Electrical Engineering Department

CDR Robert J. Voigt, USN
Chair

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

Funding for our research comes from the Naval Research Laboratory (NRL), the Naval Surface Warfare Center (NSWC), the National Aeronautics and Space Administration (NASA), the Johns Hopkins University Applied Physics Laboratory (JHU/APL), and from within the Naval Academy. Research topics supported during the past year included high performance fiber optic communications, wireless communication of distributed shipboard sensors, satellite oscillator frequency determination, noninvasive probing of high performance microwave circuits, JAVA applet applications, adaptive error correction coding, and very low elevation antenna effects. This faculty research contributes directly to the fleet's operational capabilities, and provides relevant topics which benefit the professional as well as the academic development of our midshipmen.

Sponsored Research

Determining Oscillator Frequency in Space

RESEARCHER: Assistant Professor C. T. Field
SPONSOR: NASA/Goddard Space Flight Center

GLAS is a laser ranging system scheduled to be launched in 2001 to measure the surface topography of the polar ice sheets. The distance between the satellite in a polar orbit about 600 km above the earth's surface and the surface will be measured with an accuracy smaller than 10 cm. The distance is determined by measuring the time required for a short pulse of light to travel from the satellite to the surface and back.

The round trip travel time is measured counting the number of cycles of an on board oscillator required for the trip. The frequency of the oscillator must be known to better than one part in 10^9 over the 5 year mission life. The researcher has been researching how to use a simple quartz oscillator and the on board GPS receiver to perform the time measurement. This has required finding a way to bound the oscillator frequency variations from an average frequency measured with the GPS receiver. This work has been performed at Goddard Space Flight Center.

Simulation in High-Speed Fiber Optic Communication Systems

RESEARCHER: Assistant Professor R. Brian Jenkins
SPONSOR: Naval Research Laboratory (NRL), Irl N. Duling, III

High performance communication across optic fiber is necessary to meet the bandwidth demands of modern telecommunication and computing systems. Data transmission on fiber optic links that operate above 10 Gb/s is influenced by both linear and nonlinear phenomena. Hence, solitons are often used, and the links require high-speed transmitters and receivers as well as amplification, filtering, and dispersion management. The design and optimization of such links can be difficult and expensive without numerical simulation. In this project, we use PTDS (Photonics Technology Design Suite), a commercially available optical fiber simulation package, to model a broadband fiber optic dispersion managed communications link which operates at 100 Gb/s using solitons (1-2 picoseconds in width). The simulation is primarily used to isolate the parameter space, making it easier to design and build an actual functioning system. A successful link operating at 100 Gb/s over 100km was demonstrated in the lab. In practical application, such a link might be the physical backbone of a packet switched optical network,

where simulation can assess the viability of other innovations, such as optical clock recovery, packetization, and wavelength multiplexing, on network architecture. Current simulations are addressing the operation of the optical demultiplexer which converts a 100 Gb/s stream of data to eight 12.5 Gb/s streams for electronic processing.

Advanced Packaging Applications

RESEARCHER: Associate Professor Deborah M. Mechtel
SPONSOR: Johns Hopkins University/Applied Physics Laboratory

Wide bandwidth applications have driven the demand for optical waveguides and other components for the processing and transmission of information. Polymers are attractive materials for optical waveguides at both the chip and substrate levels because of their desirable electrical and optical properties as well as their ease of processing. We are developing a technique to simultaneously use polyimide as both a dielectric layer and an optical waveguide in the same multichip substrate structure. Our technique, using poled polymers, will permit electrical and optical interlayers to be formed simultaneously, thus allowing buried optical waveguide and electrical signal lines on the same MCM-D.

We have also used a technique that employs a noninvasive, laser-based instrument to probe MCM structures fabricated with poled polyimide interlayer dielectrics and thin film metallizations on silicon carriers. The electro-optic interaction between the poled dielectric and the laser beam allows the strength of the internal fields within the MCM to be determined as a function of position. Electric field measurements and mappings can be useful in diagnosing module performance, locating sites of circuit shorts and opens, and determining the efficacy of field containment structures. The detection of electric fields in polyimide with buried circuit elements in multiple layers characteristic of MCM-D structures is being studied. Test systems of two dielectric layers with one metal interlayer are being studied.

The details of the poling and processing operations along with the mechanical, thermal, electrical, optical and electro-optic properties for both lightguide and dielectric layer applications are being examined.

