced ideas for nuclear propulsion plants, computer-based thermodynamics instruction, reduction of emissions from marine power plants, and the combustion of shipboard solid wastes. In the area of energy conversion, research was conducted on using both flat heat pipes and capillary pumped loop systems with thermophotovoltaic generators. Other projects included the study of radiation on microelectronic devices, thermoluminescent dosimeter investigations, and hazardous waste remediation.

Research funding was made available from many sources including department operating funds, the Trident Scholar Program, and contracts and grants from the Office of Naval Research; the Naval Sea Systems Command; the Naval Dosimetry Center; the National Science Foundation; the Institute for Water Resources; the American Society of Civil Engineers; the Department of Energy and the Knowles Atomic Power Laboratory; Strategic Systems Programs; the Naval Research Laboratory; the Naval Facilities Engineering Services Center; the Applied Physics Laboratory; and the American Bureau of Shipping.

Sponsored Research

Wave Groups and Wave Breaking in Random Seas

RESEARCHER: Professor Thomas H. Dawson
SPONSOR: Office of Naval Research (ONR)

Wave groups in random deep-water waves are being studied experimentally using the Naval Academy's 380 foot wave/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.

Impact Loads of Flood-Borne Debris

RESEARCHER: Professor David L. Kriebel
SPONSOR: American Society of Civil Engineers (ASCE)

This project involved an extensive literature review and the forces that can be imparted by floating debris on buildings located in flood-plains. This is the first phase of a multi-year project aimed at revising building codes for flood-prone areas as part of the American Society of Civil Engineers (ASCE) Standard ASCE-7-98 "Minimum Design Loads for 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 in flood-plains must consider the effects of floating debris that may be carried by the flood water and impact the building. This is a problem both in riverine flood-plains, where the typical debris consists of large trees and logs, as well as in coastal flood-plains where the typical debris may consist of foundation piles from destroyed buildings and pier. This project has involved: (1) a review of riverine flood debris, (2) a review of coastal flood debris, (3) development of new guidelines for debris sizes (weights and lengths) that should be considered in building design, (4) a review of available guidance on predicting debris impact loads, and (5) development of a recommended test plan, to be conducted in 2000-2001 to obtain new field data on debris impact loads.

Model Testing of a Mobile Offshore Base Module

RESEARCHERS: Professor David L. Kriebel and Ms. Louise Wallendorf
SPONSORS: Office of Naval Research (ONR) and Naval Facilities Engineering Services Center

This project involved small-scale physical model testing of one semi-submersible module of the Mobile Offshore Base (MOB), a future-generation floating air base currently being investigated for its technical feasibility. The overall MOB platform considered in this project would be about 5000 feet long, 400 feet wide, with a total height from keel to deck of about 250 feet. The structure would consist of five modules linked end-to-end. Each module would be a semi-submersible floating platform, 1000 feet long and 400 feet wide, with a draft of about 40 feet when transiting across the ocean and a draft of about 100 feet when ballasted down for air take-off and landing operations. If constructed, this structure would be much larger than any semi-submersible platform now in use.

The USNA research effort involved two distinct phases: (1) construction of a scale model of a single module of the MOB platform and (2) testing of this model in the large wave/towing tank located in the Naval Academy Hydromechanics Laboratory. The purpose of these tests was to evaluate the dynamic motions of such a large semi-submersible in heave, pitch, and roll, specifically in the transit condition. The MOB model was built in the TSD shops in Rickover Hall during the summer and fall of 1998. The model was built using as scale ratio of 1-to- 70, and was thus more than 14 feet long, almost 6 feet wide, and about 3.5 feet high. Initial testing was performed in January 1999 with the model held stationary in the wave tank, and additional tests were completed in March 1999 with the model towed at various forward speeds. Results of these tests were presented at the Very Large Floating Structures Conference in September 1999. A final set of tests was completed in December 1999 to evaluate the wave elevations under the deck and to measure dynamic motions for the model under a deep-draft or ballasted condition. Work is in progress to complete project reports.

Evaluation and Design of Heat Pipes for Cold Side Heat Sinks

RESEARCHERS: Associate Professor Martin R. Cerza, Professor Keith W. Lindler
and Ensign Britt Boughey, USN
SPONSOR: Knowles Atomic Power Laboratory (KAPL)

Thermophotovoltaic (TPV) energy conversion utilizes photons from a thermal radiator to convert photonic energy to electrical energy. Due to the nature of the system, the thermal radiator must emit uniform radiation and therefore maintain a uniform temperature profile in order to achieve maximum efficiency. Heat pipe technology can effectively meet the demand for an isothermal emitter as it utilizes near isobaric phase changes to transfer heat at a uniform temperature. In this project, heat pipes are explored for use in TPV energy conversion systems. A flat heat pipe offers many advantages over the conventional cylindrical design. These include increased surface area to volume ratio in order to maximize power density, as well as the ability to stack or layer the system with photovoltaic (PV) cells on both sides of the flat heat pipe to utilize available energy. Not only do flat heat pipes present unique engineering demands inherent in their operation to counteract pressure differences across their vessel walls, but they are also difficult to construct. To date, only limited analyses of their thermal characteristics have been done for use in performance predictions. Therefore, it is necessary to conduct analyses to enable consideration of heat pipes for implementation into TPV systems. This report details the design and construction of a flat heat pipe analyzed both in symmetric and asymmetric heating conditions, involving a low temperature version of future emitter designs due to safety considerations. Water was used as a working fluid instead of the liquid metal required to achieve the temperatures of a functional emitter. Despite this difference in working fluid, the data presented is valuable to both TPV and heat pipe research.

Analysis of a Capillary Pumped Loop System

RESEARCHER: Midshipman 2/C Richard C. Herron, USN (Trident Scholar Project in 2001)
ADVISERS: Associate Professor Martin R. Cerza and Associate Professor Mark J. Harper
SPONSOR: Knowles Atomic Power Laboratory (KAPL)

The purpose of this research was to study the feasibility of utilizing a capillary pumped loop (CPL) system as the cold heat sink for an energy conversion system. A capillary pumped loop energy transfer system is similar to a heat pipe system. The major difference is that the CPL system consists of separate evaporator and condenser devices. The CPL evaporator employs capillary forces which are surface tensile forces across gas/liquid surfaces of curvature in the evaporator wick. These capillary forces provide the pumping head when heat is input to the evaporator, to drive an evaporation-condensation energy transfer scheme much like a heat pipe.

A capillary pump was designed, built, and tested satisfactorily. While the desired heat flux of 2.6 watts per square centimeter were not achieved, further refinements to the design and improved fabrication methods should significantly improve the maximum heat flux.

Flat Heat Pipes and Capillary Pump Loops as Heat Removal Devices for use in Thermophotovoltaic (TPV) Generators

RESEARCHERS: Professor Keith W. Lindler, Associate Professor Mark J. Harper,
Associate Professor Martin R. Cerza, and Ensign Britt Boughey, USN (Trident Scholar, Class of 1999)
SPONSOR: Knowles Atomic Power Laboratory (KAPL)

The United States Naval Academy was tasked with the design and fabrication of a combustor/emitter that was compatible with a DOE furnished thermophotovoltaic (TPV) power module. Following successful completion of that project, the goal was to design and fabricate a heat pipe to radiate heat at uniform temperatures over a flat surface. A theoretical model was devised to predict performance, and a novel flat heat pipe was designed. Two flat heat pipes were constructed and tested under asymmetric heating conditions. Results of testing indicated definite potential for low temperature, water-filled flat heat pipes to serve as cooling devices for photovoltaic cells in a TPV power generation system.

During FY2000 the thrust of research was the design and development of a capillary pump loop that will remove heat from the photovoltaic cells of a TPV power generator.

Manpower and Technology Issues for Submarines of the Future

RESEARCHER: Associate Professor Mark J. Harper
SPONSOR: Naval Sea Systems Command, Naval Surface Warfare Center (NSWC)

This ongoing effort examined manning of ships in general and submarines in particular. It chronicled the history of the VIRGINIA Class SSN manpower requirements. The studies examined various methods for estimating the costs of manning submarines, and indicated that the payoffs from reducing existing manning levels are negligible. Only by incorporating the notion of reduced manning into every aspect of the submarine's design will real savings of manpower dollars be achieved. Later studies involved a series of workshops that attempted to address technology issues associated with manning future submarines. The principal finding was that the entire design philosophy and procedure must change radically in order to provide optimal manning for submarines of the future.

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

RESEARCHERS: Assistant Professor Jennifer K. Waters and Associate Professor Robert H. Mayer
SPONSOR: Institute for Water Resources, U.S. Army Corps of Engineers,
Summer intersessional period, 1998 and 1999.

The goal of the Institute for Water Resources (IWR) work unit #33123: "Impacts of Navigation Trends on Channel Usage and Design" 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. 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 is important since it is well-recognized that navigation channels are not necessarily maintained or utilized as they were originally designed.

The goal of this proposed work effort is to support IWR's work unit #33123 through completion of related tasks. In summary, the researchers propose to assist in identifying, investigating and integrating many of the technical, operational, and economic issues affecting navigation channel usage, design, and maintenance. During the course of this effort, progress reports in the form of semi-annual presentations and formal task summaries are provided to IWR. Also, a short course that covers the significant ocean engineering and naval architectural aspects of this study is under development.

Durability of Marine Composites

RESEARCHER: Assistant Professor Paul H. Miller
SPONSOR: American Bureau of Shipping, TPI, Maricomp

This project is part of the investigator's doctoral research and focuses on the fatigue durability of fiberglass (e-glass/polyester) marine composites. These materials have been commonly used to construct hulls, decks and superstructures of small craft for the last three decades. Recently the Navy and others have constructed larger craft with these materials but concerns exist whether the methods developed to predict fatigue effects are accurate.

To validate these methods this project looks at standard coupon test results and compares them with proposed panel test methods. The comparisons include both physical and numerical (finite element analysis) methods. To accurately simulate long-term exposure to the marine environment moisture effects are also tested. Additionally, the coupon and panel results are compared to full-size vessel tests. Results during the Jun 99-Jun 00 period included: continued moisture exposure, design and construction of the compression and panel test jigs, testing of tensile, shear, compression and flexural coupons, panel and fatigue coupon testing, final development of the finite element models, on-the-water tests, and submission of the dissertation. Key

results showed that a coupon/FEA program can predict stiffness reduction and that current Navy and ABS Guides may not provide sufficient material margins for long life.

