

# NAVAL POSTGRADUATE SCHOOL RESEARCH

Volume 11, Number 2

June 2001

## SEA LANCE: SEABORNE EXPEDITIONARY ASSETS FOR LITTORAL ACCESS NECESSARY IN CONTESTED ENVIRONMENTS

LT Howard B. Markle II, United States Navy

The Total Ship Systems Engineering (TSSE) Program is a one-year program that NPS students in the Naval and Mechanical Engineering, Electrical Engineering, or Combat Systems curricula take as electives in addition to the normal Master of Science degree requirements. The TSSE students take courses in systems engineering, naval architecture, combat systems, shipboard electrical power, and hull, mechanical, and electrical systems integration. The program culminates with a two-quarter capstone design course in which the student team designs a complete ship. The SEA LANCE (Seaborne Expeditionary Assets for Littoral Access Necessary in Contested Environments) project was the capstone design project for the 2000 Team.

SEA LANCE is designed as the deployment mechanism for the Expeditionary Warfare Grid proposed in the Capabilities of the Navy after Next (CNAN) study being conducted by the Naval Warfare Development Command. The system composed of the SEA LANCE and Expeditionary Grid will be capable of providing the deployability, flexibility, versatility, lethality and survivability necessary within the contested littorals to provide the operational commander with increased awareness and improved access assurance capability. After the end of the Cold War, the view of the world has shifted from a global-war scenario to one of regional crisis situations. This fact implies a very important shift in operational orientation for the Navy, because the battlefield has moved from blue waters into the contested littoral environment. Emerging powers are developing massive access denial capabilities to prevent power projection into their territory.

The first quarter of the design effort was largely devoted to narrowing the scope and defining the problem. A Mission Needs Statement (MNS) was developed and Operational Requirements Document (ORD) was authored that included a description of the operational capability, threat summary, shortcomings of existing systems, the range of capabilities required of the SEA LANCE system and other considerations required of the total system design. The first quarter effort also included an analysis of alternatives for three different system architectures and major system components.

The size of the contested littoral environment of threat nations continues to grow. The Navy needs to develop a system that can provide assured access in these closely contested littoral environments. The Navy After Next must marry new capabilities with the best capabilities of the fleet of the Program Objective Memorandum (POM) to gain, sustain and exploit that access. It must be an integral part of Network Centric Warfare (NCW) and be capable of joint and combined operations.

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# STUDENT PROJECT

## SEA LANCE, *continued from page 1*

An essential key to success in the littoral environment is increased numbers of sensors, weapons, combatants and unmanned vehicles to produce a force structure capable of tipping the scales in our favor. Numbers will matter and the Navy After Next must be affordable and yet be robust enough to provide the support required of our current forces as well as produce the numbers necessary to upset the future littoral force imbalance. The combatant and its payload must be expendable to the extent that it is not viewed as a high value unit, but have a level of survivability capable of allowing the crew time to eject when the combatant is no longer capable of sustaining them (much like modern-day aircraft).

Concealment together with the surprise factor, inherent to the enemy operating in its own littorals, will pose undue risk to our conventional power projection assets. This weakness creates the need to develop a capability that will allow gaining, maintaining, sustaining and exploiting access to the littorals, in order to project power into enemy territory. SEA LANCE in conjunction with the Expeditionary Warfare Grid will be capable of performing this vital mission.

The NPS TSSE Program supported the Platform Team of the NWDC CNAN study. The NPS TSSE team developed a design of a combatant that will distribute the Expeditionary Warfare Grid discussed in the mission needs statement, tend (and be part of) the Expeditionary Warfare Grid once in place, and become an integral part of the warfighting capability of the Expeditionary Warfare Grid system in support of the Expeditionary Warfare Grid's access mission.

To facilitate war gaming and analysis by other teams, the Expeditionary Warfare Grid Team defined a toolbox of subsystems. This toolbox was used to determine payload weight and volume requirements for the combatant. The Expeditionary Warfare Grid system will consist of four parts: a global satellite-based network, logistic support ships (which may or may not be the existing logistics force), a distributed sensor and weapons system, and a squadron(s) of small combatants that deploy/tend the sensors and weapons.

The Expeditionary Warfare Grid is assumed to be robust, secure, and readily accessible for two-way exchange of information. Antenna requirements will not exceed 40 cm in diameter and need not be aimed at specific satellite coordinates.

The logistics force will be capable of providing any asset needed by the combatants. This will include food, replacement parts, fuel, replacement-distributed components, Fly-Away Teams for extensive preventive/corrective maintenance

and all administrative support. The logistics force will not provide berthing or long-term mooring for the combatants or their personnel. The logistics force will not be capable of transporting the combatants. Logistics replenishment will be performed in relatively safe waters and in modest sea states.

The sensors will be connected to the Expeditionary Warfare Grid via some form of modems and will have some limited mobility. The sensors are acoustic arrays, radar array elements, magnetic detectors, electronic support measures (ESM) sensors, infrared detection arrays, and optical elements. The weapons are also connected to the network and receive their firing authorization via the network. The weapons will include torpedoes, torpedo-based mines, surface-burst fragmentation mines, canister surface-to-air missiles, canisterized surface-to-surface missiles and strike missiles. The sensors and weapons will be deployed wherever they are tactically needed. This may include blue water, in littoral waters, near the shore or inland.

The following are some of the significant capabilities from the ORD:

- Maximum speed of 38 knots with a goal of 40 knots
- Minimum sustained speed of 30 knots with a goal of 34 knots
- Minimum range of 3000 Nm at 13 knots
- Maximum crew size of 20 officer and enlisted combined with a goal of 13
- Maximum of \$100 million for the first ship cost in FY01 dollars
- Maximum displacement of 1000 LT
- Transit in sea state 6, grid deployment in sea state 4

These capabilities were divided and further subdivided until the basic function was derived. The capabilities were paired in functional groups to produce the functional flow diagrams to define the ship. The measures of effectiveness (MOE) as defined by the sponsor were flexibility, versatility, lethality, survivability and deployability. The MOE were broadly defined as follows: flexibility was evaluated as how well the combatant performed the mission, versatility as how many missions could be performed, lethality as how much total weapons capacity, survivability as the ability to survive in the hostile littoral environment, and deployability as the measure of ease of deploying to and operating in theatre. The MOE were further subdivided and paired with the individual functional requirements they needed to evaluate. The required operational capabilities' (ROCs) MOE were utilized through-

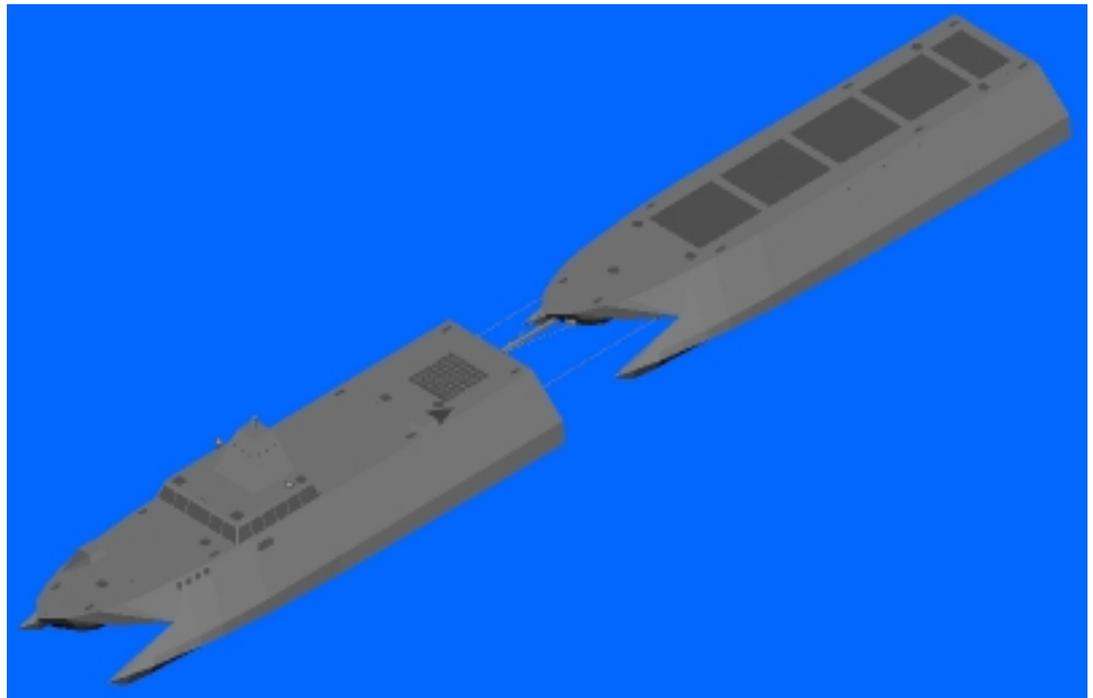
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# STUDENT PROJECT

## SEA LANCE, *continued from page 2*

out the analysis of alternatives to determine the platform that most completely fulfilled the mission needs statement.

The combatant and tow architecture (Figure 1) was chosen over the medium sized (600 LT) architecture or the mixture of small (250 LT) and medium (800 LT) architecture because of its versatility and flexibility to meet the required mission needs. The combatant and tow architecture had the advantage of producing a true fighter when the deployment phase was complete. The tow would be detached following deployment to produce a high-speed, low radar cross section combatant with a robust combat systems suite and a relatively large organic weapons payload. The other architectures had the distinct disadvantage of producing a fighter with too little firepower or a freighter with too little payload



**Figure 1. SEA LANCE consists of a Combatant and a Close-Towed Grid Deployment Module.**

carrying capacity. The freighter of the other architectures would become a liability to the other craft once deployed. They would require protection from the freighters until removed from the access assurance zone to be rearmed or

reloaded. The wave-piercing catamaran hull form was chosen over other designs because of its good sea keeping abilities, low resistance at high speeds, shallow draft and large deck area and internal volume.