Distributed Sensor System with Wireless Communication Network

RESEARCHER: Professor Antal A. Sarkady
SPONSOR: Naval Surface Warfare Center, Carderock Division (NSWCCD),
Philadelphia, PA, Code 825, Henry Whitesel

A distributed shipboard sensor system currently is in a design stage at the Naval Surface Warfare Center, Carderock Division, Philadelphia PA, Henry Whitesel, Code 825. This system is intended for machinery monitoring and advanced damage control applications on U.S. Navy ships. An individual “smart “sensor consists of a transducer connected to a microcomputer with a spread-spectrum receiver for control input and spread-spectrum transmitter for control output. These “smart” sensors are powered by a rechargeable battery, operate at low power levels (approx. 1mW) and have small physical size (size of a credit card). An important property of these sensors is the ease of shipboard installation (cabling is not required), which also allows rapid sensor reconfiguration. Large numbers of distributed “smart” sensors using spread spectrum transmitters and receivers are linked, forming a wireless communication network with display terminals at strategic shipboard locations. Such a wireless network is in the planning and design stage. The researcher provided guidance and help to configure this system, to define problem areas and to maximize system performance parameters (channel bandwidth and signal to noise ratio) when electromagnetic waves are propagating inside steel compartment (with doors closed) and obscured by electromagnetic noise produced by shipboard fire.

Independent Research

Effects of Imperfections in Single-Mode 3x3 Optical Fiber Couplers

RESEARCHER: Commander Charles B. Cameron, USN

Single-mode 3x3 optical fiber couplers have been used successfully in the design of highly sensitive, interferometric, push-pull differential sensor transducers. Normally it is desirable that the optical power entering any of three inputs be evenly split across the three outputs. However, it is technically difficult and consequently rather expensive to achieve this goal. As a consequence, this class of sensors has been unattractive despite the extremely high sensitivity it can attain. The goal of the research is to investigate the extent to which imperfections in these couplers affect the output of this class of sensors and to ascertain whether imperfect couplers can be used. Since such couplers are less expensive to manufacture, the economics of the situation might then permit such sensors to be used more widely with consequent benefits from their superior performance.

Enhancement of a Core Electrical Engineering Course Using WebCT

RESEARCHER: Associate Professor David S. Harding

WebCT was used to enhance an electrical engineering survey course at the United States Naval Academy. WebCT is a suite of HTML based course tools which an instructor can use to provide Web based content. It is a commercial product created at the University of British Colombia. The course authoring tools are free to download and use. A modest fee is paid to site license it for student use. The course in which it was used is the second in a two-semester sequence taken by Juniors and Seniors in non-electrical engineering majors. The second course emphasizes applications, while the first course emphasizes basics such as DC and AC circuit theory. One objective of each course is that students acquire the ability to answer conceptual and short answer questions. Short answer questions are a significant component of each hour exam. Objectives and short answer questions are provided for each course topic. WebCT was used to help students learn short answer material through the use of on-line multiple choice quizzes. Conceptual material is emphasized without adding much additional burden to the instructor. Quizzes on computational material have also been used in a mastery learning mode. WebCT allows quizzes to be taken multiple times. Each time a quiz is taken, the component values are varied. This allows students to make mistakes, go back and ask questions or review the text and then retake the quiz for a better score. Student reaction to this use of WebCT has been positive.

Wireless Systems Innovation and Design

RESEARCHER: CDR Thaddeus B. Welch, III, USN

The researcher is working with Professor Rodger Ziermer (University of Colorado at Colorado Springs) on a variety of wireless/cellular design and analysis projects. This includes, but is not limited to, the bit error probability determination for a differentially coherent direct-sequence spread-spectrum multicarrier modulation system operating in a double spread channel. These and other projects are progressing very well. Success and publication of each result is expected.

Research Course Projects

RF Propagation Measurements

RESEARCHERS: Various Midshipmen: Electrical Engineering majors
FACULTY ADVISER: Commander Thaddeus B. Welch, III, USN
SPONSOR: AFCEA gift fund

The faculty advisor is working with several midshipmen to measure the effects of placing an antenna very near to the ground. This geometry is of concern for tactical forces as well as for civilian cellular, cordless, wireless, and PCS systems users and designers (3G and 4G alike). We have published three papers. NSWC-DC is very interested in our work.

Publications

JENKINS, R. Brian, Assistant Professor, "Simulation and Animation in Optical Fiber Communication," Computers in Education Journal, IX (July-September 1999), 16-22.