Characterization of the INWS Site at Kirtland AFB

RESEARCHERS: Professor Martin E. Nelson, Associate Professor Mark J. Harper, and R. August (NRL)
SPONSOR: Naval Research Laboratory (NRL)

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 to 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 analyses 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. A final report was issued in November, 1999.

Two presentations have been given at technical conferences on the results obtained by the project. The first conference presentation, which was entitled "Characterization of Thorium in Soil at the INWS," was presented to the 1998 annual Health Physics Society meeting in July, 1998 in Minneapolis, Minnesota. The second presentation, which was entitled "Environmental Remediation Research," was presented at the 1998 Symposium on Radiation Measurements and Applications in May, 1998 in Ann Arbor, Michigan. A journal article entitled "Mixed Waste Characterization in Soil," was published in Nuclear Instruments and Methods in Physics Research (Section A) in 1999.

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

RESEARCHERS: Professor Martin E. Nelson and Associate Professor Mark J. Harper
SPONSOR: Naval Research Laboratory (NRL)

Eight sites at Kirtland Air Force Base (KAFB) were 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 were proposed. Several publications were generated from this research, including the report listed in attachment (2) here.

Advanced Concepts for Naval Nuclear Propulsion Plants

RESEARCHER: Associate Professor Mark J. Harper
SPONSOR: Knolls Atomic Power Laboratory (KAPL)

Research continued 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 (A 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."

Composite Pressure Vessel Fabrication Technology Project

RESEARCHERS: Associate Professor Sarah E. Mouring, Associate Professor Oscar Barton, Jr., Professor Gabriel N. Karpouzian, and Associate Professor Michael Mackney
SPONSOR: Office of Naval Research (ONR)

The researchers at the Naval Academy are studying mechanical property characterization of coupon and structural composites as part of the Composite Pressure Vessel Fabrication Technology Project TDL 99-04. The experimental study includes an assessment of proposed experimental methodology, specimen testing, and subsequent mechanical property characterization. 30 K-fiber tow coupon specimens, 30 structural composite tubes, and 30 additional coupon specimens will be tested. Some of these specimens will be tested at elevated temperatures ranging between 300ºF and 450ºF. Mechanical testing of the 30 K-fiber tow specimens started in the spring of 2000. Testing will continue through the summer of 2000.

Behavior of Composite Joints Adhesively Bonded Using an Innovative Joining Method

RESEARCHER: Associate 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) is 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 performed to validate the analytical models. In the final year of the grant, 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. At this time, three technical papers on the results of the research have been published and one paper has been accepted for publication in the Fall of 2000.

Fiber Steering for Lightweight Affordable Composite Structures

RESEARCHERS: Associate Professor Sarah E. Mouring, Associate Professor Oscar Barton, Jr., Professor Gabriel N. Karpouzian, and Associate Professor Michael Mackney
SPONSOR: Office of Naval Research (ONR)

The objective of the program was 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. Technical support was provided for several aspects of mechanical behavior and testing of composite structures containing non-unidirectional fibers. The research effort was organized into two main focus groups; theoretical methods and experimental methods. The theoretical study included performing a literature survey, investigating current models, and investigating current failure models. The experimental study included an assessment of proposed experimental methodology, coupon specimen testing, and investigating empirically-based modeling. Testing was completed by the summer of 1999. At this time, one technical paper on the results of the research has been published.

Fiber Placed Inlet Duct Program

RESEARCHERS: Associate Professor Sarah E. Mouring, Associate Professor Oscar Barton, Jr., Professor Gabriel N. Karpouzian, and Associate Professor Michael Mackney
SPONSOR: Office of Naval Research (ONR)

The study supported ongoing work in the Fiber Placed Inlet Duct Program. The researchers at the United States Naval Academy provided technical support for several aspects of mechanical behavior and testing of composite structures. This support is intended to lead to a knowledge base for the utilization of fiber placed sandwich composite structure for advanced aircraft.

Testing for the Fiber Placed Inlet Duct Program included static compression and damage testing of fiber placed sandwich structure specimens and will address structural integration of this component. The Naval Academy participated in the test program and was tasked with input and evaluation of the results of the mechanical testing. Testing began in the Spring of 2000 and continued into the Summer of 2000. In the Summer of 1999, the researchers hosted a program review at USNA for over 20 participants from the Navy and industry.

Investigation of Charge Deposition in Microelectronics

RESEARCHERS: Professor Martin E. Nelson and LT Eugene Canfield, USN, Strategic Systems Programs
SPONSOR: Strategic Systems Programs (SSP)

One of the major concerns in strategic applications of microelectronic circuitry is radiation hardness. However, cost concerns are driving strategic designers to consider commercial microelectronic systems in order to take advantage of their low cost. One area of research that today is not well understood is charge deposition within such devices as a function of incident neutron energy and reactions within the microchip substrate material. In this project charge deposition in transistor devices will be studied when irradiated with 14 MeV neutrons using the USNA neutron generator. The project will attempt to model the radiation transport with the devices using 3D radiation transport codes (i.e., MCNP) and charge particle energy deposition models (i.e., TRIM), the model predictions for microelectronic simulation models being developed by Vanderbilt University. The results of this research will serve as the basis of the doctoral dissertation of LT. Canfield, who is a doctoral candidate at the University of Maryland.

Concept Assessment of a Diver Heater Using Hydrogen Catalytic Reactions

RESEARCHER: Professor M. L. Nuckols
SPONSOR: Office of Naval Research (ONR)

The hydrogen catalytic heater has already been shown to be an effective apparatus to warm and humidify diver's inspired gases in open-circuit, demand SCUBA systems with a small catalyst bed placed between the 1st and 2nd stage regulators, and in semi-closed circuit systems with the catalyst bed placed in the breathing circuit just upstream of the mask or helmet. This investigation will show the heating capacity that can be obtained from this method for whole body thermal protection. Preliminary analysis suggests that this technique can greatly minimize the power and space requirements that must be dedicated to diver thermal protection in an SDV. Additionally, the hydrogen catalytic heater testing to date suggests that:

- Heating capacity can be easily controlled with a simple mechanical metering valve for the hydrogen.
- Hydrogen catalytic heater does not require an active heating source.
- It continues to provide supplemental heating as long as hydrogen is present in the gas mixture.
- Provides water vapor as a byproduct of the reaction to help humidify breathing gases.
- Can control inspired gas temperatures almost instantaneously by simply adjusting the percentage of hydrogen passing through the catalyst bed.
- Can be used as either a primary heating source or as an emergency backup heating source which can be initiated when malfunction of the primary heating source occurs.
- Can be easily adaptable to either open, closed, or semi-closed circuits.

Heater cost is anticipated to be a fraction of the cost of batteries used in electrical resistive heating systems.

Passively-Controlled Semi-Closed/Closed Rebreather

RESEARCHER: Professor M. L. Nuckols
SPONSOR: Office of Naval Research (ONR)

The objective of this effort is to optimize the design of a respiratory-coupled circuit using current predictive models, and verify that a safe alternative to the traditional constant mass injection circuit design is feasible. In so doing, this respiratory-coupled design will provide divers with stable, and predictable circuit oxygen levels across their full range of activity levels. One anticipated application of this technology would be Naval Special Warfare personnel deployed from the Advanced SEAL Delivery System (ASDS). The desired lockout depth from the ASDS will probably be deeper than can be supported with closed-circuit, pure oxygen rebreathers such as the LAR V. Although the MK 16 mixed-gas closed-circuit rebreather could support the depths required for ASDS diving operations, its size and complexity would make its use unpopular. A passively-controlled semi-closed rebreather, which can be switched to closed-circuit mode, could satisfy the full range of the ASDS mission without the complexity and cost of the MK 16. The simple respiration-coupled gas supply feature of this design would give the diver a predictable oxygen level in his circuit which would minimize the determination of oxygen dosage levels and any decompression obligations. The expected payoff from optimizing this respiratory-coupled injection system is a greatly reduced variation in oxygen partial pressures within the breathing circuit. It is anticipated that a diver will be able to control his oxygen partial pressure within a very narrow range, without the necessity for expensive, and complex, oxygen monitoring and control systems necessary in mixed-gas, closed-circuit rebreathers. An additional important feature, due to the simple, demand gas make-up mechanism proposed in this design, it is anticipated that a diver will have the option to switch this semi-closed rebreather to a closed circuit mode, in water, during different phases of the dive mission.

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 was upgraded to MCAS, Machinery Condition Assessment System, from the DEMA, Diesel Engine Monitoring and Analysis System several years ago and is currently being upgraded to ICAS, the Integrated Condition Assessment System. Upgrading to ICAS will 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 that has been placed in the budget and ICAS software that will be added as an upgrade when the computer upgrade arrives. The system has an 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 DEMA System on the GM 3-71 Diesel Engine/ Generator Set using a Personal Computer. The IDAX 100 computer that controls data acquisition, monitors alarm conditions, makes log sheets, maintains trend analyses and offers some expert system capability has a unique operating system. The new PC Interface has made a dramatic improvement in the quality of the instruction being given the midshipmen in modern maintenance concepts. The Diesel engine has been modified to allow measurement of cylinder firing pressures. Also, 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. A slide presentation was added to instruct the midshipmen in modern maintenance concepts such as Reliability Centered Maintenance and Condition Based 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 ten years, approximately nine 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.

Computer Based Thermodynamics Instruction

RESEARCHERS: Professor Chih Wu (Mechanical Engineering Department) and
Associate Professor Kenneth L. Tuttle (Naval Architecture, Ocean and Marine Engineering Department)
SPONSOR: Office of Naval Research (ONR)

The researchers are developing a course and producing a manuscript on how to teach thermodynamics using computer based instruction for cycle analysis. Thermodynamic cycle analysis would be the main thrust of the course. The software package that fits this objective and is being used is CyclePad. This software is sophisticated and interactive. The students will be able to construct models of complex heat engines and power plants and other energy systems. The analysis capability of the software will allow them to then analyze those systems for capacity and efficiency. The graphics capability of the software produces plots of experimental data and sensitivity analyses. It is a challenge for instructors to find the most effective method to teach and for authors to write the best manuscript for current technology. Classical thermodynamics is a relatively stable subject and few fundamental changes of presentation are proposed. However, this course is a software oriented one. Property table searches and analyses of systems are done on a computer. It will be the first fully immersed computer software manuscript and course of its kind in teaching and in learning thermodynamics.