The second quarter of the capstone design project was dedicated to the design of the combatant and tow. The following summarizes the results of the analysis in specific areas. A complete analysis is contained in the technical report posted on the TSSE website listed at the end of this article.

There were many design

*--continued on page 4*

### About the TEAM

LT Howard Markle, USN, is an Engineering Duty Officer enrolled as a student in the Mechanical Engineering Program. He is a candidate for a Master of Science in Mechanical Engineering as well as a Mechanical Engineer Degree. He was the team leader for the Team 2000 design team. The team has presented the project to the President of the Naval War College, VADM Cebrowski, the CNO's Executive Panel and numerous DON personnel.

Faculty members of the TSSE 2000 Design Team include Professor Charles Calvano, Department of Mechanical Engineering and NAVSEA Professor of Total Ship Systems Engineering (Hull, Mechanical and Electrical Systems), Dr. Dave Byers, Visiting NAVSEA Professor, Senior Lecturer Robert Harney, Department of Physics and NAVSEA Professor of Total Ship Systems Engineering (Combat Systems), Associate Professor Fotis Papoulias, Department of Mechanical Engineering, and Associate Professor John Ciezki, Department of Electrical and Computer Engineering. Student team members in addition to LT Markle were LTJG Ahmet Altekin, Turkish Navy, LT Tim Barney, USN, LT Karl Eimers, USN, LCDR Garrett Farman, USN, LT Ricardo Kompatzki, Chilean Navy, LT Chris Nash, USN and LT Rick Trevisan, USN.

# STUDENT PROJECT

## SEA LANCE, *continued from page 3*

drivers and associated design enablers that created a complex system to map each driver/enabler pair and evaluate the pairing and affect on other drivers/enablers. An example of this complexity was the choice of water jet propulsion to enable the craft to operate in shallow water environments. This choice produced the desired draft to enable the ship to operate in the littorals however, it produced some serious concerns when endurance and fuel consumption were reviewed. The conventional water jet works well at high speeds producing efficiencies comparable to and in some instances, greater than a controllable pitch propeller. However, at the transit and deployment speeds with the tow attached (15 knots) the efficiency of the conventional water jet drops to approximately 40% and there are duty cycle restrictions that would preclude continuous operation. This led to the choice of the Advance Water Jet for the 21st Century (AWJ-21) under joint development by Bird-Johnson and Rolls Royce. The initial design analysis of the AWJ-21 shows efficiencies that meet or exceed that of propellers for the range of operating speeds required.

SEA LANCE is pair of vessels composed of a combatant

### Combatant

Full Load Displacement	450 LT
Light Ship Displacement	283 LT
Payload Fraction	35%
Length Overall	167 feet
Length at Waterline	146 feet
Draft	8 feet
Individual Hull Beam	10 feet
Overall Beam at Waterline	40 feet
Overall Beam at Weather Deck	30 feet
Block Coefficient (CB)	0.625
Prismatic Coefficient (CP)	0.857
Midship Section Coefficient (Cx)	0.729

### Grid Deployment Module (GDM)

Light Ship Displacement	146 LT
Payload Fraction	67 %

**Table 1. Physical Characteristics of the SEA LANCE Vessels.**

and tow. The tow has relatively the same hull form and naval architecture characteristics as the combatant. It is a semi-fixed close proximity tow of approximately 20 feet. The tow is referred to as the Grid Deployment Module (GDM). Some of the naval architecture characteristics of the

combatant and tow are contained in Table 1. A detailed analysis of the tow mechanism has preliminarily shown that the tow is viable in the required sea states. For sea states greater than the sea state 4-deployment requirement, the tow can be extended to a conventional tow until the short tow can once again be established.

The GDM carries nine half-size sensor modules or weapons modules.

A half-size module is a container 18 feet wide x 11 feet long x 9 feet deep.

These modules fit in bays in the center hull that are open top and bottom. Each sensor or weapons module contains a quantity of one or more deployable sensor packages or deployable weapons packages. The packages are deployed while SEA LANCE is moving between the twin hulls using a gravity feed mechanism. This eliminates the need for personnel to physically effect the package deployment and hides the deployment from external observation. The specific loadout of modules would be determined prior to deployment and might be different for each SEA LANCE. If more module space is available than required for the planned expeditionary grid, the modules might be replaced by additional vertical missile launchers, by SEAL team insertion equipment, or other special mission equipment of similar or smaller weight and volume. To extend the range of the SEA LANCE, 103 tons of fuel is fed to the diesel engines in the Combatant through an umbilical contained in the tow bar. The GDM also contains an auxiliary generator and a suite of decoy launchers. Once the expeditionary grid has been deployed, the GDM may be cast off. The GDM can now act as a strategic decoy by radiating signals mimicking a SEA LANCE Combatant or some other battle group combatant

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# STUDENT PROJECT

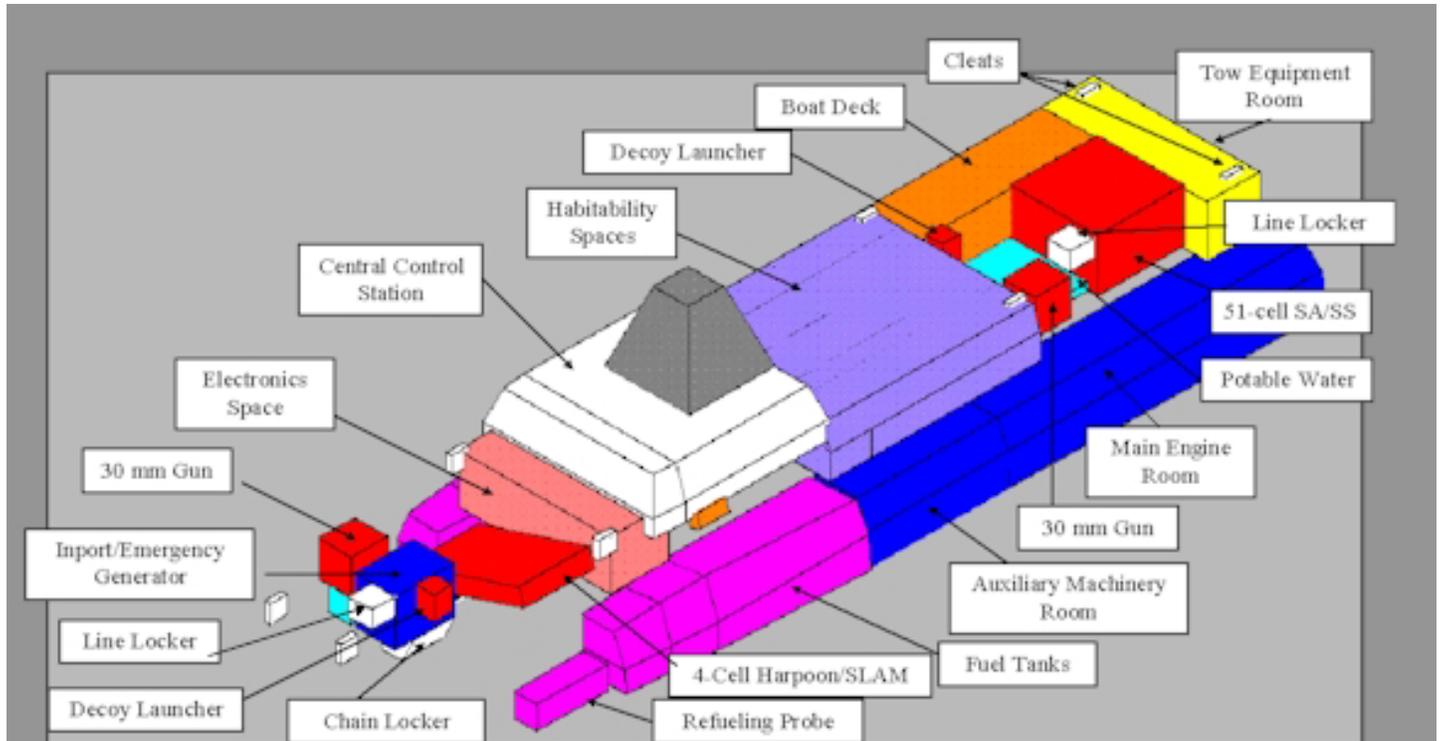
## SEA LANCE, *continued from page 4*

or can be used for a lily pad for Special Operations Forces (SOF) or amphibious forces.

The combatant (Figure 2) is a robust fighting platform that provides its 13-person crew with all the support necessary to conduct operations in support of the mission needs statement. From the combined control station to the auxiliary

equipment, all components are connected to the Ships Wide Area Network via a Total Open Systems Architecture (TOSA). Technology advancements such as remote monitoring, automated damage control, and simplicity of controls and displays are essential to the success of the austere

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**Figure 2. Arrangement of Critical Components within the SEA LANCE Combatant.**

## **TSSE** Total Ship Systems Engineering

The Total Ship Systems Engineering (TSSE) program at NPS:

- Develops for U.S. Naval Officers a program in the interdisciplinary area of Total Ship Systems Engineering, which complements and enriches their accredited degree programs. This includes the necessary engineering and physical sciences, classical engineering and computer-aided design tools, and systems engineering methodologies that will address classical Hull, Mechanical & Electrical (HM&E) and Combat Systems subject matter in a Total Ship context.
- Encourages research into Total Ship Systems Engineering

problems and processes. This includes faculty participation in Navy TSSE activities, student experience tours involving TSSE, and TSSE research projects and theses.