Students find certain concepts in fiber optic communication theory difficult to grasp. A classic example is electromagnetic mode theory in cylindrical coordinates. The solutions of the differential equation which describe the modes of the fiber are Bessel Functions, with which most students are unfamiliar, and the vectorial nature of the analysis only complicates the situation. A second difficult concept is dispersion. The fact that different frequencies of light travel at different speeds in the fiber is not confusing. It is in the implications where the difficulty arises. Specifically, the concept of group velocity is physically counterintuitive, and an analysis of the pulse spreading that results because of dispersion often includes a rigorous Fourier analysis. This paper describes how computer simulation and animation can provide a visual means of simplifying these concepts so that they are easier to understand.

JENKINS, R. Brian, Assistant Professor, Michael L. Dennis, Walter I. Kaechele, Thomas F. Carruthers, and Irl N. Duling III, "Cross-phase modulation and multiwavelength adibatic solitions," Optics Letters, 25 (1 May 2000), 604-606.

In an experimental demonstration of four-channel, wavelength division multiplexed repeaterless transmission over 235 km, adiabatic soliton propagation allows for precise spectral characterization of cross-phase modulation effects during initial soliton collisions. Theoretical predictions of the spectral shifts that occur are verified for ultrashort solitions. The relationship between the frequency shift and the initial pulse separation is confirmed by measuring the bit-error-ratio as the pulse spacing is varied at the fiber input. Adiabatic expansion of narrow solitions may help alleviate the channel restrictions that are required for prevention of soliton collisions at the fiber input.

MARTIN, Richard L., Professor, "Use of MATLAB in Design and Analysis of Analog Bandpass Filters to Meet Particular Specifications," Proceedings of the 1999 ASEE Annual Conference, June 20-23, 1999.

In this paper, it is shown how MATLAB's various capabilities, primarily those associated with its frequency response plot (freqs) function, greatly enhances the design of analog bandpass filters. Specifications for in-band variation and out of band rejection are presented for an analog bandpass filter. After MATLAB is used to show how some simplistic approaches fall short of meeting the specifications, various MATLAB functions are used in a methodical approach to develop the transfer functions for more sophisticated filter forms. Finally, it is shown how MATLAB is used to aid implementation and in determining the sensitivity of the final design to component variations.

MECHTEL, Deborah M., Associate Professor, H.K. Charles and A.S. Francomacaro, "Non-invasive Laser Probing: A Solution for Improving the Testability of Buried MCM-D Circuit Structures," Proceedings of the 32nd International Microelectronics Symposium, October 1999, pp. 367-372.

Non-invasive techniques for measuring electric field strengths in multichip module (MCM) substrates can be extremely important in determining ultimate module performance. Certain polymers such as polyimide exhibit an electro-optic response, after appropriate doping and poling, that permits direct measurement of the internal fields with a laser probe. We have built MCM circuit structures using electro-optic polyimides for the dielectric layer. We report mechanical, thermal, electrical, optical and electro-optic properties for these dielectric layers. We report results for multiple layer structures and recommend processing guidelines.

MECHTEL, Deborah M., Associate Professor, H.K. Charles and A.S. Francomacaro, "Poled Polyimides: Applications in Multichip Modules and Lightguides," Proceedings of the 2nd Annual ASME1999 Workshop on Polymeric Materials for Microelectronics and Photonic Applications: Mechanics, Physics, Reliability, Processing, December 1999, EEP-VOl, 27, pp. 27-37.

Low dielectric constants and ease of processing make polymers attractive materials for building both optical waveguides and dielectric layers. The change in the index of refraction of certain polymers such as polyimide, after appropriate doping and poling, makes it possible to build an optical waveguide using established polymer processing techniques. Our work uses these results to demonstrate optical waveguide fabrication for applications requiring optical and electrical interlayers on the same thin-film multichip module structure (MCM-D). In addition, the doped and poled polyimide exhibits an electro-optic response. This characteristic is attractive not only as a basis for developing electro-optic components such as modulators, but also permits direct noninvasive measurement of the internal electric fields of MCM circuit structures with a laser based probing technique. We have built MCM circuit structures using electro-optic polyimides for the dielectric layer. We describe laser probing results for multiple dielectric layer structures and recommend processing guidelines. We report mechanical, thermal, electrical, optical and electro-optic properties for both lightguide and dielectric layer applications.

MECHTEL, Deborah M., Associate Professor, H.K. Charles and A.S. Francomacaro, "Laser Testing of MCM-D Structures," International Journal of Microcircuits and Electronic Packaging, Vol. 22, No. 3, 1999, pp. 242 - 247.