Environmental Text

RESEARCHER: Associate Professor Kenneth L. Tuttle
SPONSORS: Society of Naval Architects and Marine Engineers (SNAME)
and Society of Naval Engineers

The Environmental Panel of SNAME in a joint effort with the Environmental Engineering Committee of ASNE, is writing a Reference Text: The Principles of Environmental Design and Operation of Ships. Planning of the text has progressed and three additional members have been appointed to the Environmental Panel. 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 was extended to include participation by the ASNE Environmental Division to help plan the text, to increase the pool of authors and to increase the justification for such a text.

Impacts of Navigation Trends on Channel Usage and Design

RESEARCHERS: Assistant Professor Jennifer K. Waters, Professor David L. Kriebel
and Associate Professor Robert H. Mayer
SPONSORS: Institute for Water Resources (IWR) / Army Corps of Engineers

The goal of this ongoing research 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.

This research effort is nearing its conclusion, with completion of the project expected at the end of FY2000.

Transport and Transformation of Navy Relevant Toxic Pollutants in Nearshore Marine Sediments

RESEARCHERS: R. Mehta, M. Misra, J. Seiber, University of Nevada-Reno, and Assistant Professor Jennifer K. Waters
SPONSOR: Office of Naval Research (ONR)

The harbor areas used by the Naval operations are considered to be extreme environments because of the dynamics of flow, resuspension of sediments and the extreme solution chemistry imposed by salt water. Interplay of these conditions control the co-adsorption of organic & inorganic pollutants onto the sediments. The resultant inorganic and organometallic compounds and the microencapsulation of sediment/metal/organic create a perpetual problem for remediation and natural attenuation of toxic pollutants.

In order to develop an effective in-situ or ex-situ strategy, it is necessary to understand the mechanisms of adsorption, speciation and transformation of pollutants in the harbor environments. In addition, the sediment resuspension, transport and dispersal of pollutants also need to be investigated. A fundamental study of these processes will provide insight into natural attenuation, remediation, monitoring, and risk assessment of the marine sediments. On the basis of this information, a cost-effective and compliance-based remediation strategy can be developed.

It is proposed to study the co-adsorption/desorption of heavy metals (Cu, Zn, Cr, Cd, Pb and Hg) onto sediments in the presence and absence of organic compounds (PAH and PCB's), in both stagnant and stirred conditions simulating the sediment environment. The growth kinetics and dispersive transport of microencapsulated metal-organic-sediment product will be studied in the water column under dynamic conditions.

The proposed objective will be achieved by conducting a series of six sequential tasks: 1) Perform microenvironmental characterization of the three real sediments procured from the three broad naval contamination areas namely, dredged site, leaking underground storage site and in-situ remediation site which will help establish base line conditions of the physical, chemical and biological parameters of each of these environments; 2) Perform flocculation, deposition and resuspension studies; 3) Understand adsorption/desorption mechanisms of heavy metals in a simulated base-line sediment environment; 4) Understand binding mechanisms of organic pollutants in a simulated base-line sediment environment; 5) Develop partitioning mechanisms of Navy relevant pollutants in a simulated base-line sediment environment, and finally; 6) Develop dynamic metal partitioning and transport models and verify the predictions by performing experiments in a settling column. The research will involve the experimental use of many of the state-of-the- art analytical techniques such as AFM, EXAFS, XRD, SEM, FI'IR and GC in addition to modeling and computational work.

Generation and Characterization of Water Waves Created by Vessels Moving in Shallow, Intermediate and Deep Water

RESEARCHERS: Mr. William Seelig, Ms. Louise Wallendorf, Mr. John Zseleczky and Assistant Professor Jennifer K. Waters
SPONSORS: Naval Facilities Engineering Services Center (NFESC)

The generation and characterization of surface waves generated by vessels moving in shallow, intermediate and deep water is still not very well understood. This research project, still under basic development and scope adjustment, intends to gain further insight into this phenomenon through analysis of existing experimental model-scale and full-scale data along with additional scaled model test data. Correlation of the physical results with numerical hydrodynamic models was also undertaken.

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

RESEARCHER: Professor Gregory J. White
SPONSOR: The Johns Hopkins University Applied Physics Laboratory (APL)

This project continued work begun in 1997 on the strength of various configurations of composite panels under inplane and lateral loads. During the period of this report, four 4-ft and eleven 6-ft panels were tested to destruction. The 6-ft panel tests

included five balsa-cored panels and two foam-cored panels tested under inplane loads only. Six of the 6-ft panels were tested first under lateral pressures up to 16 psi and then under a constant lateral pressure of 5 psi with inplane load applied until destruction. The four 4-ft panel tests were for foam-cored panels also experiencing combined inplane and lateral loads.

The strain records from the up to 21 installed gages and deflection measurements from 7 locations were recorded along with the applied load. Analysis of the data with plotted results were provided along with the data files. Each test report included still photographs and in some cases digital video photography. A final test report summary was delivered to JHU/APL in December of 1999.

Independent Research

Combustion of Shipboard Solid Wastes

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 are 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 has published data on the emissions from the combustion of solid waste fuels. The data are based on a statistically designed, fractional factorial experiment that includes seven independent variables and seven dependent variables. The experiment includes both unsteady state experiments as well as steady state experiments. A paper was presented to and published in the Proceedings of The Thirteenth International Conference on Solid Waste Technology and Management. A second paper was presented to the 14th Conference in 1998 and submitted to the Journal of Solid Wastes. The author has several prior publications and one US Patent on the subject of solid fuels, combustion and gasification of solid fuels and combustion generated emissions and helped innovate wood gasification, pulverized wood combustion and environmentally sound wood fired boiler combustion. Wood or biomass is still the predominant fuel used in the world by individuals and homes.

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. A paper was presented at the SNAME Annual Conference that will be published in the1998 SNAME Transactions. This paper is the result of a joint effort that has been developed between SNAME and ASNE. A fourth paper has been published in the Proceedings, Marine Environmental Stewardship for the 21st Century, October 1999.

Research Course Projects

Analysis of a Capillary Pumped Loop System

RESEARCHER: Midshipman 2/C Richard C. Herron, USN (Trident Scholar Project in 2001)
ADVISERS: Associate Professor Martin R. Cerza and Associate Professor Mark J. Harper
SPONSOR: Department of Energy (DOE)

The purpose of this research is to study the feasibility of utilizing a capillary pumped loop (CPL) system as the cold heat sink for an energy conversion system. A capillary pumped loop energy transfer system is similar to a heat pipe system. The major difference is that the CPL system consists of separate evaporator and condenser devices. The CPL evaporator employs capillary forces which are surface tensile forces across gas/liquid surfaces of curvature in the evaporator wick. These capillary forces provide the pumping head when heat is input to the evaporator, to drive an evaporation-condensation energy transfer scheme much like a heat pipe.

The project involvement will be to design a capillary pump loop evaporator capable of providing 2.6 W/cm^2 of thermal dissipation from an advanced energy conversion scheme. Other project requirements are to study the effect of CPL evaporator angle of inclination, heat input and cold side sink temperature on the CPL system performance.

Applications of GIS in Coastal Engineering

RESEARCHER: Midshipman 1/C Janice Geldmacher, USN
ADVISER: Professor David L. Kriebel

The goals of this project were to develop a working knowledge of Geographical Information Systems (GIS) and to apply a GIS system in the study of shoreline erosion on the Severn River. Geographical Information Systems are software packages that permit digital manipulation of any map-oriented information. A key feature of GIS is that map information can be defined in Alayers so that each map layer depicts a different set of information. These layers can then be displayed individually or in any combination. In this project, digital shoreline maps of the Severn River were obtained from the Maryland Geological Survey (MGS) going back to 1847. In addition, the MGS supplied a digital aerial photograph of the Severn River from 1989. The research effort involved creation of a digital shoreline map showing the 1989 shoreline and comparison of the 1989 shoreline to other historical shoreline maps. From this basic GIS data, several sections of the Severn River shoreline near Round Bay were selected for more detailed analysis. Shoreline erosion rates and eroded areas were calculated from the shoreline maps and areas of relative stability, as well as areas of rapid erosion, were identified. Results of this project will be included in EN420 Coastal Engineering next fall.

Redesign of Navy 44 Keel

RESEARCHER: Midshipman 1/C Aaron DeMeyer, USN
ADVISER: Assistant Professor Paul H. Miller

This EN496 project focused on the detailed design of a new keel to be included in the design of the new Navy 44 sail training vessel. The current keel was designed using practices common in the 1970's. These favored a high center of gravity, NACA 0012 section and trapezoidal planform. The result was a vessel with a limit of positive stability of 126 degrees, which is only slightly above that recommended for offshore sailing.

The project had as design criteria the desire to: improve righting moment, increase capsize resistance (through a higher mass moment of inertia), increase roll damping, maintain grounding toughness and lower drag. The research included reviewing section lift and drag data, developing stability spreadsheets and analyzing various keel configurations. The final structural analysis was performed in accordance with ABS guidelines.

The resulting keel used a J5012 section, ranging from 12-16%, and a bulb. All the design criteria were met. Righting moment increased 10%, mass moment of inertia increased 20% and keel drag decreased 10%.

Redesign of Navy 44 Hull Laminate

RESEARCHER: Midshipman 2/C Mark Arvidson, USN
ADVISER: Assistant Professor Paul Miller
SPONSOR: Composites One, Inc. (a material distributor)
has arranged donations of material from resin, core and fiber manufacturers

This EN494 project addressed the laminate design used in the Navy 44 sail training vessel. The current vessel used composite technology common in the late 1970's. The resulting laminate used knitted fabrics combined with random chopped mat in vinyl ester resin. Feedback from the Naval Station indicated a desire for a more durable and easier to repair laminate. Feedback from the sailors indicated a desire for a lighter weight laminate.