- Supports NAVSEA in its responsibilities to conceive and explore future ship and ship system designs and innovations by coordinating the TSSE student capstone design project with NAVSEA, by encouragement of NPS student thesis research and by involvement of TSSE faculty members in NAVSEA future ship explorations, as permitted by their teaching responsibilities.

## FEATURED PROJECT

### FREE ELECTRON LASERS FOR WARSHIPS

Distinguished Professor W. B. Colson  
Northrop Grumman Professor  
Department of Physics

When I arrived in the Physics Department at the Naval Postgraduate School (NPS) in 1989, the Strategic Defense Initiative Organization (SDIO) was just beginning to wind down. The free electron laser (FEL) was the main weapon in an ambitious system that proposed to shoot down thousands of missiles at a range of tens of thousands of kilometers in about 20 minutes time utilizing orbiting mirrors. While the whole system was extremely ambitious, the large FEL that had been designed may have actually worked. Several panels of experts met often over many years and continued to approve the FEL design. Since the beginning of FEL development in the 1970s, we had known that the FEL could operate at high power. The laser interaction volume, containing only a relativistic electron beam, a static magnetic field, and laser light, could not be damaged at high-power and was transparent to all optical wavelengths. An intense electron beam could burn through tens of feet of steel in seconds, but would only propagate about 10 feet through the atmosphere. The FEL converts the energy of the electron beam into light, and

light could propagate through the atmosphere to a target some distance away.

At NPS I spent less time on SDIO research and developed physics courses, PH2911 and PH4911, which teach students to write simulations of physical systems and processes. The PH4911 course starts with simulations of the Navy's PHALANX gun and follows the trajectories of penetrators including the effects of gun dispersion, atmospheric air-drag, and gravity. The gun's ability to hit an oncoming missile is evaluated, and the trajectories of pieces of missile debris are followed showing that much of the debris hits the ship despite destruction of the missile. The students and I were surprised to find that the PHALANX does not destroy missiles sufficiently far from the ship to protect the ship and sailors from serious damage and injury. As indicated by the *Stark* and *Sheffield* examples, both of which were hit by missiles whose warheads did not explode, there are many things on ships that will burn or explode when hit by a high velocity projectile. Even worse, in the early 1990s, the Navy was moving to littoral missions where hostile missiles could be launched from relatively short range. The Navy needs an effective and surgical defensive weapon against short-range missiles.

#### About the INVESTIGATOR

**William B. Colson** is a Distinguished Professor in the Department of Physics. He joined NPS in 1989 after considerable experience in both academia and industry. Dr. Colson received his B.S and M.S. in Physics from Wayne State University, followed by a Ph.D. in Physics from Stanford University. He has held positions at Wayne State University, Rice University, the University of California-Santa Barbara, Berkeley Research Associates and Stanford University. He has also worked with Berkeley Research Associates and the Bendix Research Laboratory. This past year he was named the Northrop Grumman Professor. The Northrop Grumman Professorship was established by an agreement between the Naval Postgraduate School, Northrop Grumman, and the Naval Postgraduate School Foundation.



**William B. Colson**

Dr. Colson is a member of the American Physical Society, the American Association for the Advancement of Science, the Optical Society of America, the International Union of Radio Science, Commission H, and the IEEE Laser and Electro-Optic Society. He has been a member of Sigma Xi since 1979.

Dr. Colson's research interests are in the theory and design of free electron lasers and particle beam systems, and simulations of laser propagation.

Recently, it has become clear that we may need to defend ships against small boats without resorting to exploding our warheads near civilians. The course follows the PHALANX exercises with simulations of the FEL and propagation of the laser beam through the atmosphere including the effects of turbulence, diffraction, and thermal blooming. While the PHALANX gun has decades of use in the Navy, the FEL appeared many years away from possible deployment on ships. I was advocating the FEL as a future weapon, but thought the future was a long ways off. It now appears closer than I thought.

Two other important developments were occurring simultaneously during the early 1990s.

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## FEATURED PROJECT

### FREE ELECTRON LASERS FOR WARSHIPS, *continued from page 6*

As I tried to interest the Navy in FELs, I was told that I had to see John Albertine, the Director of the Navy's High Energy Laser Directed Energy Office in Washington DC. He had already constructed a chemical laser that had shot down missiles at White Sands Missile Range in New Mexico. I invited him to give an NPS physics colloquium and was surprised to hear him end his talk with the recommendation that FELs were the best solution for directed energy. The FEL could be designed to operate at a wavelength that would better propagate through the atmosphere.

The second development was a proposal to build an FEL at the newly formed national laboratory in Newport News, VA, now called the Thomas Jefferson National Accelerator Facility (TJNAF). This FEL was to be used for industrial processing and used superconducting RF accelerators to create the intense, relativistic electron beam. The design recirculated the electron beam back through the accelerator to recover beam energy and would have many of the characteristics needed for a shipboard weapon: high efficiency, reliability, compactness, and minimal shielding from radiation. Dr. Fred Dylla, Director of the FEL Program at TJNAF, asked whether I had any contacts in the Navy interested in Directed Energy. I introduced Dylla to Albertine, and money was found to construct a new building at TJNAF housing the superconducting, recirculating FEL. Dr. George Neil was hired at TJNAF from TRW where he had worked on FELs and high power lasers. We began a collaboration that has now lasted over 10 years involving a total of about 40 NPS students. NPS simulated the TJNAF FEL before it was built and continues to contribute to its development. At present, the TJNAF FEL is the most powerful FEL in the world producing about 2 kW average output power at infrared wavelengths for many hours at a time. We are actively working with TJNAF on plans to upgrade to 10 kW in the near future and then on to 100 kW. It has become increasingly clear that the TJNAF FEL can be made more compact, efficient, and reliable as we work toward the 1 MW power level needed for ship defense applications.

Many of the concepts for the 1 MW FEL were developed at a workshop held at TJNAF about 5 years ago and attended by several NPS students. A second MW workshop will be held on June 5th and 6th, 2001 at TJNAF, Newport News, VA, and is organized by Dr. Alan Todd of Advance Energy Systems. The workshop is being sponsored by the Joint Technology Office for High Energy Lasers, and will have over 100 participants from the Navy, industry, universities, and

national laboratories. Eight NPS students who are now taking PH4055 on FEL physics and system design will attend the conference. Interested sponsors are Admirals Nanos, Mathis, and Cohen with technical support from CDR Roger McGinnis who is a recent NPS PhD graduate in FELs.

The FEL system described below is one scheme that results from NPS research and discussions with physicists Todd and Neil. I am grateful for their help and interaction over many years. They are major contributors to the FEL 1 MW system.

The shipboard FEL would put about a MW of laser power at a wavelength around 1 micrometer. This is about 1000 times the power of a typical microwave oven and would be focused on a section of the target missile about 5 inches in diameter for a couple of seconds. The desired result is destruction of the missile guidance system, ignition of the missile fuel or warhead, or structural damage that causes the visible break up of the missile at ranges like 5 km so that debris does not reach the ship. The FEL wavelength can be selected to optimize propagation through the atmosphere in order to minimize absorption and the effects of turbulence. Unlike all other lasers, the FEL design would not be significantly altered if a better wavelength in the infrared was found. In fact, the continuously tunable FEL would be the best machine to find the optimum wavelength. The laser beam would be directed to the supersonic target by means of a mirror on the ship about a foot in diameter mounted somewhere high on the ship. The beam director would weigh about 1 ton and could be mounted in the ship's PHALANX gun position (PHALANX is up high on ships and weighs 6 tons). Tracking supersonic targets has been done for some time, and the laser spot can be held on a specific area of the missile to "cook." When a missile is destroyed, verification and damage assessment is immediate because the operator is looking at the damaged area with a tracking telescope.

The 1 MW laser beam would be generated down in the hull of the ship near a large source of electrical power. The FEL is an all-electric system similar, in principle, to the traveling-wave-tubes and klystrons that generate microwaves for radar. It would reside in a rectangular box 12m x 4m x 2m (see Figure 1). Inside the box is a vacuum pipe in the shape of a racetrack where the intense electron beam recirculates. A short pulse of new electrons enters the racetrack

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# FEATURED PROJECT

## FREE ELECTRON LASERS FOR WARSHIPS, *continued from page 7*

from a high-voltage injector which accelerate the beam to about 7 MeV energy. The pulse of electrons a few millimeters long then enters a superconducting RF accelerator that increases the beam energy at a rate of about 20 MeV/m over about 5 m length to 100 MeV. The short pulses of electrons are timed to enter RF cavities just as the oscillating RF electric field is ready to accelerate them to higher energies. The increased energy of the electrons comes from the RF power which must be continually replaced. Static magnetic fields then bend the 100 MeV electron beam in the vacuum pipe around the other side of the box.