Non-invasive techniques for measuring electric field strengths in multichip module (MCM) substrates can be extremely important in determining ultimate module performance. Certain polymers such as polyimide exhibit an electro-optic response, after appropriate doping and poling, that permits direct measurement of the internal fields with a laser probe. We have built MCM circuit structures, suitable for laser probing, using different electro-optic polyimides for the dielectric layer. We report mechanical, thermal, electrical, optical and electro-optic properties for these dielectric layers. Test results were used to compare the different polyimides for their efficacy as both an MCM dielectric layer and as an electro-optic material, as the doping and poling process was varied. We recommend processing guidelines for the test polyimides and identify the polyimide dielectric with the best characteristics for laser probing.

MECHTEL, Deborah M., Associate Professor, FIELD, Christopher T., Assistant Professor, and JENKINS, Brian, Assistant Professor, "Graphical Analysis and Animation in an Introductory Electrodynamics Class," Computers in Education Journal, (April-June) 2000.

Students frequently experience difficultly visualizing complex multidimensional electrodynamics topics, especially those with time variation. The classic stationary illustrations of inherently dynamic concepts can be greatly enhanced via computer animation. Animation significantly improves student comprehension of time dependent functions, and provides a secondary benefit for students by improving computer programming skills.

MORROW, M.G., CDR, and WELCH, T.B., CDR, "winDSK: A Windows-Based Demonstration and Debugging Program," June 2000, ICASSP, Istanbul, Turkey.

MORROW, M.G., CDR, "An Embedded DSP Development System for Teaching Real-Time Interfacing," Proceedings of the 1999 ASEE Annual Conference, (Charlotte NC), June 1999.

Historically, microcomputer interfacing has been taught using relatively low-performance 8 bit systems. While this gives students the benefit of a relatively simple architecture to work with, it also presents serious limitations, particularly in obtaining real-time performance. To overcome this, the Texas Instruments TMS320C31 DSP Starter Kit (DSK) is used as the engine for new laboratory stations in and advanced microcomputer course emphasizing real-time interface design and operation in embedded systems. A first stage demonstration prototype augmented the DSK with an electrically erasable memory, boot source selection, a reset controller, and a digital/analog prototyping area. By using this prototyping system as a foundation, the students are able to undertake much more ambitious signal processing design projects, without having to design the entire system from the ground up. The end product added a high speed programmable logic device (PLD), and a solderless breadboarding areas. This allows interfacing to complex devices in a solderless environment while eliminating the need for discrete device "glue" logic with its attendant power, delay and signal concerns. In addition to our interfacing course, the laboratory station is ideally suited as the foundation of a hardware-based DSP course.

Moskowitz, M. T., SELLAMI, L., Associate Professor, and Newcomb, R. W., "Complementary Clock Feed-Through Reduction for Switched Current Systems," Proceeding of the International Semiconductor Device Research Symposium, pp. 152-156, December 1999.

A novel method of clock feed through reduction in switched current circuits is introduced here that outperforms previous methods. In principle, the output of identical circuits with complementary switches are added to cancel out switch based error without the requirement of separate DC and signal distortion cancellation in separate stages. Spice results are shown and compared with analysis and hardware layout. These circuits are useful for digital computation with analog hardware. With respect to simulations, this circuit has yielded successful results when used in an ear-type network that requires a delay as part of its matrix.

Rice, J.L., WOOTEN, E.C., Instructor, HARDING, D.S., Associate Professor, FIELD, C., Assistant Professor, and WELCH, T.B., CDR, "Active Learning Techniques for a Core Engineering Course," July 1999, ASEE Conference, Charlotte, NC.

SELLAMI, L., Associate Professor, and R.W. Newcomb, "MOSFET Bridge Fluid Biosensor," Proceedings of the IEEE International Symposium of Circuits and Systems, Vol. 5, pp. 140-143, Orlando (Florida), May 30-June 2, 1999.

This paper presents a MOSFET based biosensor circuit for the monitoring of such things as creatinine in patients with renal failure. Its VLSI layout is presented for 1.2um or for 2.0um MOSIS CMOS processes. The proposed biosensor circuit is a capacitive gas sensor where the device consists of a bridge made of three standard PMOS devices connected either as resistors or capacitors and forming three arms of the bridge. The fourth arm is a similar PMOS transistor but with a gap between the channel and a raised poly layer in which fluid, such as creatinine, or a gas, can be placed. PSpice simulations and Spice extractions from the layout are included to demonstrate the operation of the circuit.