Input from vendors and boatbuilders was combined with laminate analysis using classical lamination theory to predict more efficient laminates for the next set of vessels. Toughened vinyl ester and epoxy resins were studied along with Airex, CoreCell and Divinycell cores. New laminate stacking sequences and materials were also considered. These led to three proposed laminates; one matching the weight of the current laminate but having substantially higher toughness, one having an equal toughness but substantially reduced weight, and a compromise laminate that had an estimated 30% improvement in toughness and 25% reduced weight.

The proposed laminates were specified and a test matrix developed. Material donations were obtained and the shop will make the panels in May and June. The testing will be performed during an internship in July.

Feasibility of Teaming Radioisotope Decay and Thermoelectrics in an Unmanned Undersea Vehicle (UUV)

RESEARCHER: Midshipman 1/C Daniel Hoffman, USN
ADVISER: Associate Professor Mark J. Harper
EN495 Project (Fall 1999 Semester)

This project developed a background on Unmanned Undersea Vehicles (UUVs), determined rough power capabilities from a theoretical design, and addressed future problems that need to be evaluated and overcome. Using theoretical and simplified geometry, a value of 6 cm was determined as the maximum thickness of the radioisotope able to be supported by the heat transfer mechanism without exceeding the melting point of the fuel (Thalium). Using the above maximum thickness (and realistic size limitations), power values in excess of 14 HP are theoretically possible. The conclusions drawn in this project lay a strong foundation for future work in the design and optimization of a Radioisotope/Thermoelectric powered UUV.

Thermoluminiscent Dosimeter Investigations Using The Mcnp Computer Code

RESEARCHER: Midshipman 1/C Travis W. Haire, USN
ADVISER: Professor Martin E. Nelson
SPONSOR: Naval Dosimetry Center

This research (EN495 and EN496 projects) investigated the modeling of a copper-doped LiF TLD based on the MCNP computer code. The purpose of this research was to develop an intrinsic efficiency (i.e. light output per measured dose equivalent) when the TLD in the US Navy's 8825 card holder is exposed to photons with energy less than 150 KeV. In the research the four photon beams were studied (i.e. H150, M150, M100, and M60). Additionally, the project also analyzed the effect of photon spectra in the LiF chips behind each of the four filters used in the 8825 card holder. The method of investigation was to use MCNP to calculate the energy absorbed per particle as well as the air kerma per particle and then to combine these results with experimental data supplied on the light output per unit dose by the Naval Dosimetry center The results showed that the intrinsic efficiency is a function of the photon beam as well as the filter.

A research report has been written detailing the results of the project. A conference presentation will be given at the Annual Health Physics Society meeting in Denver, Colorado in June, 2000. This summer further investigations on the copper doped LiF TLD will be conducted by three midshipmen serving as interns at the NDC.

Drag Testing and Evaluation of a Commercially Available Diver Propulsion Vehicle

RESEARCHER: Midshipman 1/C Jeremy Gates, USN
ADVISER: Professor M. L. Nuckols

Hydrodynamic drag characteristics of a commercially available diver propulsion vehicle (DPV) were determined during simulated Navy SEAL missions. Drag data was analyzed to determine the maximum limits of the vehicle in terms of its battery life.

Development of a Semi-empirical Model For SEUs in Modern Drams

RESEARCHER: Midshipman 1/C Justin A. Sarlese, USN (Trident Scholar 2001)
ADVISER: Professor Martin E. Nelson

In this project a model was developed to characterize single event upsets (SEUs) in commercial-off the shelf (COTS) 64 Mb Dynamic Random Access Memory devices (DRAMs) produced by cosmic rays entering the earth's atmosphere. The project developed a new and improved model, which is based on particle energy, particle flux, and SEU cross section data taken from a wide-range of experiments. The study also investigated nuclear reactions, chip characteristics, and particle environments which affected DRAM's SEU rate. The model also calculated the soft error rates for six COTS 64 Mb at various altitudes, latitudes, and longitudes around the world. The results indicated that soft error rates for a DRAM could vary by a factor of nearly 100,000 depending on particle location and vendor.

Research was presented at the HEART Conference in Anaheim, California in March, 2000. A paper was published in the conference proceedings. The paper has also been nominated for the best paper in the conference. As a result of this nomination, a more detailed paper on the research has been submitted for publication in the Journal of Radiation Effects. A Trident Scholar research report was also issued.

Development of a MCNP Model for the Neutron Response of a Special Area Monitor

RESEARCHER: Ensign Mark C. Parrella , USN
(1999 graduate of United States Naval Academy;
VGEP program at University of Maryland, Masters degree granted in May, 2000)
ADVISER: Professor Martin E. Nelson
SPONSOR: Naval Dosimetry Center

A detailed MCNP model for the neutron response of a US Navy special area monitor (SAM) has been developed. The model incorporated the following important features: (1) two centrally located LiF TLD cards, (2) polyethylene cylinder with an attached borated silicon based liner inside which the TLDs were placed, and (3) air spaces and aluminum wall of the SAM. Additionally, each of the four chips which compose the TLD were modeled in order to make better comparisons with experimental data. In making the MCNP calculations, both neutron and photon transport were considered by use of superposition. The MCNP model predictions were validated with experimental data collected using a moderated Cf-252 source at NIST. To make comparisons with the MCNP runs, the TLD cards were read at the Naval Dosimetry center and ratio of chip responses were developed. Similarly chip response ratios were developed from MCNP, which replicated the experimental conditions. Within experimental and MCNP statistical errors, the expected response was obtained for each chip's gamma and neutron response. The MCNP model showed that the SAM's aluminum wall had little effect on the TLD, but that the boron liner was quite important in determining the SAM's neutron sensitivity.

This project has resulted in a Master's paper being developed at the University of Maryland and a conference presentation to be given at the Health Physics Society Annual meeting in June, 2000.

Resistance Prediction for Unconventional Planing Hulls

RESEARCHER: Midshipman 1/C Jason R. Morrison, USN
ADVISER: Professor Bruce C. Nehrling

This project involved developing a revision to the Savitsky algorithm for predicting the resistance and trim of unconventional planing hulls. The algorithm was originally developed as a means of predicting the performance of constant deadrise, hard chine planing hulls. The algorithm needed to be changed so that it would make accurate predictions for "inverted W" hull shapes.

The beginning of the semester was spent learning the fundamentals of planing boat performance and coming to understand the details of the Savitsky algorithm. A model hull was selected and tested which fit within the limitations of the Savitsky algorithm in the 380 ft tow tank and the data was used for comparison later in the semester when the hull was modified and the Savitsky algorithm began to be changed.

After testing the original hull, modifications to the hull were designed which effectively transformed it from a hard chine, constant deadrise hull into one with an "inverted W" shape. The modifications essentially amounted to wedges running longitudinally beneath the chines of the original hull. Two sets of these wedges were designed but only one was tested this semester. Once the wedges were built by the Model Shop, the hull with the wedges was tested in the 380 ft tank. At the same time, the first iteration of a modified Savitsky algorithm was proposed to predict the resistance and trim of the modified hull.

The semester concluded with the proposal of the second iteration of the modified Savitsky algorithm and the final test of the modified hull was conducted in the 380 ft tow tank. The predictions made by the modified algorithm agreed favorably with the results of the last test.

Performance Prediction for Unconventional Planing Hulls

RESEARCHER: Midshipman 1/C Jason R. Morrison, USN
ADVISER: Professor Bruce C. Nehrling

This project involved developing a revision to the Savitsky algorithm for predicting the resistance and trim of unconventional planing hulls. The algorithm was originally developed as a means of predicting the performance of constant deadrise, hard chine planing hulls. The plan was to change the algorithm so that it would make accurate predictions for inverted-W hull shapes. The work this semester built upon similar research that was conducted in the first semester.

Constant deadrise, hard chine planing hull, and three systematic modifications of that hull designed to mimic various inverted-W hull shapes were tested in the 380 foot tow tank. The goals during the tests were to quantitatively and qualitatively determine how the extent of the inverted-W shape affected the performance of the hull.

During the middle of the semester, the data and observations from the tank tests were utilized in order to develop a modified Savitsky algorithm. The modified algorithm adjusted the inputs to the original Savitsky algorithm - along with the associated calculations - in order to make improved drag and trim predictions for inverted-W hull shapes. Some of the modifications were exact where as others were empirically-based.

The semester was concluded by completing the analysis of the data and finalizing the modified algorithm. The effectiveness of the modified algorithm was then assessed and problem areas were identified. Finally, the work was synthesized into a paper which explained the reasoning and methods for creating a modified Savitsky algorithm. The final paper was presented to the Chesapeake Section of the Society of Naval Architects and Marine Engineers on April 19, 2000.

Technical Reports

August, R., G. Phillips, M.J. HARPER, Associate Professor, M.E. NELSON, Professor, S. Gann, Y. McClellan, and L. Forsley, Installation Restoration Program, Kirtland Air Force Base, Albuquerque, New Mexico, 30 Nov 1999.

This report has been prepared for the United States Air Force by the Radiation Detection Section of the U.S. Naval Research Laboratory in collaboration with the United States Naval Academy for the purpose of aiding in the implementation of a final remedial action plan under the Air Force Installation Restoration Program (IRP). The report for Site OT-10, Defense Nuclear Weapons School Training Sites TS5-TS8 (OT-10), summarizes the findings of samplings conducted at four Defense Nuclear School Sites listed on the IRP. These four sites are currently inactive. The study investigates the presence and extent of radiological and chemical contamination above background levels at these sites. Additional measures to be completed as part of a Corrective Measures Study (CMS) and Design (CMD) are identified.

HARPER, M.J., Associate Professor, "Implications of Submarine Manning: Considering Issues Related to Optimizing Manpower and Integrating Advanced Technology for Submarines in the Year 2090," prepared for the Naval Sea Systems Command, Submarine Advanced Development Division (SEA 05U), February 2000.