The pulse of electrons enters the FEL interaction region where it exchanges energy with the powerful laser beam stored between the mirrors of a resonator cavity. The resonator mirrors are about 10 m apart and several centimeters in diameter so that the intense laser beam does not damage the highly reflective mirrors. One mirror is partially transparent so as to allow 1 MW of output power to escape into an optical path of mirrors that takes the laser light up to the beam director topside. In Figure 1, the transverse dimensions of the mirrors and laser beam are exaggerated so they can be seen. A few percent of the electron beam energy is extracted

in the interaction region to amplify the laser beam. This extracted energy continually replaces the 1 MW output power beamed off the ship. The interaction and energy exchange occurs when the light and electron pulses travel together through a static, periodic magnetic field called an undulator, or wiggler. The undulator field will have about 25 periods over a 1 m length and causes the electron beam to wiggle in the transverse direction.

After the electron beam transfers a few percent of its energy to laser light, the beam continues around the racetrack back through the accelerator. The electron pulses are now timed to enter RF cavities out of phase so that the oscillating RF electric field decelerates them to lower energies. The reversed accelerating field cause the electrons to give back most of the energy they had gained except for the injector energy of 7 MeV. The electrons are then guided into the beam dump at this low remaining energy. Lowering the beam energy below 10 MeV before dumping significantly reduces the radioactive shielding needed. Recovery of the electron beam energy in the RF cavities greatly increases the system efficiency and greatly reduces the RF generators required. The system

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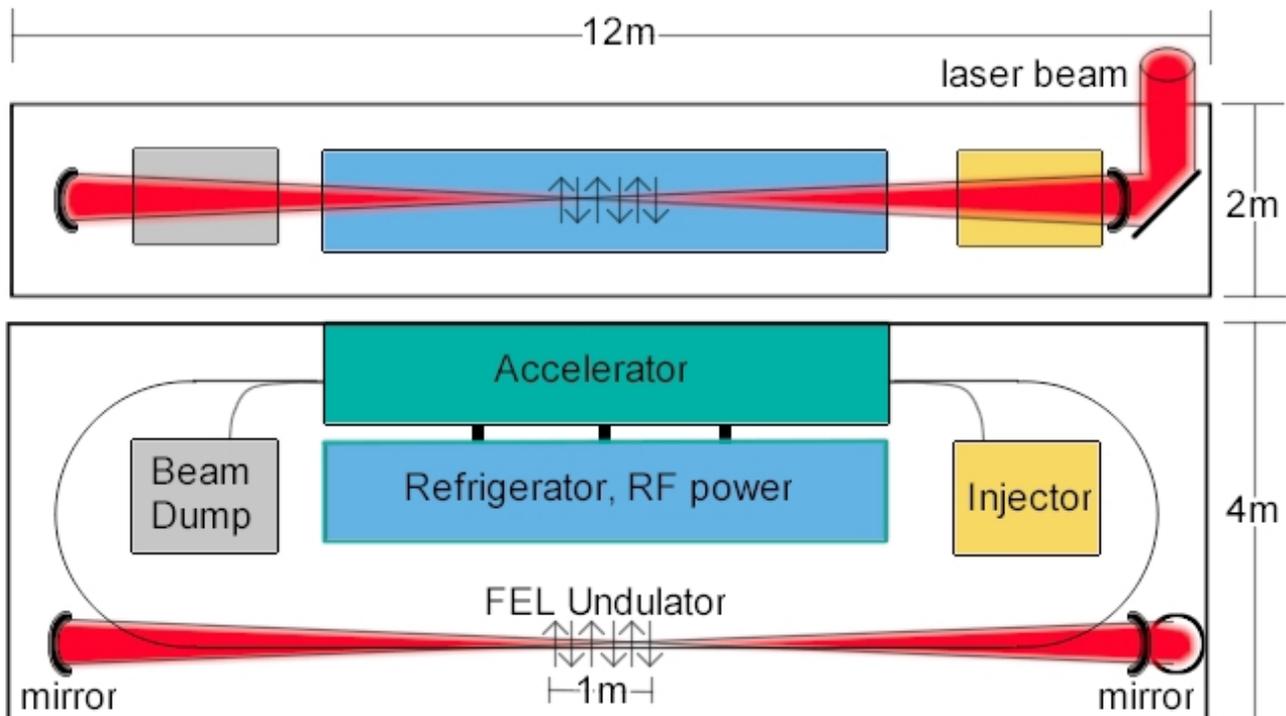


Figure 1. The Free Electron Laser uses a relativistic electron beam recirculating through a magnetic wiggler to amplify a multi-megawatt laser beam. A partially transparent mirror allows a megawatt of laser power to be directed to a target miles from the ship.

## FEATURED PROJECT

### FREE ELECTRON LASERS FOR WARSHIPS, *continued from page 8*

efficiency is expected to be about 10%, so that the ship must provide about 10 MW of electric power to run the laser. For electric ships, this power is available and the FEL could run continuously as needed. For conventional ships with less electrical power, a few cubic meters of capacitors or flywheels may be added to store power for engagements that would last tens of seconds. Minutes would elapse before the system was available again as the stored energy was replaced. If a 2.5 MW generator were fully available, the downtime would be minimal. The complete FEL system containing the necessary shielding and refrigerators would weigh about 30 tons.

The average current in the electron beam is about 0.5 A in the form of short millimeter long, high current pulses every few meters. Both the electron and laser pulses must be timed to overlap during their co-propagation and interaction through the undulator. The 100 MeV electron pulses are traveling at 99.998% of the speed of light so they almost keep up with the light pulse. The resulting laser beam is made up of millimeter long pulses spaced every few meters in a continuous train averaging to the 1 MW of power needed. This series of intense pulses are very different than the continuous beam of light produced by chemical lasers. The peak power is thousands of times the intensity of the chemical lasers. There is some evidence that there are advantages to the short pulse format in both propagation through the atmosphere and damage at the target. These are active areas of research. Another important research area is the transport of the electron beam around the racetrack. The recirculating electron beam power is  $0.5 \text{ A} \times 100 \text{ MV} = 50 \text{ MW}$  in a

millimeter diameter spot. If even a small fraction of the beam strays off the path and hits the vacuum pipe somewhere, the system stops immediately. When the recirculation path is broken, shut-off is rapid, in a few microseconds.

Our current research at NPS studies the design of the FEL interaction region and continues work published about 5 years ago. We proposed a modification to the typical FEL design which narrows the optical beam in the middle of the undulator so that the laser spot on the mirrors is maximized. Changes in the FEL interaction have impact on the electron beam peak current, beam quality, and duty factor. As in many areas of physics, practical applications of new physical principles lead to the consideration of the complete system.

There are now two chemical lasers that are powerful enough to shoot down missiles. The all-electric, tunable FEL has advantages over both. Just as physics has been a key to the development of radar, nuclear weapons, satellite surveillance, fiber optics, computers, just to name a few examples, so physics will be key to the development of the FEL for warships. Essential to these goals are naval officers who have enough technical education to participate wisely in scientifically challenging projects. The Navy has sufficiently powerful offensive weapons, but few effective defensive weapons. We need defensive weapons that allow a sustainable naval presence. We all grew up with John Wayne westerns where he would let the other guy draw first, then shoot the gun out of bad guy's hand; no injuries and the enemy was defeated. The FEL may prove to be the modern version of that American morality play.

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### FREE ELECTRON LASER DEVELOPMENT FOR DIRECTED ENERGY

CDR Roger D. McGinnis, United States Navy  
Doctor of Philosophy in Physics – December 2000

This dissertation investigates power requirements for a Free Electron Laser (FEL) to burn through various missile radome materials. It also includes computer simulation results for several FEL system configurations designed to achieve maximum power while maintaining strict energy spread constraints. The method used to determine power requirements to burn through materials was to use the Thomas Jefferson National Accelerator Facility's Free Electron Laser to conduct material damage experiments. As the laser was improved and increased in power, the laser spot sizes on the target materials were increased while maintaining a constant irradiance. The key results from these experiments included determining minimal spot sizes that can be used for future experiments, and validations that an irradiance level of  $10 \text{ kW}/\text{CM}^2$  can burn through most missile radome materials in a few seconds. The computer simulations involved changing various parameters of an FEL such as electron energy levels, pulse lengths, magnetic field strengths, desynchronization, as well as several other parameters, to determine the best possible configuration to achieve the desired power levels and energy spread requirements for development of a megawatt size FEL. The results indicated that for the proposed designs, both the required power and the required energy spread limit can be met.

## FEATURED PROJECT

### ESTIMATING NEAR-SURFACE ATMOSPHERE PROPERTIES THAT AFFECT WEAPON SYSTEMS

Professor K. L. Davidson, Department of Meteorology

Research Associate P. A. Frederickson, Department of Meteorology

#### Background

High speed, sea-skimming missiles are a serious threat to the U.S. Navy. They are difficult to detect and identify and can be launched in near-coastal regions where U.S. ships operate within range of these threats. The widespread availability of anti-ship cruise missiles and their impact has led to increased concerns about the atmosphere's effects on the performance of the shipboard sensors and fire control systems required to engage these threats.

Both radar and infrared (IR) sensors are possible methods to track sea-skimming missiles, as well as other threats. For this reason, considerable effort has been spent to increase platform survivability through the development of sophisticated multi-spectral sensor systems, both radar and infrared. Future sensor system amplifier and signal processing modifications and future target characteristics may lead to a few dB change for detection or a fractional change in detection ranges.

However, the ability to take into account environmental effects on sensor systems may be responsible for large (10s of dBs) improvements in both detection and tracking capabilities. This is particularly true if adjustments can be made to sensor operation or to multi-sensor selection or placement to optimize the systems capabilities for the current environmental conditions. Improvements to radar and IR systems allow for changes from a standard or reference atmosphere. This would include waveform and frequency selection for fire control radars, better weighing of radar and electro-optical (EO) track sensor use and data, and adaptively setting radar sensitivity versus range and bearing based on environmental conditions. For example, there is a program underway to use knowledge of the propagation and clutter as seen by fire control sensors to optimize sensor operation and allow for improved fire control tracking and weapons delivery.