SELLAMI, L., Associate Professor, S.K. Singh, R.W. Newcomb, A. Rasmussen, and M.E. Zaghloul, VLSI Floating Resistors for Neural Type Cell Arrays," International Journal of Circuits, Systems, and Computers, Vol. 8, Nos. 5&6, pp. 559-569, 1999.

Two novel CMOS circuit designs implementing floating resistors are introduced, using the structure of a two-transistor CMOS bilateral linear resistor in the first configuration and two two-transistor CMOS bilateral linear resistors and cascode current mirrors in the second configuration. Linearity is achieved through nonlinearity cancellation via current mirrors over an applied range of +-5V. PSpice simulations using parameters of MOSIS transistors are presented to verify the theory. These floating resistors can be used for coupling weights in VLSI neutral-type cell arrays.

VOIGT, Robert J., Commander, USN, "Multimedia Approaches to Teach Engineering to Non Engineers," Conference Proceedings of ASEE, Charlotte, North Carolina, 21 June 1999.

This paper addresses some of the challenge of teaching electrical engineering to humanities majors in a demanding academic environment. We focus on the use of multimedia tools in the classroom in order to "engage the students." The circumstances are such that the students are enrolled in the course as a core requirement, thus, while they are motivated to pass, they may not be motivated to excel. The challenges we face in teaching this type of course to non-engineering

students are many and varied. For example, they may not have a strong math or physics background to rely upon; therefore, we are restricted from using higher order mathematics in conveying electrical engineering principles which are defined by such methods. We also are faced, in this institution, with an intense demand for the student's time in academic, athletic and military obligations. This is not unlike any collegiate environment where there are time demands on the students beyond the control of the teachers. For example, part time or full time students with job required to pay for their education. Thus, we are faced with the problem of teaching as much information as can be comprehended with the realization that the load for this course is only a small portion of the student's overall time demands. Efficiency in the classroom is essential and the use of multimedia, in and out of the classroom, to reach what is most likely to be a high percentage of visual learners appears to be one method which brings about the desired results of making the material interesting and understandable. In this paper we focus on a subset of ideas and methods we have used and we try to qualify their results. We illustrate the importance of cooperative and collaborative learning in this environment and show how we have approached the problem. We also will describe some of the tools we have developed which can be applied across disciplines other than engineering and can provide these tools to interested parties via a web based server.

WELCH, T.B., CDR, C.H.G. Wright, and M.G. MORROW, "Poles, Zeros, and MATLAB, Oh My!," July 1999, ASEE Conference, Charlotte, NC.

This paper describes some innovative programs using a graphical user interface (GUI) for Matlab and the C31 DSK which makes DSP concepts interesting and entertaining, yet educational. The programs eliminate the need to purchase any expensive specialized software or hardware, relying on the commonly available Matlab program and the inexpensive Texas Instrument C31 DSK for this purpose. The programs described in this paper are a follow-on to the one presented at DSPS Fest '98. The new programs are far more capable and even easier to use than their predecessor: one author (TBW) even managed to get 4th graders to design real-time digital filters then run them on a C31 DSK with one of these programs, and college students love the graphical user interface and the ease of interfacing with the DSP hardware. The programs have been used with great success at both the U.S. Air Force Academy and the U.S. Naval Academy.

Wright, C.H.G., WELCH, T.B., CDR, MORROW, M.G., CDR, and Gomes III, W.J., "Teaching Real-World DSP Using MATLAB and the TMS320C31 DSK," July 1999, ASEE Conference, Charlotte, NC.

A graphically-oriented Matlab program written by the authors facilitates teaching real-world digital signal processing concepts such as quantization of digital filter coefficients that occur in fixed-point processors, for example the widely used TMS320C5x. While many universities have or plan to buy the inexpensive floating-point TMS320C31 DSKs for pedagogical reasons, this Matlab program simulates certain fixed-point effects on these floating-point devices and eliminates the need to purchase expensive specialized software programs or extra hardware. The program described in this paper provides an interactive graphical user interface that communicates directly with the DSK, and demonstrates in real-time how both coefficient quantization and filter implementation affect filter performance, without the need for tedious programming of the TMS320C31.

Presentations

HARDING, David S., Associate Professor, "Active Learning Techniques for a Core Engineering Course," Annual ASEE Conference, Charlotte, North Carolina, 22 June 1999.