This report chronicles the efforts of nearly two dozen people, working in the fall of 1999, to address submarine manning issues. Organized by the Submarine Advanced Development Division of tha Naval Sea Systems Command as part of their commitment to provide innovative solutions to design challenges, four workshops were conducted. During these sessions outside experts presented briefings, current submarine paradigms were discussed, novel submarine manning schemes were proposed, and general philosophies of ship manning were examined. The principal finding of these proceedings was that technology capabilities and design philosophy must change radically in order to provide optimal manning of submarines in the future. *If there are about 134 men assigned to U.S. submarines in the year 2090, then we have failed in our mandate to provide the best warfighting platforms for the security of our nation.*

HARPER, M.J., Associate Professor, "Reduced Manning in Submarines," prepared for the Naval Surface Warfare Center, Carderock Division, Contract Number N00167-95-D-0128, Delivery Order 0011, June 1999.

The March 1998 Department of Defense Technology Area Review and Assessment (TARA) for DDR&E suggested there was a lack of focus on submarine affordability, including acquisition and support costs. The TARA specifically mentioned manning reduction as a prospect for cost reductions. This report examines manning of ships in general and submarines in particular. It chronicles the history of the VIRGINIA Class SSN manpower requirements. Various methods for estimating the costs of manpower are presented, and the total savings effected by eliminating a submarine billet are computed using VIRGINIA as a benchmark. The payoff is virtually negligible and does not justify extraordinary efforts to reduce manning levels on currently built or designed submarines. Reducing the overhead associated with shore support of the submarine, by improving intermediate level maintenance and by outsourcing indirect support, might cause significant payoffs. This study concludes that the best time to reduce manning is in the early concept phase of a submarine's design process, when the synergistic effects of interactive design can be captured.

MAYER, R.H., Associate Professor, WATERS, J.K., Assistant Professor and KRIEBEL, D.L., Professor, "Design & Maintenance of Deep-Draft Navigation Channels: An Overview of Current Practice with an Annotated Bibliography," Institute for Water Resources, U.S. Army Corps of Engineers, Alexandria, VA.

Given the increasing size and speed of ships in the world fleet and related changes in port and channel usage, the Corps' Institute of Water Resources (IWR) has initiated a study entitled "Impacts of Navigation Trends on Channel Usage and Design." Its principal goal is to improve the design and maintenance of navigation channels in order to sustain effective channel navigation and port operations well into the next century. A critical element of this study will be an assessment of how Corps' deep-draft channel design and maintenance guidance compares with other domestic and international policies and practices. This assessment will serve to identify areas for further research and for recommending changes in Corps' policies and procedures.

Prior to initiating the assessment, the authors were asked to review current practices used domestically and internationally to design and maintain deep-draft navigation channels. Technical publications and the policy guidance of numerous government, professional, and other U.S. and international maritime organizations were identified. A bibliography containing over 200 of the references was gathered and captured in a database that is discussed in Part IV of this report. Contents of the bibliography are reproduced in the Appendix.

Whereas this document, with its annotated bibliography, provides an overview of current deep-draft channel design and maintenance policies world-wide, a follow-on study is underway to compare Corps policy and procedural guidance with the policies and practices of other U.S. and international maritime organizations. A second report that details results of the assessment will be forthcoming.

Publications

BARTON, O., Associate Professor, M. MACKNEY, Associate Professor, S.E. MOURING, Associate Professor, G. N. KARPOUZIAN, Professor, "The Longitudinal and Transverse Properties of Fiber-Steered Composites," 14th Technical Proceedings of the American Society of Composites, Fairborn, OH, September 1999, 587-596.

In this paper, results are reported for the mechanical properties of test coupons that have been manufactured using steered fibers. The motivation of the research is to assess the effect of fiber curvature on mechanical properties. The properties under investigation include longitudinal tension and compression response, transverse tension and compression response, and both the longitudinal and transverse compressive strengths. To accomplish this effort, twelve composite panels were fabricated using a productions fiber placement machine. Fiber placement is the technology that uses composite materials in the form of tape to be placed in any desired path thus maximizing the utility of the material. The tape, called tows, can vary in width from 0.125 in to 0.182 in. Each panel is constructed using an IM7/977-3 composite system in the form of 10.7 mil slit tape which is stacked either in a 4 or 8 ply unidirectional lay-up. For these tests, the fiber placement occurred along paths with radii varying from 18 in to 45 in. This generated test specimens with 20 in, 30 in and 40 in radii. Specimens tested included a set of baseline coupons with straight fibers. To adequately assess the effect of fiber curvature on the mechanical properties, groups of specimens were tested with each group consisting of 5 specimens. All tests were conducted according to ASTM standards.

DAWSON, T.H., Professor, "Group Structure of High Waves in Heavy Seas," Proceedings of ASME Offshore Mechanics and Arctic Engineering Conference, New Orleans, Vol 1, pp 1-6, February 2000.

Group structure of high waves in heavy seas and its variations with wave height and wave breaking are investigated using laboratory measurements of severe Jonswap seas. Results for both non-breaking and breaking seas show appreciable structure for waves with heights exceeding 60% of the significant wave height, but decreasing structure for increasingly higher threshold levels. In addition, no structure is found for a non-breaking sea when threshold levels exceed 160% of the significant wave height and none is found for breaking seas when threshold levels exceed 140% of the significant wave height.

DAWSON, T.H., Professor, "Markov Theory for Runs of High Waves," Proceedings of International Offshore and Polar Engineering Conference, Vol 3, pp 20-24, Seattle, May 2000.

The application of Markov theory to runs of high waves is examined using extensive computer simulations of random Jonswap 3.3 seas. Results show direct application when account is taken of the variation of the Markov coefficient with threshold level defining high waves. The variation is shown to be consistent with theoretical results from Markov and envelope descriptions of wave runs.

Hawley, G.J., P.G. Vining, P.F. WIGGINS, Professor, and K.W. LINDLER, Professor, Thermodynamics of Marine Engineering Systems, 3rd Edition, Kendall Hunt Publishing Company, Dubuque, Iowa, May 2000.

This text provides a fundamental, applied understanding of thermodynamics relating to the design and operation of marine power systems. The 3rd edition has added material in the areas of: centrifugal pumps and electric motor propulsion systems. This text is designed for non-engineering majors at the U.S. Naval Academy.

Hofman, G.J., Peterson, R.J., Gelderloos, C.J., Ristinen, R. A., NELSON, M. E., Professor, Thompson, A., Ziegler, J. F., and Muhlfeld, H., "Light-Induced Scaling Relationships for 16 Mb and 64 Mb DRAMS," IEEE Transactions on Nuclear Science, Vol 7, no. 2, pp. 403-407, Apr 2000.

This paper reports on soft error rates (SER) of 16 and 64 Mb dynamic memory chips induced by three types of elementary particles, neutrons, protons, and pions, with emphasis on results obtained with pion beams. Significant SER differences, up to a factor 1000, are seen between various manufacturers and cell technologies. Reaction mechanisms are discussed and by comparing SER rates to nuclear reaction cross sections guidelines are presented for predicting failure rates.

Knafelc, M.E., and NUCKOLS, M.L., Professor, "Evaluation of a Phase Change Material (PCM) Liner For The Non-Return Valve (NRV) Hot Water Suit," Proceedings of the 1999 Undersea and Hyperbaric Medical Society Annual Scientific Meeting, Boston, MA, Vol 26 (1999 Supplement), p. 64, 26-30 June 1999.

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 quiescent water immediately surrounding the diver is removed. This proof of concept study was designed to determine if incorporating bulk PCM into the hot water suit=s liner blunts the thermal stress. The study was conducted during a saturation dive, Deep Dive 98. The mean skin temperature value was based on regional weighting according to the percentage of body surface area. The formula for mean skin temperature is: T_{sk} = 0.3 (chest + upper arm temperatures) + 0.2 (thigh + calf temperatures). Eight male U.S. Navy Saturation divers were used as subjects. Four divers wore the PCM (Octadecane 83) liner; four divers wore the standard (lycra/fleece) liner. The water temperature was 1.1 to 2.2 ^{o}C at a depth of 850 fsw (26.7 ata). The diver positioned himself in the current stream created by the discharge side of the water circulation pump. Temperatures were recorded every 15 seconds and the mean skin temperature was calculated using the above formula.

When maintaining the hot water flow to the diver, the PCM-liner maintained the diver's T_{sk}, which decreased with the standard liner. After securing the hot water, the divers wearing the standard liner experienced a rapid drop in their T_{sk}. The average duration of the exposure was 6.6 minutes before the diver terminated the exposure. In contrast, the divers wearing the PCM-liner experienced a less dramatic decrease in skin temperature and were able to complete the 20-minute exposure.

This pilot study suggests that the bulk PCM-liner under a NRV hot water suit is superior to the standard liner in blunting the thermal heat loss when there is a loss of hot water.

KRIEBEL, D.L., Professor, and WALLENDORF, L., "Physical Model Tests on a Generic MOB Module," Prof. Conf. On Very Large Floating Structures, Honolulu, HI, Sept. 1999, pp. 511 – 520.

Physical model tests were conducted at the United States Naval Academy on a large semi-submersible model, representing a 1-to-70 scale model of a single module of the Mobile Offshore Base. The full-scale MOB module was over 900 feet long so that the model was very large and more than 12 feet in length. Tests were conducted for transit conditions, with the model floating on its pontoons, with realistic forward speeds, and with a wide range of sea states, in both head and following seas. This paper discusses the design and construction of the model, the experimental setup and test conditions, and the resulting measurements of the heave and pitch motions.

KRIEBEL, D.L., Professor, "Performance of Vertical Wave Barriers in Random Seas," Proceedings of Coastal Structures '99 Conference, Santander Spain, June 1999, pp. 525 – 532.

This paper evaluates the performance of vertical wave barriers in random waves, based on a comparison of measured and predicted wave transmission, wave reflection, and wave forces on the wall. Measured wave loads are obtained from a large-scale laboratory experiment conducted in the large wave flume at the Oregon State University. Theoretical wave loads are computed using eigenfunction expansion theory, modified to account for frictional losses at the base of the wall, and applied on a frequency-by-frequency basis to the incident wave spectrum. Results of this study suggest that the eigenfunction theory can predict random wave transmission, reflection, and wave loads to within about 10% to 20% accuracy for a wide range of wave conditions, water depths, and wave barrier drafts.

KRIEBEL, D.L., Professor and ALSINA, M., "Simulation of Extreme Waves in a Background Random Sea," Proc. of Intl. Conf. On Offshore and Polar Engineering, Seattle, WA, June 2000, pp. 31 – 37.