--continued on page 11

#### About the INVESTIGATORS

**Kenneth L. Davidson** is a Professor in the Department of Meteorology. He earned his M.S. and Ph.D. in Meteorology from the University of Michigan. He was an USAF weather officer between undergraduate and graduate studies and came to NPS in 1970 on completion of his Ph. D. degree. Professor Davidson is principal investigator on several research projects including formulations of models for the near-surface properties, and evaluations potential



**Kenneth L. Davidson**

operational meteorological measurement approaches. He serves as a technical advisor to several METOC programs. He teaches courses on Atmospheric Factor in Rf/EO Propagation to students in the Air-Ocean and ECE/EW curricula at NPS and in short courses to the Swedish Defence University (Advanced

Technology Workshop) and to the Singapore Armed Forces (Defense Technology and Systems Course).

**Paul A. Frederickson** is a Research Associate in the Department of Meteorology at the Naval Postgraduate School. He has been with the Department of Meteorology since 1990 after graduate studies at the University of Maryland, where he performed research in the Center for Ocean-Land-Atmosphere



**Paul A. Frederickson**

Interactions. He now conducts research in air-sea interactions and boundary layer meteorology, including surface flux measurement and parameterization, near-surface atmospheric effects on EM/EO propagation and marine surface remote sensing verification. He has participated in developing and conducting over 30 collaborative at-sea and field experimental programs on buoys, ships and land stations.

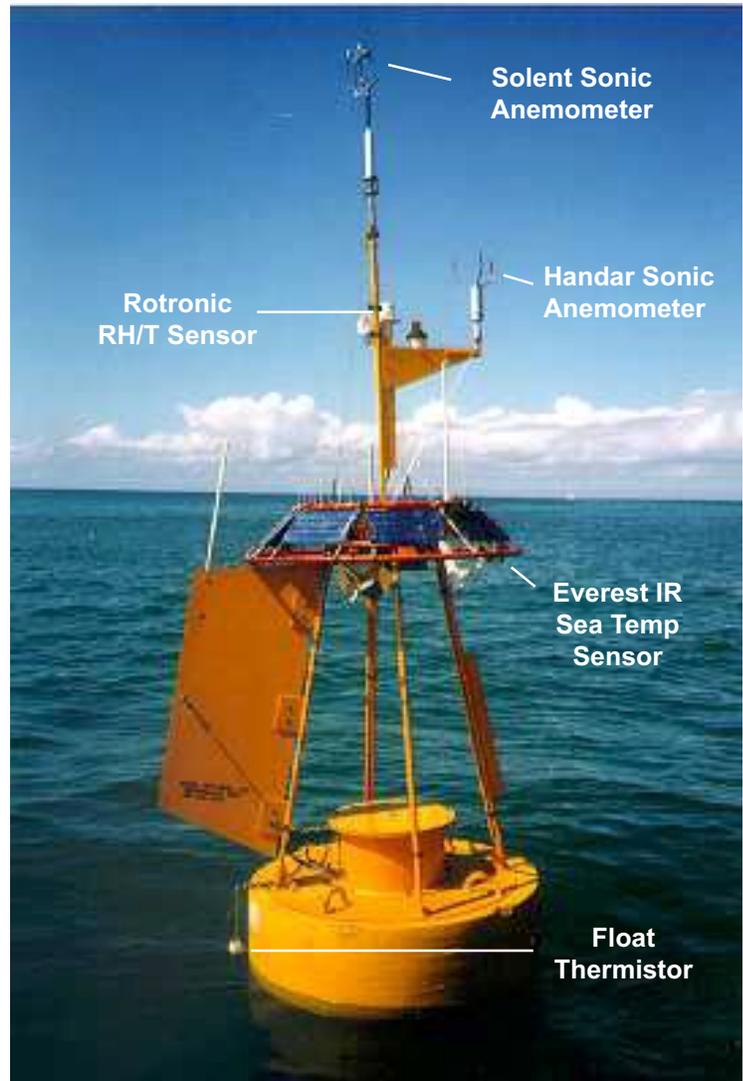
## FEATURED PROJECT

### ESTIMATING NEAR-SURFACE ATMOSPHERE PROPERTIES, *continued from page 10*

The near-surface atmosphere properties that affect both radar and IR propagation are the height variations of humidity and temperature. These variations or gradients can cause non-standard refraction of the rays that could lead to extended or reduced detection ranges for both radar and IR sensors or to increased surface clutter for radar and position errors for IR systems. Direct determination of the gradients would require multi-level fixed sensors starting near the surface and extending to heights well above the ship superstructure, which is not possible from an operational ship. A near-surface property that affects IR is rapid change of temperature and humidity caused by turbulent motion. This can cause target image intensity fluctuations (scintillation) or increase the spread and, hence, reduce the energy illuminating the target. Direct measurement of the small-scale turbulence causing these to occur would not be possible either from an operational ship because of fragility of instruments and the levels to which the descriptions have to be made.

#### NPS Accomplishments

The Naval Postgraduate School (NPS) Department of Meteorology has been involved in basic and applied research programs for several years with the objective of understanding the near-surface properties that affect radar and IR propagation and of formulating operational models to describe the atmospheric phenomena. NPS has developed operational near-surface refractivity and optical turbulence models for inclusion within a forthcoming shipboard measurement and display system (Frederickson et al 2000a and 2000b). These models compute near-surface propagation affecting properties from environmental measurements provided by the upgraded Shipboard Meteorology and Oceanography Observing System (SMOOS(R)). The model predicted radar refractivity profiles, for example, which then can be input into propagation assessment programs such as the Advanced Refractive Effects Prediction System (AREPS) to estimate the near-surface radar performance in the current environment, including the probability of detection of specific threats. The NPS model has been incorporated into the system software developed by the Johns Hopkins University, Applied Physics Laboratory (JHU/APL). Further, NPS has been involved in the development and evaluation of nearly all near-term shipboard measurement systems being considered. NPS has



**Figure 1. NPS instrumented buoy for radar and IR (EO) studies.**

established collaborations with subject matter experts in the required fields of expertise, ranging from radar systems performance to basic marine boundary layer research. Because of the multi-discipline requirements for the solution of the operational prediction problem, these established partnerships are essential to the successful solutions of it.

Deployments of weeks to months of instrumented buoys (Figure 1) have occurred at both West and East Coast locations in conjunction with both radar and IR propagation studies. Two near-identical toroid buoys in the NPS suite are

*--continued on page 12*

# FEATURED PROJECT

## ESTIMATING NEAR-SURFACE ATMOSPHERE PROPERTIES, *continued from page 11*

instrumented to measure mean vector wind, and four-level profiles of mean temperature and humidity of the air and mean sea surface temperature and the two-dimensional wave field (see Table 1). Further, the buoys are instrumented to measure turbulent wind, temperature, and humidity and profiles of temperature. Power and storage capacities enable up to three-month deployments with radio transmission to shore for real-time performance evaluations and conditions monitoring.

NPS was involved in five IR propagation field studies (1996 through 1999) to evaluate prediction of factors affecting IR detection of near-surface targets, including turbulence, refraction and absorption. The program was called Electro-Optical Properties and Coastal Environments (EOPACE), Jensen et al (2001). All but one EOPACE field experiment occurred in the vicinity of San Diego Bay with the NPS buoy at the midpoints of two over water propagation paths (Figure 2). The fifth and last IR propagation field study occurred off Duck NC in 1999 with two NPS buoys along a path extending out to sea from the shoreline (Figure 3).

*--continued on page 13*

PARAMETER MEASURED/CALCULATED
Mean Vector Wind
Mean Temperature Profile
Mean Humidity Profile
Momentum Turbulence/Flux
Temperature Turbulence/ Buoyancy Flux
Humidity Turbulence/Flux
Sea Surface Temperature (bulk & IR)
1 & 2-D Wave Spectra

Table 1. NPS Flux Buoy Measurements.