JENKINS, R. Brian, Assistant Professor, Dennis, Michael L., Kaechele Walter L., Carruthers, Thomas F., and Duling, III, Irl N., "Cross-phase modulation in multiple-wavelength adiabatic soliton repeaterless transmission", OFC 2000 Optical Fiber Communication Conference and Exhibit, Baltimore, Maryland, 9 March 2000.

Kaechele, Walter I., Irl N. Duling III, Thomas F. Carruthers, Michael L. Dennis, and R. Brian JENKINS, Assistant Professor, "Dispersion-managed transmission of 100 Gb/s time-division multiplexed return-to-zero format data," OFC 2000 Optical Fiber Communications Conference and Exhibit, Baltimore, Maryland, 7 March 2000.

MARTIN, Richard L., Professor, "Use of MATLAB in Design and Analysis of Analog Bandpass Filters to Meet Particular Specifications," 1999 ASEE Annual Conference, June 20-23, 1999.

MECHTEL, Deborah M., Associate Professor, "Laser Testing of MCM-D Structures," Washington IMAPS chapter meeting, Laurel, Maryland, 8 September 1999.

MECHTEL, Deborah M., Associate Professor, H.K. Charles and A.S. Francomacaro "Non-invasive Laser Probing: A Solution for Improving the Testability of Buried MCM-D Circuit Structures," International Microelectronics Symposium, Chicago, Illinois, October 1999.

MECHTEL, Deborah M., Associate Professor, H.K. Charles and A.S. Francomacaro, "Integrated Optical Waveguides Produced from Doped and Poled Polyimides," Poster presentation, Johns Hopkins Applied Physics Laboratory Research and Development Symposium, Laurel, Maryland, 2 November 1999.

MECHTEL, Deborah M., Associate Professor, H.K. Charles and A.S. Francomacaro, "Poled Polyimides: Applications in Multichip Modules and Lightguides," ASME 1999 Workshop on Polymeric Materials for Microelectronics and Photonic Applications: Mechanics, Physics, Reliability, Processing, Paris, France, December 1999.

MECHTEL, Deborah M., Associate Professor, H.K. Charles and A.S. Francomacaro, "Application of Electro-optic Polymers to Improve MCM Design and Testability," American Ceramic Society annual meeting and exposition, St. Louis, Missouri, May 2000.

MECHTEL, Deborah, Associate Professor, Christopher FIELD, Assistant Professor, and Brian JENKINS, Assistant Professor, "Graphical Analysis and animation in an introductory electrodynamics course,"ASEE Annual Conference, Charlotte, North Carolina, 22 June 1999.

MORROW, Michael G., Lieutenant Commander, CEC, USN, "winDSK: A Windows-Based C31 DSK Demonstration and Debugging Program," Texas Instruments DSP Educator's Conference, Houston, Texas, 5 August 1999.

Rice, J.L., WOOTEN, E.C., Instructor, HARDING, D.S., Associate Professor, FIELD, C., Assistant Professor, and WELCH, T.B., CDR, "Active Learning Techniques for a Core Engineering Course," July 1999, ASEE Conference, Charlotte, NC.

VOIGT, Robert J., Commander, USN, "Multimedia Approaches to Teach Engineering to Non Engineers," American Society of Educating Engineers Conference, Charlotte North Carolina, 21 June 1999.

WELCH, T.B., CDR, et al, "Very Near Ground RF Propagation Measurements for Wireless Systems," May 2000, VTC, Tokyo, Japan.

WELCH, T.B., CDR, and R.A. Foran, "Very Near Ground Radio Frequency Propagation Measurements and Analysis for Military Applications," November 1999, MILCOM, Atlantic City, NJ.

WELCH, T.B., CDR, C.H.G. Wright, and M.G. MORROW, "Making DSP Fun for Students Using MATLAB and the C31DSK," August 1999 ASEE Conference, Charlotte, NC.

WELCH, T.B., CDR, C.H.G. Wright, and M. G. MORROW, "Poles, Zeros, and MATLAB, Oh My!," July 1999, ASEE Conference, Charlotte, NC.

WELCH, T.B., CDR, B. JENKINS, Assistant Professor, and C.H.G. Wright, "Computer Interfaces for Teaching the Nintendo Generation," July 1999, ASEE Conference, Charlotte, NC.

Wright, C.H.G., T.B. WELCH, CDR, and M.G. MORROW, "Making DSP Fun for Students Using MATLAB and the C31 DSK, August 1999, DSPS, Houston, TX..

Wright, C.H.G., T.B. WELCH, CDR, M.G. MORROW, and W.J. Gomes III, "Teaching Real-World DSP Using MATLAB and the TMS320C31 DSK," July 1999, ASEE Conference, Charlotte, NC.