Laboratory experiments were conducted to embed a large transient wave within a random sea as a means of simulating rogue or freak wave events in a wave tank. The total wave energy spectrum was split into two parts: one for the background random sea and the other for the transient or freak wave. It is shown that a freak wave, having a height of more than twice the significant wave height can be generated using just 15% to 20% of the total wave energy in the transient wave and 80% to 85% of the energy in the random sea. This implies that a freak wave may occur relatively easily due to the focusing of only a small part of the overall wave energy.

MAYER, R.H., Associate Professor, "An Integrated Approach to Teaching Engineering Design and Design Decision-making," Proceedings of the 1999 ASEE Annual Conference, Charlotte, N.C., June 1999. Available on CD-ROM.

An extensive case study to facilitate design instruction at the U.S. Naval Academy is described. "Restoration of a Coral Reef" is a semester-long engineering design experience involving five related exercises. These exercises provide a useful context in which to discuss and apply various design tools and methods used in different phases of the engineering design process — from problem assessment through project planning and construction cost estimating. Students also have the opportunity to experience design-team interactions and develop communication skills associated with the design report.

Mead, P., Moore, D., Natishan, M., Schmidt, L., Brown, S., Lathan, C., Goswami, I., and MOURING, S.E., Associate Professor, "The ESTEAM Program's Phase I Results: Faculty Views on Engineering Student Team Effectiveness," Journal of Women and Minorities in Science and Engineering, 5 (1999), 351-363.

Recent emphasis on the use of teams in the engineering curriculum has increased interaction and collaborative aspects of the learning process for engineering students and faculty. However, a corresponding emphasis on preparation for students and faculty has not occurred . The translation from individual learning in a customized environment to learning in a group environment can be challenging, even in a homogeneous team atmosphere. This process is even more complex against a backdrop of diversity, including communication style and learning style differences. This article presents results from a series of interviews and focus groups of engineering faculty and students regarding the use of teams in their courses and the benefits and challenges they believe are a direct outcome of team-oriented approaches in engineering. The results reveal training deficiencies in effective practices for team-oriented activities, and large inconsistencies in the experiences of students across disciplines.

Miller, M., Nadeau J., and WHITE, G.J., Professor, "Longitudinally Stiffened Panels B A Comparative Analysis of the Compressive Strength of Three Common Construction Methods," Transactions of the Society of Naval Architects and Marine Engineers, Volume 107, 1999, pp. 291 – 308.

Due to the reduction in labor, material, and weight, intermittent welding is often used in lieu of continuous welding to join longitudinal stiffeners to hull plating. Traditionally, use of this cost reduction technique, common in both ship and barge construction, has not been considered significantly detrimental to the overall strength. Similarly, in barge construction,

serrated stiffeners are considered an acceptable alternative to continuously welded stiffeners. After the catastrophic failure of the deck plating of two inland tank barges constructed using intermittently welded serrated stiffeners, the Coast Guard conducted testing on stiffened panels at the U.S. Naval Academy. The ultimate strength of panels constructed using continuously welded stiffeners, intermittently welded stiffeners, and intermittently welded serrated stiffeners was determined and compared. Testing results and analysis of the failures showed that the use of serrated stiffeners introduces a different failure mechanism which can lead to significantly earlier failure.

MILLER, P.H., Assistant Professor, "Durability of Marine Composites," a dissertation filed in partial satisfaction for the Doctor of Engineering Degree, University of California, Berkeley, April 2000.

The growing use of marine composite materials has led to many technical challenges. One challenge is predicting lifetime durability. This project systematically extended and further developed the isotropic material method to the application of fiberglass vessels in the marine environment. The research compared two identical composite vessels having significantly different fatigue histories with baseline, undamaged laminates representing a new vessel. Analytical models based on classical lamination theory, finite element analysis, ship motions, probability analysis and wind and wave mechanics were used to predict strains generated by the vessels while underway. Material properties based on wet and dry conditions were determined and compared through coupon and panel tests. Fatigue endurance limits were found to be near 25% of static load, indicating a fatigue design factor of 4 is required for these materials. This is higher than specified in ABS and US Navy design guides.

MOURING, S.E., Associate Professor, "An Innovative Method for Joining Composites," 8th International Conference on Marine Applications of Composite Materials 2000 Proceedings, Melbourne, FL, (March 2000), H1-11.

An innovative method for joining composite structural elements has been developed as an alternative to current joining methods. This method uses a combination of liquid adhesive and adhesive tape to fabricate joints. The adhesive tape is used to temporarily "tack" structural elements together and to form a channel between the structural elements in which liquid adhesive can be injected at a later time. The resulting bond lines are more consistent than bond lines constructed using current bonding methods. Tape thickness determines the bond line thickness while spacing between tape strips determines the bond line width. One advantage of this technique is that it can be used for variety of structural configurations. Furthermore, quality control is possible not only before the application of liquid adhesive but also after the application of liquid adhesive. This joining method shows great promise to be a more cost-effective, less labor-intensive technique without reduction in the structural performance. This paper discusses the ongoing development and evaluation of this novel joining method. Both experimental and analytical results of the research are presented.

NUCKOLS, M.L., Professor, Clarke, J.R., and MARR, W.J., CDR, USN, "Assessment of Oxygen Levels in Alternative Designs of Semi-Closed Underwater Breathing Apparatus," International Journal of Life Support and Biosphere Science, Vol 6 (1999), pp. 239-249.

A method for predicting the circuit oxygen levels in semi-closed underwater breathing apparatus (UBAs) is presented. Oxygen levels are assessed for traditional circuit designs using sonic metering valves to inject a constant mass flow of fresh make-up gas, as well as two alternative respiration-rate-coupled gas dosage designs using demand injection valves. The impact of variations in diver depth, activity level, gas injection rate, circuit volume and make-up gas composition on these circuit oxygen levels is demonstrated. Respiration-coupled, demand gas delivery systems are shown to have significantly reduced circuit oxygen variations over a wide range of diver activity levels when compared to constant mass flow injection systems. Additionally, the respiration-coupled designs are shown to have potential reduced gas usage at low diver activity levels, resulting in longer mission duration capability, when compared to constant mass injection systems.

NUCKOLS, M.L., Professor, "Test and Evaluation of A Carbon Dioxide Absorption System Using Seawater For Underwater Life Support," Proceedings of the 15th Meeting of the US/Japan Cooperative Program in Natural Resources, 1-6 Dec 1999, Tokyo, Japan, pp. 179-196.

During FY1999 the National Undersea Research Program (NURP) Office of the National Oceanographic and Atmospheric Administration (NOAA) invited ocean engineering students at the U.S. Naval Academy to participate in a joint partnership

project in underwater technology development. The NURP operates the most advanced underwater observation platform in the world to study the coral reef system off the Florida Keys. This underwater platform, the *Aquarius* underwater habitat, supports up to six scientists/researchers during 10-day missions without surfacing. Support systems within the underwater habitat maintain the life-sustaining atmosphere throughout these missions to provide air conditioning, oxygen supply and carbon dioxide removal for these scientist/aquanauts. The U.S. Naval Academy designed a new method of carbon dioxide removal using seawater absorption instead of the conventional chemical removal methods presently used on *Aquarius*. This carbon dioxide absorption system can potentially provide a safe and inexpensive alternative of removing metabolically-produced carbon dioxide from cabin gases in underwater habitats, submarines, or a wide range of diving applications. This method involves the direct absorption of carbon dioxide in small concentrations in diffused air by a seawater tower, either pressurized or unpressurized. The design can be externally or internally mounted on an underwater habitat, submarine or diving life support system without any chemical replenishment or disposal requirements. Results from testing an unpressurized seawater tower inside NOAA's *Aquarius* underwater habitat during May 1999 verified the feasibility of this carbon dioxide absorption technique.

NUCKOLS, M.L., Professor, VanZandt, K., Alderson, R., "Design and Evaluation of a Hydrogen Catalytic Breath Heater For Diving Applications," Proceedings of Underwater Intervention 2000, 23-26 Jan 2000, Houston, TX, CD-ROM, paper B.2.3.

During July 1999 a hydrogen catalytic breath heater concept was tested in the Hydrospace Laboratory at the Coastal Systems Station in Panama City, FL. The objective of this test series was to determine the potential breath heating performance of a hydrogen catalytic heater incorporated into an off-the-shelf, open circuit SCUBA regulator and in the current UBA Ex14/1 semi-closed circuit backpack at simulated depths up to 850 FSW. In all tests, hydrogen levels in the circuit and test chamber were maintained below its flammable limits of 4.0%. Specific variables investigated included (1) the percentage of hydrogen (between 0.25% and 1.0%) required to be mixed in the breathing circuit gas to achieve heating goals, (2) the quantity of the catalyst necessary to maximize heat production efficiency, and (3) the effect of the catalyst bed starting temperature on hydrogen reaction efficiency and heat production. Additionally, testing was conducted to determine if pre-conditioning of the catalyst bed to remove surface oxides prior to testing would improve the catalyst efficiency. Tests were repeated to determine what, if any, degradation in the catalyst performance would be seen following catalyst pre-conditioning.

Major findings in this test series included the following:

a) Less than 0.25% hydrogen by volume was found adequate to heat the breathing gas in the EX14/1 helmet to 89-90°F at 850 FSW in 35°F water temperatures.

b) Hydrogen percentage content in the breathing mixture was seen to have a direct correlation with gas heating temperatures in the open circuit SCUBA testing at surface conditions. Gas temperature increases of approximately 45°F and 90°F were measured in the open circuit mode during surface testing when using 0.5% and 1% hydrogen in the breathing mix, respectively.

c) In contrast, hydrogen percentage contents above 0.25% in the semi-closed circuit testing at 850 FSW were seen to have minimal additional heating benefit. While higher hydrogen contents were observed to give an initial surge in heating levels for the first 2-3 minutes of use, stabilized gas temperature increases of approximately 40° - 50°F were observed in the semi-closed mode, independent of hydrogen content.

d) Startup and operation of the catalyst bed does not appear to be affected by cold temperatures. Similar gas heating was observed when the catalyst bed was submerged in bath temperatures between 32°F and 83°F.

e) Catalyst pre-conditioning was found to have no noticeable impact on the hydrogen reaction efficiency. Repeated testing with catalyst beds having no pre-conditioning showed similar heating capability as compared to pre-conditioned catalyst beds.

f) No degradation in catalyst performance was observed during successive testing with the same catalyst bed.