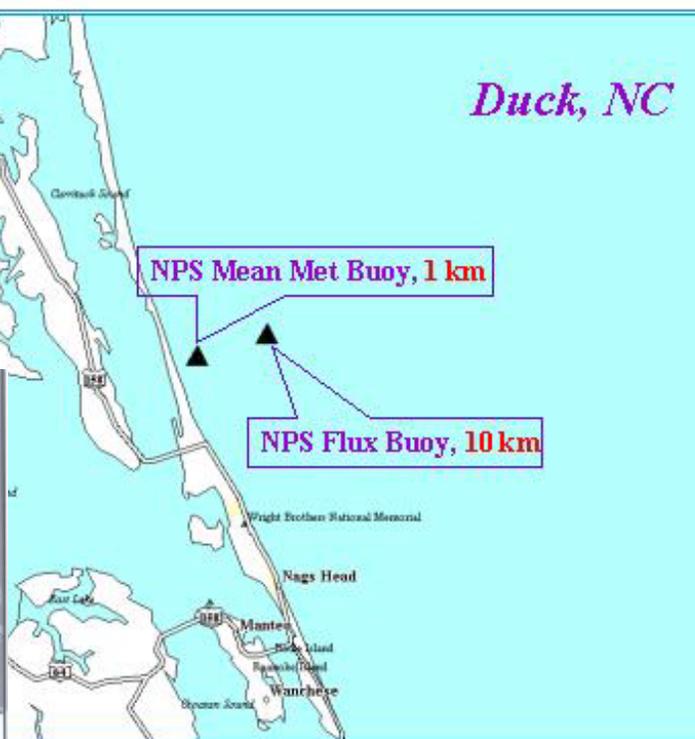
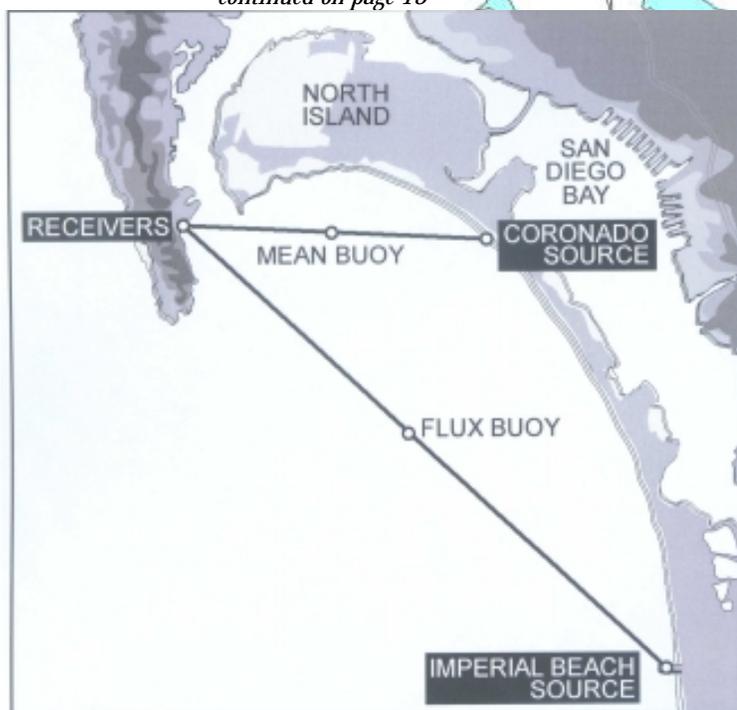


Figure 2 (left). San Diego buoy measurement and EO propagation path location.

Figure 3 (above). Duck, NC sites.

# FEATURED PROJECT

## ESTIMATING NEAR-SURFACE ATMOSPHERE PROPERTIES, *continued from page 12*

These combined buoy surface layer measurement and along path propagation experiments revealed that the models perform differently depending if the water is warmer or colder than the water. Results in Figures 4 and 5 show that problems arise with the bulk model for those times when the water is cooler, by ~ 1-2 degrees, than the air. The difference also is not the same on the West and East Coasts due to wave influence, which is not accounted for in the model.

NPS participated in two (1998 and 2000) radar

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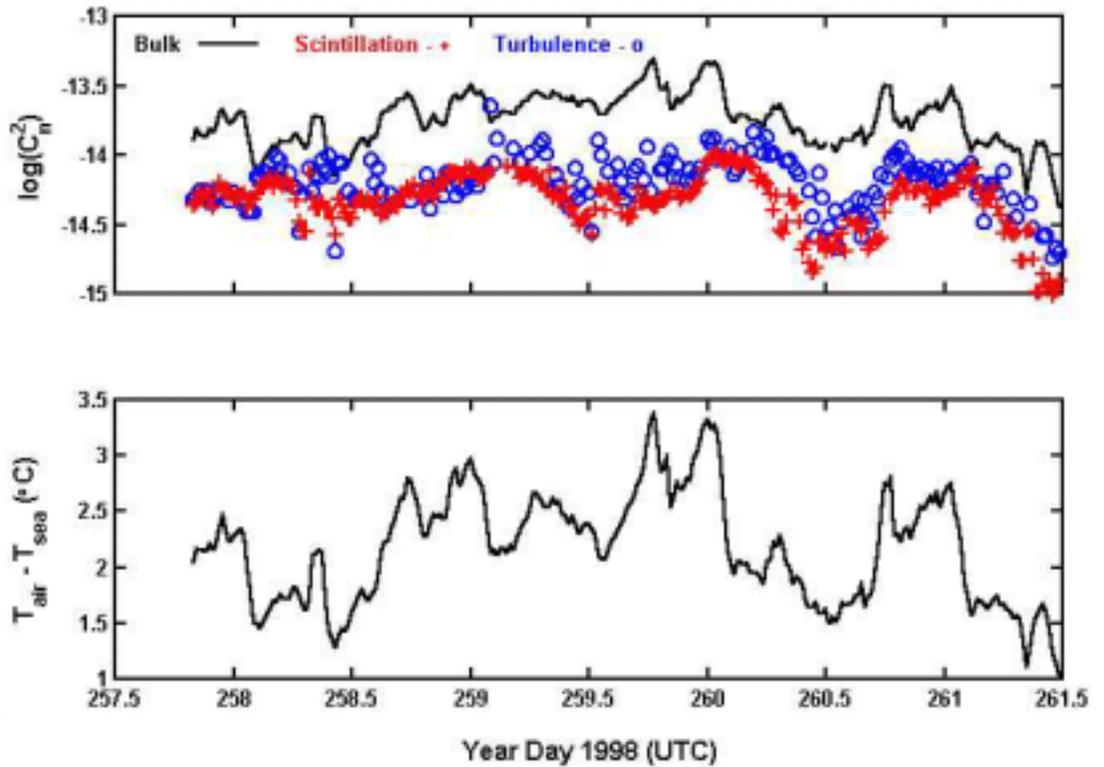


Figure 4 (above). Air warmer than water IR scintillation results.

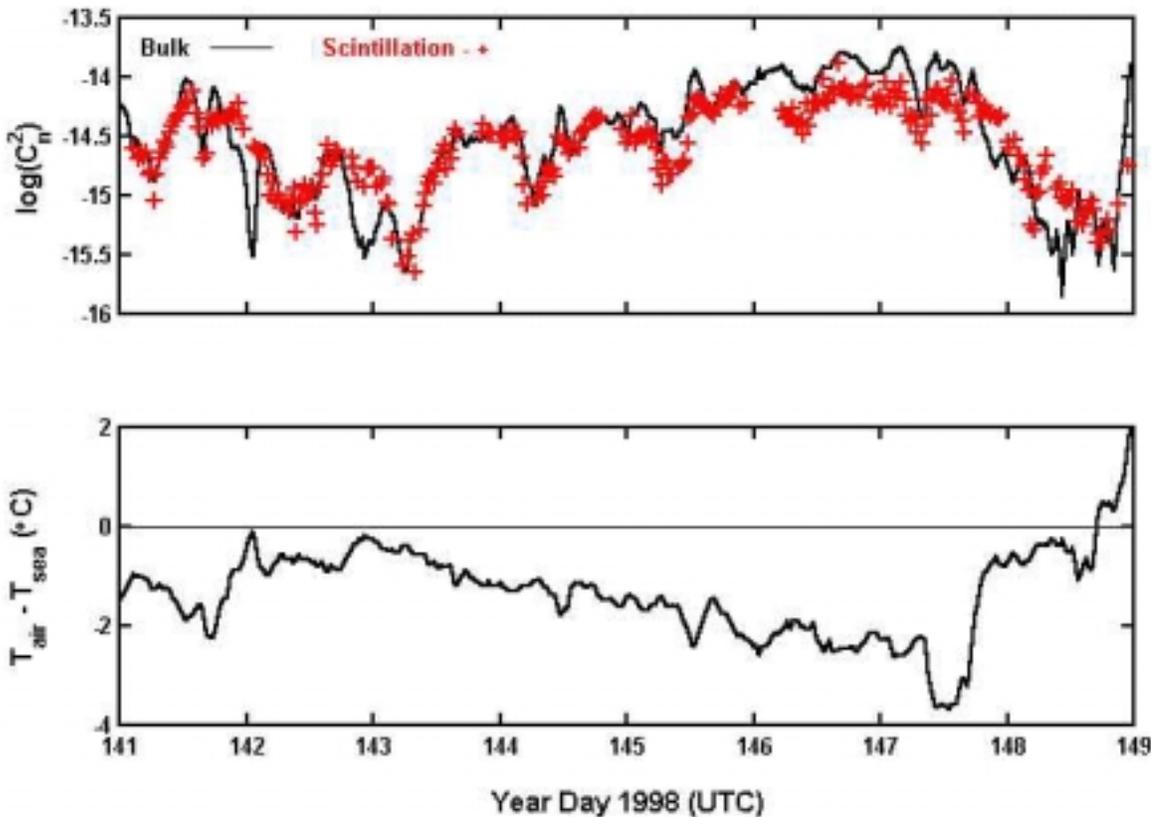


Figure 5 (left). Air cooler than water IR scintillation results.

# RESEARCH AND EDUCATION

## SMALL SATELLITE DESIGN PROGRAM BRINGS HANDS ON EDUCATION TO STUDENTS

### Introduction

The Small Satellite Design Program provides a mechanism for research and instruction in satellite technology and its applications. The principal investigator is **Professor Rudolf Panholzer**, Chair of the Space Systems Academic Group and Dean of Science and Engineering. The focus is on the design, development, and ultimately, launch and operation of small satellites by officer students at NPS. In addition to the building and flying of complete spacecraft, other space flight experiments are also investigated which may eventually provide a better solution to existing technology for space systems.