Hydromechanics Laboratory

Professor David L. Kriebel, P.E.
Director

The Hydromechanics Laboratory supports Midshipmen education, as well as Midshipmen, faculty and staff research, in the areas of naval architecture and ocean engineering. The laboratory facilities include a large towing tank (380-ft long, 26-ft wide, and 16-ft deep), a small towing tank (120-ft long, 8-ft wide, and 5-ft deep), a coastal engineering wave basin (52-ft long, 48-ft wide, and 2-ft deep), a circulating water channel, and a stability and ballasting tank. All facilities are linked by a local network to a host computer system which is used to both operate the facilities and to acquire and analyze data.

The laboratory facilities are used on a weekly-basis by Midshipmen in the Naval Architecture and Ocean Engineering majors, and are used each semester by Midshipmen in the Mechanical Engineering, Electrical Engineering, Systems Engineering, Physics, and Oceanography majors. In addition, the laboratory is used by more than 600 Midshipmen each year in EN200, a core engineering course taken by all midshipmen in science or humanities majors. As a result, nearly all Midshipmen use the Hydromechanics Laboratory facilities at some point during their four years at the Naval Academy.

In addition to classroom support, the laboratory facilities are used for both fundamental and applied research by Midshipmen, faculty and staff supporting, other naval laboratories and government agencies. During the past year, research programs conducted by the laboratory have included:

I. Development of laboratory experimental documentation procedures which allow “virtual” towing tank laboratory experiments. (Sponsor: Academic Dean (Curriculum Development Project))

II. Development of a ship design “self taught” computer software package (Sponsor: Hydromechanics Laboratory)

III. Towing tank tests of a high speed planning boat (Sponsor: Noesis, Inc)

IV. Towing tank tests of a foil designed for a human powered hydrofoil vehicle (Sponsor: Hydromechanics Laboratory)

V. Seakeeping tests to verify Computational Fluid Dynamics (CFD) predictions for the Mobile Offshore Base (Sponsor: Office of Naval Research and Naval Facilities Engineering Services Center)

IV. High speed towing tank tests of a trimaran hull form (Sponsor: Hydromechanics Laboratory)

V. Towing tank tests of diver propulsion vehicles and Navy divers (Sponsor: Naval Coastal Systems Center)

The laboratory is operated and maintained by a multi-talented staff which includes four engineers/naval architects, three engineering technicians, and an office manager/secretary. Supporting laboratory efforts are the shop and model-making facilities in the Technical Support Department. The laboratory is further supported by a Memorandum of Understanding (MOU) with the Naval Station-Annapolis, providing support of diving operations in the laboratory.

Sponsored Research

Mobile Offshore Base - Phase 3 Model Tests

RESEARCHERS: Prof. David L. Kriebel, P.E. and Ms. Louise Wallendorf, P.E. (Hydro Lab)
SPONSOR: Naval Facilities Engineering Services Center

The Naval Academy's Hydromechanics Laboratory (NAHL) has performed three sets of model tests on a 1/70th scale model of a Mobile Offshore Base (MOB). In concept, a Mobile Offshore Base (MOB) is a modular floating base that can be deployed to an area of national defense interest to provide flight, maintenance, supply and other forward logistics support operations for U.S. and Allied forces. MOB semi-submersibles have significantly smaller wave-induced motions compared to conventional hulls. The NAHL model was designed to be a structurally stiff, geometrically simple and representative of the overall dimensions of the conceptual MOB designs being developed by the three outside contractors, Bechtel, McDermott and Kvaener. The model tests conducted during December 1999 were the third set of model tests conducted by NAHL. The primary purpose of these tests were the verification of a numerical model, the Large Amplitude Motions Program, (LAMP), developed by Science Applications International Corporation (SAIC) of Annapolis, Maryland. The numerical model predicts the motions and the water surface elevations under the deck and near a single MOB in regular and irregular wave conditions. Model tests in regular waves and seastates 6 and 8 were performed for a full scale operating draft of 115' and displacement of 316,648 long tons. Motions of the model were measured using a new 6 degrees of freedom (surge, sway, heave, pitch, roll, yaw) photographic motion measurement system developed by Krypton Electronic Engineering; full-scale translational motions were measured to within .75" and angular motions to within .10 degrees.

Towing Tank Tests of a High Speed Planing Boat

RESEARCHER: Mr. John Zseleczky, Naval Architect, P.E. (Hydro Lab)
SPONSOR: Noesis, Inc.