NUCKOLS, M.L., Professor, VanZandt, K., FINLAYSON, W.S., LT, USN, and Price, K., "Invention Disclosure For a Hot Water Diver Heater Using Hydrogen Catalytic Reactions," Navy Patent Disclosure, 25 Mar 2000.

A hydrogen catalytic combustion water heater is disclosed which provides a safe, reliable source of warm water for active thermal protection of divers over a wide range of diving applications. The water heater can be used in an open, closed or semi-closed configuration to support surface tethered diving applications or autonomous, self-contained missions with free-swimming divers or within wet or dry underwater vehicles. Water temperatures can be easily adjusted when using this heater by regulating the percentage of hydrogen injected into the catalyst bed. The catalytic heater can be used either as the primary active heating source or as a backup heating system in the event failure occurs to the primary heat source.

NUCKOLS, M.L., Professor, VanZandt, K., and Alderson, R., "Method and System For Heating and Humidifying A Breathable Gas," Navy Patent Disclosure, Navy Case No. 79,938, Sept 1999.

The invention relates generally to the heating of a gas, and more particularly to a method and system for heating and humidifying a breathable gas supplied to an underwater diver's breathing mask, helmet or mouthbit.

NUCKOLS, M.L., Professor, Pelstring, J., and Stinespring, B., "A Method For Supplying Breathable Gas For an Underwater Habitat," Navy Patent Disclosure, Navy Case No. 79,937, Sept 1999.

The invention relates generally to life support for underwater habitable environments (habitats, submersibles, submarines, etc), and more particularly to a method and system for supplying breathable gas for an underwater environment using the surrounding water environment to remove carbon dioxide from respired gases withing the underwater habitat.

NUCKOLS, M.L., Professor, and Henkener, J., "Record and Disclosure of Invention: Liquid Insulation for Underwater Applications," Navy Patent Disclosure, Jan 2000.

An inert, pourable liquid insulating medium is described which provides superior thermal protection for divers or underwater cabins (chambers, submersible hulls, waterproof housings, etc). This insulating medium is neutrally buoyant in water (specific gravity of 1.0), eliminating the necessity for ballasting and, unlike conventional closed-cell foam or fibrous batt insulations, is not thermally degraded by compression in elevated hydrostatic pressures.

NUCKOLS, M.L., Professor, and FINLAYSON, W.S., LT, USN, "Record and Disclosure of Invention: Respiratory-Coupled, Mass Injection Semi-Closed Circuit Underwater Breathing Apparatus," 23 March 2000.

A new semi-closed circuit breathing apparatus design is disclosed which injects fresh makeup gas by mechanically coupling the injection rate of this makeup gas with a diver's respiratory minute volume (RMV). The invention maintains a constant oxygen fraction in the breathing circuit, similar to an open circuit SCUBA, while decreasing the gas supply requirements by up to 80% of that used in open circuit SCUBA.

PIPER, G., Associate Professor, WATERS, J.K., Assistant Professor, T. DWAN, Professor and K. KIRIAKIDIS, Assistant Professor, "Teaching Multidisciplinary Engineering Principles Through Environmental Topics," Journal of Engineering Education, *Accepted.*

Environmental topics such as pollution prevention, pollution remediation, natural resource utilization, as well as global and local weather studies provide excellent catalysts to teach a wide breadth of engineering principles. Since environmental issues are real and tangible to most students, engineering applications involving the environment tend to capture the students' interest. Environmental topics also provide a great opportunity for discovery, learning, and meaning application of learned mathematic, scientific and engineering and principles. For instance, having students explore ways to extract energy from natural resources exposes them to a variety of topics such as thermodynamics, power generation, energy transmission and storage. Through such topics as thermal pollution and weather monitoring, students are exposed to heat transfer, partial differential equations, sensor design and signal processing. In virtually all environmental topics, students can experience the synthesis of concepts and methods of many different disciplines, which is truly the essence and purpose of engineering.

For the past three years, the Systems Engineering and the Ocean Engineering Departments at the U.S. Naval Academy have collaborated to offer an innovative course sequence in environmental engineering. In this course sequence, a host of engineering principles are explored under the umbrella of environmental topics for non-environmental engineering students. This paper presents the techniques used in this course sequence in which engineering principles are either taught or reinforced, and then applied to a real system or problem through environmental topics.

Schmidt, L., P. Mead, M. Natishan, C. Lathan, S. Brown, I. Goswami, and S.E. MOURING, Associate Professor, "BESTEAMS: Building Engineering Student Team Effectiveness and Management Systems," Section 3325 of the Proceedings: 1999 ASEE Annual Conference & Exposition, Charlotte, NC (June 1999).

The current paper introduces the BESTEAMS Project. BESTEAMS seeks to transform the professional engineering environment into one comfortable for all by training engineering students to recognize and accept diverse learning, communication, and behavior styles in their colleagues. Here we report the findings of our student focus group sessions on type and amount of team training students get before working in a project and their perceptions of differences in team member behavior that fall along gender, ethnic, or learning styles lines. We also present the first data from two student focus groups conducted after the BESTEAMS pilot team training was done in the course.

TUTTLE, K.L., Associate Professor, "Impact on NO_X Emissions from Fixed Nitrogen in the Fuel," Proceedings, Marine Environmental Stewardship for the 21st Century, ASNE & SNAME, 1999, Arlington, pp. 87–93, October 21, 1999.

One of the most interesting emissions from marine power plants is nitric oxide. Oxides of nitrogen, grouped as NO_X, are produced from the nitric oxide generated during the combustion process in engines and boilers. The production of nitric oxide depends on the combustion temperature. Hence, NO_X is a function of engine loading in most engines. Organic nitrogen, such as in protein, increases the production of nitric oxide during combustion. Although many fuels burned by marine engines and boilers are not expected to be high in nitrogen, there is still concern that fuel-borne nitrogen is making a substantial contribution to pollution from ships. This paper examines stack emissions and fuel data taken from a large number of ships operating at steady-state. Since the stack emissions data include nitric oxide emissions and the fuel analyses include fixed nitrogen in the fuel, these data can be used to determine whether the effect of nitrogen in the fuel has a significant impact on oxides of nitrogen in the exhaust emissions.

The theory has been accepted since at least the 1960's that nitrogen bound to the organic fuel molecules would be converted to nitric oxide, NO, in any combustion process (Perkins, 1974). The nitrogen in the fuel, often called organic nitrogen, is part of an organic molecule such as a protein molecule. As the protein molecule decomposes during the process of combustion, it is possible the nitrogen atom will react with an oxygen molecule producing a nitric oxide, NO, molecule and an oxygen atom. If this reaction occurs, the level of nitric oxide produced by that combustion process would be increased at least by the NO contributed by the organic nitrogen in the fuel. However, if this reaction occurs, there is also an oxygen atom produced that may react with a nitrogen molecule to form another molecule of NO and another nitrogen atom. This scenario is disturbing as a single atom of organic nitrogen has reacted to produce two molecules of NO plus a new atom of nitrogen. Presumably, the cycle could repeat indefinitely and fuel nitrogen could produce a substantial increase in the levels of NO measured in the exhaust gases of any engine or power plant burning fuel having any organic nitrogen.

WATERS, J.K., Assistant Professor, D.L. KRIEBEL, Professor and R. H. MAYER, Associate Professor "Analysis of U.S. Coast Guard Accident Data," *Marine Technology, Accepted*.

U.S. Coast Guard accident data files were obtained and analyzed in order to assist in the safety performance review portion of a funded research study on navigation channel design. The research study was specifically interested in identifying those ports whose incidents may be associated with the design and/or maintenance of their navigation channels. The accident data statistics were therefore interpreted and analyzed with this emphasis in mind.

Data from all domestic ports from 1992-1998 are included in the analysis. Discussions of incident types, vessel types and causal factors are included. The incident types of particular interest to this study include allisions, collisions and groundings. The ports are ranked as to the number of these incidents experienced over two different time periods. It was found that the top five ports in both cases were New Orleans, Paducah, Morgan City, Mobile and Galveston. Results of

this analysis also indicate some interesting additional statistics. More than 90% of all vessels involved in incidents were U.S.-flag vessels, and more than two-thirds (2/3) of the relevant incidents indicated "human factors" as the primary causal factor. The vessel type most often involved in the relevant incidents were barges (34%), with ships involved in only 12-24% of these incidents. Of the grounding incidents, nearly one-third (1/3) were reported as occurring within a channel.

An additional, limited, but similar analysis including only tank ship and freight ship vessel types was also conducted. These vessels were selected for a separate analysis in order to gain a better measure of statistics for deeper draft vessels. As expected, the results from this analysis differed significantly from those including all total vessel types, but still point to New Orleans as the port with the most accidents.

WHITFORD, D.J, Captain, USN, M. E. VIEIRA, Associate Professor, and J.K. WATERS, Assistant Professor, "Teaching Ocean Wave Analysis: Part 1, Using Finite Fourier Analysis," American Journal of Physics, Vol 69 (4), pp. 490 - 496.

Analysis of progressive, wind-generated surface gravity waves is a fundamental learning objective for students majoring in ocean engineering and physical oceanography. Students usually find the transition from understanding monochromatic (i.e. single frequency) waves to understanding a more realistic random sea to be difficult. A two-part laboratory exercise is described which addresses this problem. The first exercise introduces the manual arithmetic steps of a finite Fourier analysis of a wave record, develops a wave energy spectrum, and compares these results to the results obtained using a Fast Fourier Transform (FFT). The second part of the exercise, described in the subsequent article, takes a longer wave record, and addresses the theoretical and observed wave probability distributions of wave heights and sea surface elevations. These results are then compared to an FFT, thus linking the two laboratory exercise parts for a more complete understanding. The exercise's benefits are cross-disciplinary in nature and can be used in any fields that deal with signal analysis.

WHITFORD, D.J, Captain, USN, J.K. WATERS, Assistant Professor and M.E. VIEIRA, Associate Professor, "Teaching Ocean Wave Analysis: Part 2, Using Wave Height and WaterSurface Elevation Probability Distributions," American Journal of Physics, Vol 69 (4), pp. 497 - 504.