The Small Satellite Design Program has been ongoing since the inception of the Space Systems Academic Group (SSAG) in 1982. A number of space flight experiments have flown including the Space Thermo-Acoustic Refrigerator (STAR) as a Shuttle Get Away Special payload, the Ferroelectric Materials in Space (FERRO) experiment as a piggyback payload aboard the DATASAT-X satellite, and a follow-on FERRO experiment aboard the APEX small satellite. The first NPS spacecraft launched is the Petite Amateur Navy Satellite (PANSAT), a small (57 kg, or 125 pound), digital communications satellite. PANSAT was launched aboard the Shuttle, Discovery, in 1998. The PANSAT small satellite is still

orbiting and operating with daily contacts from NPS for telemetry downloads and software uploads. [Visit on the World Wide Web at <http://www.sp.nps.navy.mil/pansat/>.]

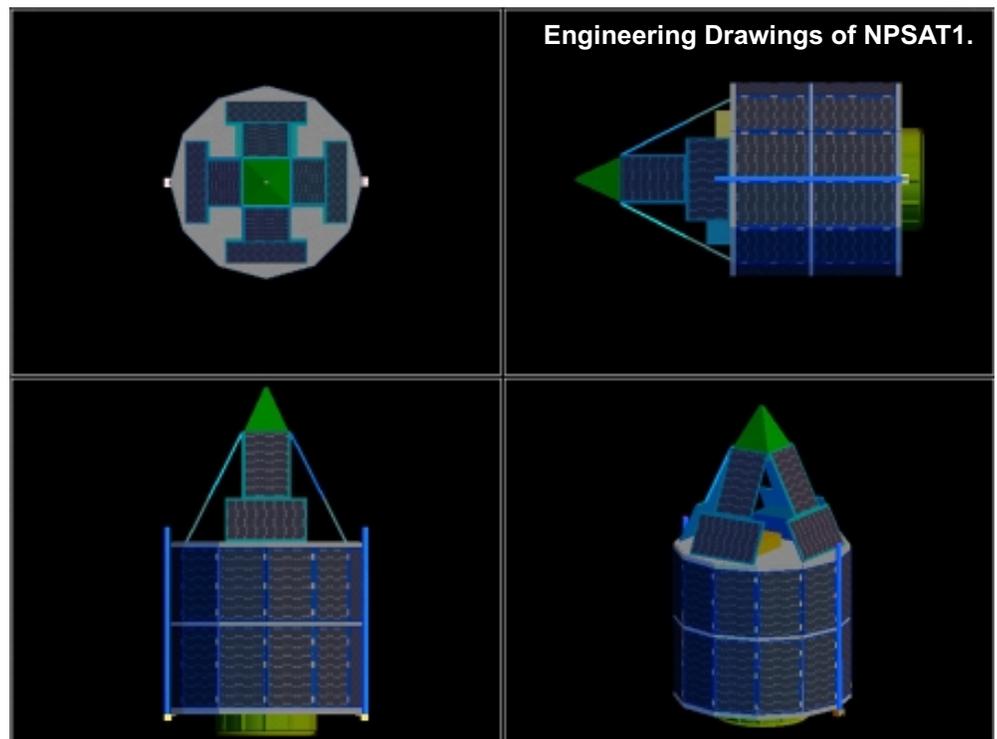
NPS officer students, faculty, and staff gained a wealth of experience with the PANSAT project in the development and on-orbit operations. The NPS space curricula continue to reap the benefits in instruction and thesis research with this space-based laboratory. In addition to the educational training, lessons were learned in the space system development cycle which are relevant to the faster, better, cheaper philosophy of spacecraft engineering, as well as the management of a spacecraft development program in an academic environment. For the long term, it is clear that a hands-on

satellite project for officer students provides invaluable experiences which are unobtainable in an exclusively classroom environment. The follow-on small satellite project, NPSAT1, is a logical extension to PANSAT capabilities and lessons learned. NPSAT1 will provide a platform for space flight experiments and address some of the bottlenecks met in the PANSAT project. NPSAT1 moves in the direction of higher capability with coarse, three-axis attitude control; and will be developed in a much shorter period of time. The long-term vision of the Small Satellite Design Program at NPS is the development of highly capable nanosatellites (1 to 10 kg) or picosatellites (0.1 to 1 kg) developed by officer students providing utility for the scientist, researcher, and warfighter.

### NPSAT1 Overview

The Naval Postgraduate School is developing NPSAT1 to incorporate commercial standards in a processor architecture that potentially improves reliability of software and decreases development time. The software part of any space system is arguably the least reliable and most prone to cause schedule delays, and thus increases the cost of the program. A likely cause for delays and unreliability is the uniqueness of the

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Engineering Drawings of NPSAT1.

# RESEARCH AND EDUCATION

## SMALL SATELLITE DESIGN PROGRAM, *continued from page 14*

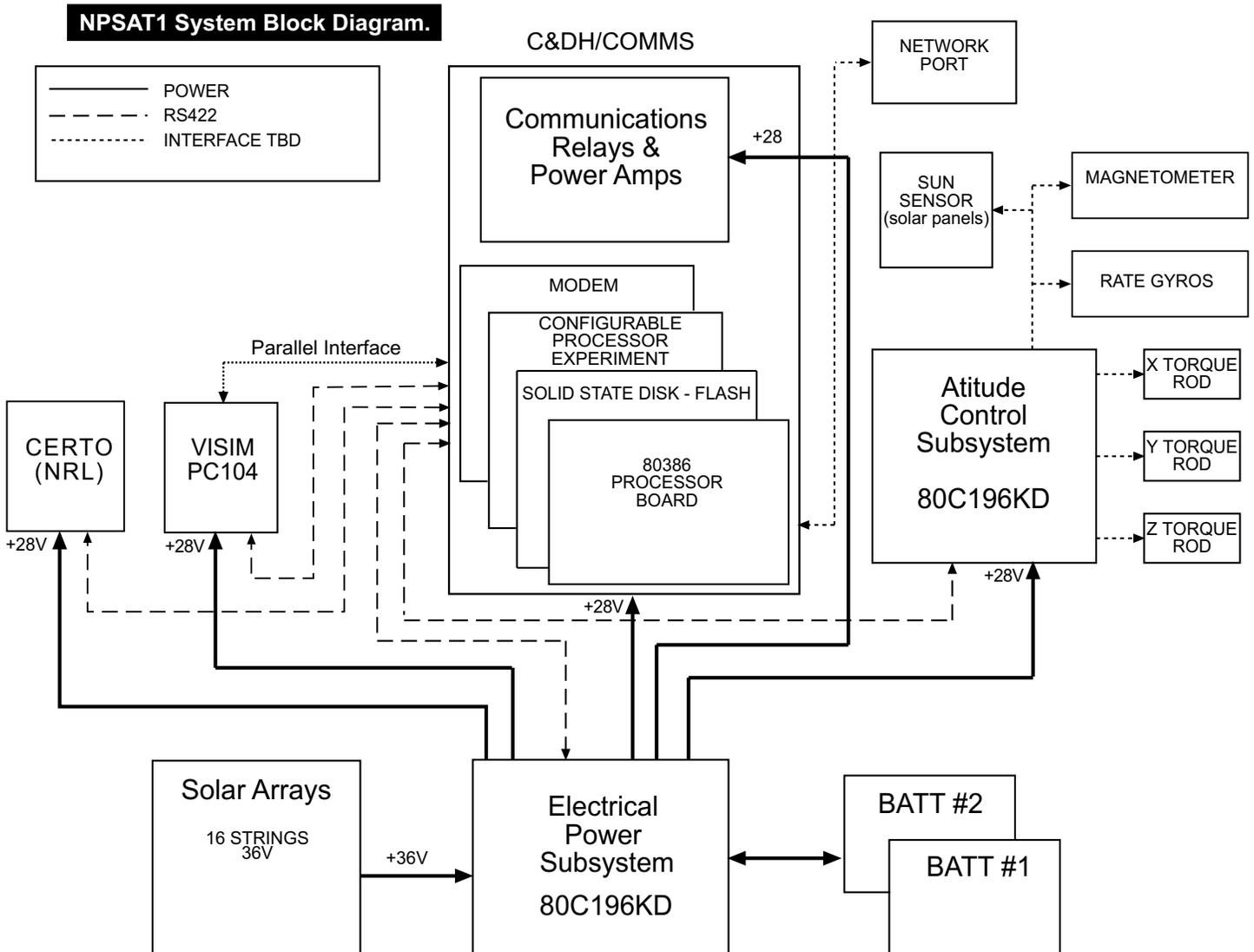
space flight hardware as a computing platform. Because of this hardware uniqueness, software cannot reliably be tested until hardware becomes available on which to run and debug software drivers, routines, and control algorithms. The problem becomes more readily apparent as more autonomy is required of the spacecraft that in turn demands a more sophisticated operating system.

One solution is to use current standards that are widely accepted in industry. This affords the use of commercial-off-the-shelf (COTS) products. The goal of the NPSAT1 small satellite is to demonstrate a command and data handling (C&DH) subsystem which is compatible with a common desktop PC along with a POSIX-compliant operating system,

namely Linux. The Linux operating system is a robust, multi-tasking operating system with a rich environment for the software developer. Combining the PC hardware with the Linux operating system software offers the means by which software development carried out on desktop PCs is fully compatible with the target flight hardware. At NPS, this means officer students can work on software algorithms without the need to code at the hardware level.