Small craft such as those used for Special Operations Warfare rely on the high power-to-weight ratio of gasoline engines developed by the civilian racing boat community to reach their high speeds. However, for safety reasons, the U.S. Navy has embarked on a program to eliminate the use of highly volatile gasoline in the entire fleet. The Hydromechanics Laboratory has been supporting this program by supplying data on the performance of one particular hull over a wide range of loading conditions. The range of conditions covers all of the alternative powerplant options under consideration.

The hull chosen for the study was the 48' Advanced Special Warfare Craft (ASWC), which has a unique "wave-piercing" hull. A 1/7th scale model was built and over one hundred model tests were conducted to map out the matrix of operating conditions over a range of speeds. This test program took full advantage of the Laboratory's physical capability and experience base for testing high-speed models. The database obtained from these tests allowed the sponsor to evaluate the feasibility of the candidate alternative powerplants on this unique hull form and avoid costly mistakes that could be made on the prototype.

Independent Research

Towing Tank Tests of a Hydrofoil Designed for a Human Powered Vehicle

RESEARCHERS: Mr. John Zseleczky, Naval Architect, P.E. (Hydro Lab) and Mr. Bill Beaver (TSD)

Over the past two decades various speed contests have been held for human-powered watercraft. The current speed record is held by the Massachusetts Institute of technology (MIT), whose team built a hydrofoil vehicle that reached a speed of 18.5 knots in 1993. This year, two Naval Academy midshipmen took up the design challenge as an independent research project (EN-495) and came up with a paper design that was similar to the MIT record-breaking craft but with a few significant differences.

Complex projects of this nature require an investment in time to identify all of the problems involved and bring the project from a paper study to reality. As one step toward this goal, staff members of the Technical Support Department and Hydromechanics Laboratory built a prototype of the student-designed main hydrofoil and conducted experiments in the 380' towing tank to measure the actual lift and drag of the foil/strut system. These measurements will allow future students involved in the project to compare theory with experiment and make more realistic predictions before investing the time and assets required to create a working vehicle. The hydrofoil and testing fixtures developed for these experiments will be used for teaching the Advanced Marine Vehicles course (EN-353) in following semesters.

Extension of Effective Horsepower Tests on a Trimaran Model

RESEARCHER: Mrs. Nancy Harris, Naval Architect (Hydro Lab)

During the 99-00 Academic Year, Midshipman 1/C Charmaine McAbrew, USN performed a series of resistance tests on a concept trimaran hull form for presentation to the Society of Black Engineers. The work was a continuation of model tests initially performed to support the U.S. Coast Guard Deepwater Project. The tests were performed on a 1:36 scale model of a 420 foot long trimaran with a displacement of 3126 long tons. Previous tests were performed to investigate the effect of sidehull position on resistance, and these tests were performed to investigate the effect of sidehull displacement on resistance. The position of the sidehulls and the main hull displacement were held constant, and the sidehull displacement was varied. Three different sidehull displacements were tested: design (6.9% mainhull displacement,) heavy (10% mainhull displacment,) and light (5% mainhull displacment.) Another purpose of these tests was to find out about the high speed capabilities of the trimaran hull form for commercial applications. The maximum ship speed tested during the original tests was 30 knots; the maximum ship speed tested during these tests was 50 knots.

Tutorials for Naval Architecture Computer Programs

RESEARCHER: Mrs. Nancy Harris, Naval Architect (Hydro Lab)

The midshipmen who study Naval Architecture and Ocean Engineering use a variety of programs to aid them in their coursework. These programs include AutoCad LT for arrangement drawings, FastShip for hull design, NavCad for powering and propeller selection, GHS and SHCP for stability and longitudinal strength, SMP for ship motion prediction, various NC Milling programs to create files for the numerically-controlled milling machine, and in-house programs written by faculty and staff at the Naval Academy. The students who take EN200 (Introduction to Naval Architecture) and High School Students enrolled in the High School Summer Science Seminar also use some of these programs in a limited fashion. Over the years a set of instructions have been written that are continually updated when computer programs are added or upgraded. These instructions include tutorials and guidelines that are geared towards the existing computing environment in the Hydromechanics Laboratory, the Naval Architecture Design Room (R126), and other electronic classrooms in Rickover Hall.

Presentations

HARRIS, Nancy A., Naval Architect, “FastShip 5 Training Session for the Junior Class at Webb Institute of Naval Architecture,” Webb Institute of Naval Architecture, Glen Cove, New York, March 17, 2000.