Analysis of water surface waves is a fundamental learning objective for undergraduate and graduate students majoring in ocean engineering and physical oceanography. Students usually find the transition from studying monochromatic waves, i.e. single frequency waves, to studying a more realistic complex and random sea of many different frequencies to be difficult. Two computer laboratory exercises are presented which enable students to make this transition with less difficulty and more understanding. The first exercise, described in the previous article, utilized spreadsheet software on which the students execute the manual arithmetic operations of a finite Fourier analysis on a complex wave record. The results were then compared to those obtained by a Fast Fourier Transform. This article, the second of this two-part series, addresses analysis of a complex sea using observed and theoretical wave height and water surface elevation probability distributions and wave spectra. These results are compared to a Fast Fourier Transform analysis, thus providing a link back to the first exercise.

Presentations

BARTON, O., Associate Professor, M. MACKNEY, Associate Professor, S.E. MOURING, Associate Professor, and G. N. KARPOUZIAN, Professor, "The Longitudinal and Transverse Properties of Fiber-Steered Composites," American Society of Composites 14th Technical Conference, Fairborn, OH, 28 September 1999.

BOUGHEY, B., Ensign, USN, M.R. CERZA, Associate Professor, and K.W. LINDLER, Professor, "Flat Heat Pipe Design, Construction and Analysis," Presented at the 34th Intersociety Energy Conversion Engineering Conference, Vancouver, British Columbia, Canada, August 2-5, 1999.

CERZA, M.R., Associate Professor, B. BOUGHEY, Ensign, USN, and K.W. LINDLER, Professor, "Infrared Videography of a Gas Loaded Heat Pipe at Various Angles of Inclination," National Heat Transfer Conference, Albuquerque, NM, August 15-17, 1999.

CERZA, M.R., Associate Professor, "Infrared Photographs of a Gas Loaded Heat Pipe," at the International Mechanical Engineering Conference and Exposition, Nashville, TN, November 14-19, 1999.

CERZA, M.R., Associate Professor, BOUGHEY, B., Ensign, USN, and K.W. LINDLER, Professor, "Infrared Videography of a Gas Loaded Heat Pipe at Various Angles of Inclination," Presented at the National Heat Transfer Conference, Albuquerque, NM, August 15-17, 1999.

HARPER, M.J., Associate Professor, "Reduced Manning in Submarines," presented to Naval Sea Systems Command, Advanced Submarine Development Division (SEA 05U), Arlington, VA, September 1999.

Kline, A.R., M.E. NELSON, Professor, Cassata, J.R., LT, USN, and G.K. Riel, "Evaluation of the Neutron Response of the Copper-Doped (LiF) TLD," Health Physics Society Annual Meeting, Philadelphia, Pennsylvania, June, 1999.

KRIEBEL, D.L., Professor, "Performance of Vertical Wave Barrier in Random Waves," Coastal Structures 1999 Conference, Santander, Spain, June 17, 1999.

KRIEBEL, D.L., Professor, "Physical Model Tests on a Generic MOB Module," Conference on Very Large Floating Structures, Honolulu, HI, 22 Sept 1999.

KRIEBEL, D.L., Professor, "Design of Vertical Wave Barriers," Navy Civil Engineer Corps, Ocean Facilities Conference, Annapolis, MD, 11 April 2000.

KRIEBEL, D.L., Professor, "Simulation of Extreme Waves in a Background Random Sea," Intl. Conf. On Offshore and Polar Engineering, Seattle, WA,29 May 2000.

MAYER, R.H., Associate Professor, "An Integrated Approach to Teaching Engineering Design and Design Decision-making," at the 1999 ASEE Annual Conference, Charlotte, N.C., Jun 1999.

MAYER, R.H., Associate Professor, "Environmental Engineering Opportunities in Ocean Engineering Education," at the 1999 ASEE Annual Conference, Charlotte, N.C., Jun 1999.

MAYER, R.H., Associate Professor, "Ocean Facilities Program - The Early Years," at the NAVFAC Ocean Facilities Program Conference, USNA, Annapolis, MD, Apr 2000.

Mead, P.F., M.E. Natishan, L. Schmidt, S. Brown, C. Lathan, I. Goswami, and S.E. MOURING, Associate Professor, "Engineering Project Team Training for Students Workshop: BESTEAMS - Building Engineering Student Team Effectiveness and Management Systems," 4TH Annual LILLY Teaching Conference on College and University Teaching - Atlantic, Towson University, Towson, MD, 7 April 2000.

MILLER, P.H., Assistant Professor, "Lifelines Research at the U.S. Naval Academy and Fundamentals of Lifeline System Design," Int'l Boatbuilders Conference, Ft. Lauderdale, Florida, 9-11 February 2000.

MILLER, P.H., Assistant Professor, "Seaworthiness and Safety," Safety-at-Sea Seminar, U.S. Naval Academy, 25-26 March, 2000.

Miller, M., J. Nadeau, and G.J. WHITE, Professor, "Longitudinally Stiffened Panels B A Comparative Analysis of the Compressive Strength of Three Common Construction Methods," Annual Meeting of the Society of Naval Architects and Marine Engineers, Baltimore, Maryland, October 13-15, 1999.

Moore, J.S., and M.E. NELSON, Professor, "S & P 500 Volatility Forecasts with Neural Networks," 19th International Symposium on Forecasting, Washington D.C., June, 1999.

MOURING, S. E., Associate Professor, "The Future of Composites in the Engineering Community," NSF Civil & Mechanical Systems and Bioengineering & Environmental Systems Conference, Arlington, VA, 27 September 1999, (invited speaker: one of 15 tenured faculty chosen from U.S. faculty members in the areas of Civil & Mechanical Systems and Bioengineering & Environmental Systems).

MOURING, S.E., Associate Professor, "An Innovative Method for Joining Composites," 8th International Conference on Marine Applications of Composite Materials 2000, Melbourne, FL, 15 March 2000.

MOURING, S.E., Associate Professor, O. BARTON, Associate Professor, M. MACKNEY, Associate Professor, and G. N. KARPOUZIAN, Professor, "Testing of Fiber Placed Sandwich Structure Specimens," Fiber Placed Inlet Duct Program Final Review, Patuxent River, MD, 11 May 2000.

MOURING, S.E., Associate Professor, O. BARTON, Associate Professor, M. MACKNEY, Associate Professor, and G. N. KARPOUZIAN, Professor, "Composite Capabilities at the U.S. Naval Academy," Fiber Placed Inlet Duct Program Review, USNA, Annapolis, MD, 18 August 1999. (Hosted the program review and lab tour which included over 20 participants from the Navy and industry.)

NELSON, M.E., Professor, J.A. SARLESE, Midshipman 1/C, USN, J.F. Ziegler, H. Muhlfeld, R.J. Peterson, A, Campbell, J.S. Melinger, K. Clark, and A.K. Thompson, "Cosmic Ray Induced Soft Error Rates of Commercial 16 Mb and 64 Mb DRAMS at Aircraft Altitudes," HEART Conference, Anaheim, California, March 2000.

NUCKOLS, M.L., Professor, "Human Engineering in Life Support Equipment," Invited speaker at the Duke University Medical School on 19 Nov 99.

NUCKOLS, M.L., Professor, "Test and Evaluation of A Carbon Dioxide Absorption System Using Seawater For Underwater Life Support," 15th Meeting of the US/Japan Cooperative Program in Natural Resources, 1-6 Dec 1999, Tokyo, Japan.

NUCKOLS, M.L., Professor, "Design and Evaluation of a Hydrogen Catalytic Breath Heater For Diving Applications," Underwater Intervention 2000, 23-26 Jan 2000, Houston, TX.

NUCKOLS, M.L., Professor, "Underwater Vehicles: Tools for Deep Ocean Research," Guest speaker at Chesapeake High School, 13 Apr 00.

Schmidt, L, P.F. Mead, D. Bigio, M.E. Natishan, J. Schmidt, J.A.Greenberg, S. Brown, C. Lathan, I. Goswami, and S.E. MOURING, Associate Professor, "BESTEAMS (Building Engineering Student Effectiveness and Management Systems) EPTTS Workshop," University of Maryland, College Park, MD, 21 January 2000.

Schmidt, L., P. Mead, M. Natishan, C. Lathan, S. Brown, I. Goswami, and S.E. MOURING, Associate Professor, "BESTEAMS: Building Engineering Student Team Effectiveness and Management Systems," 1999 ASEE Annual Conference & Exposition, Charlotte, NC, 20-23 June 1999.

Schmidt, L., M.E. Natishan, P.F. Mead, D. Bigio, J.A. Greenberg, S. Brown, C. Lathan, I. Goswami, and S.E. MOURING, Associate Professor, "Faculty Workshop on Building Engineering Student Team Effectiveness and Management Systems," National Collegiate Inventors and Innovators Association Annual Conference, Washington D.C., March 2000.

TUTTLE, K.L., Associate Professor, "Thermodynamic Computer Models Using SpreadSheets," Computational Skill Colloquim," Problem Solving Across the Curriculum, U.S. Naval Academy.

WATERS, J.K., Assistant Professor, "Environmental Issues in Navigation Channel Design and Nearshore Marine Environments," National Science Foundation WEE '99, Arlington, VA, Sep 1999.

WATERS, J.K., Assistant Professor, J. Blacketter, B. Mulligan, and M. Werner, "Career Roundtable," Webb Institute, Glen Cove, NY, 2 Nov 1999.

WATERS, J.K., Assistant Professor, "Impacts of Navigation Trends on Channel Usage and Design," Marine Transportation System R&D Coordination Conference, Washington DC, 3 Nov 1999.

WATERS, J.K., Assistant Professor, "Impacts of Deep-Draft Navigation Trends on Channel Usage and Design and Impacts to Inland Waterway System," Transportation Research Board, Washington DC, 13 Jan 2000.

WATERS, J.K., Assistant Professor, "U.S. Army Corps of Engineers Research and Development Projects: Impacts of Navigation Trends on Channel Usage and Design," PROSPECT Civil Works Orientation Class, Washington DC, 9 Mar 2000.