Other COTS technology is currently available which is directly applicable to space with little or no modification. One such example is ferroelectric (FERRO) memory. FERRO RAM devices are currently available in sufficient

*--continued on page 16*



# RESEARCH AND EDUCATION

## SMALL SATELLITE DESIGN PROGRAM, *continued from page 15*

densities to allow for their use as a replacement of conventional (or RAD-tolerant) RAM devices. FERRO RAM offers the inherent property of radiation-tolerance and offers a non-volatile memory storage. FERRO RAM is a form-fit, as well as a functional, replacement for RAM devices currently being used. NPSAT1 will demonstrate the use of FERRO RAM as part of the spacecraft electrical power subsystem (EPS) and attitude control subsystem (ACS).

Another example of COTS components, which would be advantageous for space application, is lithium-ion (Li-ion) polymer rechargeable batteries. Li-ion polymer batteries offer the highest energy density (Watt-hours per kilogram) than any of the currently used battery technologies, such as nickel-cadmium, nickel-hydrogen, or nickel-metal hydride. Li-ion polymer batteries offer energy densities starting from 120 Watt-hours per kilogram and do not exhibit any memory effect. NPSAT1 will attempt to fly the Li-ion polymer battery as part of the EPS which provides a safe battery cell in terms of damage due to overcharging, discharging or handling.

NPS will gain from the experiences with the PANSAT small satellite in processing COTS components for space flight to ensure that the electronics can survive the launch environment as well as the space environment. Although little can be done to remove the possibility of single-event upsets (SEU), the NPSAT1 C&DH will address the problem of SEUs by implementing error-detection-and-correction (EDAC) memory for system RAM. EDAC RAM will be able to detect

and correct any single-bit errors found within a sector of EDAC RAM. In the event of a dual-bit error, the processor board will be reset. The C&DH will also be under the watchful eye of a watchdog timer in the EPS. Should the C&DH processor fail to reset the watchdog timer, the EPS will power cycle the C&DH.

NPSAT1 will support a number of experiment payloads. The Naval Research Laboratory is providing both the Coherent Electromagnetic Radio Tomography (CERTO) experiment as well as a Langmuir probe to fly on NPSAT1. An NPS experiment to be flown is a configurable processor investigated by **Dr. Alan Ross**, the Navy TENCAP (Tactical Exploitation of National Capabilities) Chair Professor, **Professor Herschel Loomis**, Department of Electrical and Computer Engineering, and **LT Peter Lashomb**, USN. NPSAT1 will also fly COTS devices as experiments to see how they operate in the space environment, such as a digital camera and some micro-electromechanical systems (MEMS) devices.

**NRL Experiment Payloads:** The CERTO experiment is a radio beacon that transmits at two frequencies, 150 MHz and 400 MHz. The space-based beacon, in conjunction with a network of ground receivers, will be used to measure the integrated electron density of the ionosphere in the plane of observation. CERTO will also be used to develop and test tomographic algorithms for reconstruction of ionospheric irregularities; to provide a database for global models of the

*--continued on page 17*

## MICRO-ELECTRO-MECHANICAL SYSTEMS FOR SMALL SATELLITE APPLICATIONS

**LT Seiko Okano, United States Navy**  
**Master of Science in Astronautical Engineering - June 2001**  
**Advisors: Professor Rudolf Panholzer, Space Systems Academic Group, and Professor Brij Agrawal, Department of Aeronautics and Astronautics**

Micro-electro-mechanical systems (MEMS) have been developing for the past few decades, but recent spaceflight demonstrations have highlighted the potential of this technology as an attractive paradigm shift in how aerospace systems should be developed, maintained and used as the dawn of a new space age emerges. MEMS will generate a revolution in the way people see and control tomorrow's satellites by combining technological advances in sensors, actuators, reactionary systems, spacecraft attitude control

systems, information processing and storage with the miniaturization of these components. MEMS will enable the realization of decentralizing satellites and, therefore, create a paradigm shift in the conceptual operation and development process of how people think about using satellites. The vision of what can be achieved from space is no longer bound by what an individual satellite can accomplish, rather, a number of much smaller cooperating satellites can share the functionality at a lower cost in development and production. This thesis will validate the concept of MEMS and their applicability to space and conclude by examining possible paths that the Naval Postgraduate School microsatellite, NPSAT1, can take to reducing subsystem mass and power through the use of MEMS components.

## RESEARCH AND EDUCATION

### SMALL SATELLITE DESIGN PROGRAM, *continued from page 16*

ionosphere; to characterize the ionosphere for geolocation; and to perform scintillation studies of the ionosphere. Radio beacons provide measurements of the scintillation environment that degrades military system performance. The electron density characterization is used to correct for ionospheric refraction that limits space-based geolocation of ground transmitters. The CERTO beacon may be used in operational systems for both of these uses. The Langmuir probe is a sensor which will be used to measure ions surrounding the spacecraft as it flies. Data will be correlated between the in-situ measurements from the Langmuir probe and those from the CERTO ground stations.

**Configurable Processor Experiment (CPE):** The configurable processor experiment (CPE) will evaluate on-orbit operation of a NPS design which uses a field-programmable gate array (FPGA) which can be configured for specific processing applications. Ferroelectric RAM memory will be used to store configuration parameters which can be uploaded from the ground to program the FPGA to accommodate different processing requirements.

**COTS Visual Imager:** The fourth NPSAT1 payload is a COTS visual imager (VISIM), or digital camera. The VISIM camera has a 652 x 492 CCD pixel array outputting raw image data in a Bayer format. Image resolution will be better than 100 meters. The VISIM payload will be used primarily to generate data that can be used to support on-board processing experiments such as image compression. Additionally, as a community outreach effort, the VISIM can be tasked by elementary and secondary schools to take images of interest, such as their hometown. Through the Internet, students can request images and view them while learning more about space systems in general.

**MEMS Rate Sensors:** The final experiment to fly onboard



**LT Seiko Okano, USN, and Electronics Engineer Ron Phelps, Space Systems Academic Group, test a MEMS (Micro-Electro-Mechanical System) gyro.**

NPSAT1 are the MEMS rate sensors. The experiment will operate COTS MEMS rate sensors in a 3-axis sensing configuration. The sensors will be used to assist the attitude control subsystem in the acquisition phase of the mission where the spacecraft is released from the launch vehicle. This initial phase is where tip-off rates will induce the highest rotational rates on the spacecraft. Following proper orientation of the spacecraft, the rate gyros will be operated intermittently to test their operation in the space environment. Space Systems Engineering student, **LT Seiko Okano, USN** (June 2001) is performing initial tests to characterize and evaluate a candidate MEMS rate sensor as part of her Masters Thesis.

#### **Officer Student Involvement**

The main objective, as stated earlier, is the educational training of the officer students at NPS in Space Systems Engineering and Operations. To date, approximately 15 officer students have been involved in preliminary design and concept of operations. Under the guidance of **Senior Lecturer Barry Leonard**, Department of Aeronautics and

*--continued on page 56*

# STUDENT RESEARCH

## WEB-BASED MARKETS FOR IMPROVING NAVAL PERSONNEL DETAILING

Assistant Professor Mark E. Nissen, Graduate School of Business and Public Policy

Associate Professor William R. Gates, Graduate School of Business and Public Policy

Major Hock Sing Ng, Singapore Armed Forces

Captain Paul A. Robards, Australian Regular Army

Lieutenant Commander Richard J. Schlegel, United States Navy

Lieutenant Melissa M. Short, United States Navy

Major Cheow Guan Soh, Singapore Armed Forces

Major Suan Jow Tan, Republic of Singapore Navy

Major Chee Meng Yeong Republic of Singapore Air Force

The process of matching the right Sailor to the right job at the right time is known as distribution and assignment. This process is essential to achieving adequate levels of Fleet readiness, utilizing expensive and perishable skills, and developing and sustaining Sailors' careers. Three key participants are involved in every assignment decision: the Sailor to be assigned, the command where the Sailor will be assigned (e.g., ship, squadron, shore activity), and the detailer, a matchmaker who works for the Navy Personnel Command. While considerable dialogue and negotiation often takes place between a Sailor and his detailer, and to a lesser extent between the command and the detailer, the primary decision-maker in this process is the detailer.

Under the current detailing process, detailers typically offer Sailors several job opportunities that satisfy Navy needs, but may or may not fulfill the Sailors' personal and professional goals. In many cases, detailers must order Sailors into jobs that they do not want and often to jobs they are not qualified to fill. The commands, on the other hand, have virtually zero contact with prospective job applicants, and commands are often dissatisfied with sailors assigned to fill billets. The result is sub-optimal matches: inappropriately trained sailors and unfilled or gapped billets compromise Navy performance; assigning Sailors to unwanted jobs reduces morale and retention and ultimately exacerbates labor supply shortages. The decision process needs to be more responsive to the two stakeholders that stand to benefit (or suffer) the most from the assignment decision: the Sailor and the command.

With funding from the Office of Naval Research (ONR), PERS-1, also called Naval Personnel Research, Science and Technology (NPRST), is sponsoring research at NPS and elsewhere to redesign the Navys enlisted distribution manage-

ment system. The NPS research effort involves two research thrusts: designing a Web-based virtual marketplace to replace the existing labor intensive detailing process, and developing an assignment algorithm to match enlisted Sailors with Navy jobs (Gates and Nissen, 2001). The virtual Web-based marketplace, referred to as the Personnel Mall, will exploit existing intelligent mall concepts, in which intelligent software agents serve as information brokers between buyers (naval commands) and sellers (Sailors). Software agents representing the Sailors will interact with software agents representing the naval commands, through broker agents, to determine the job assignments that match the Sailors' preferences and the Navy's needs as closely as possible.

To support the Personnel Mall, the broker agents need to embody a market clearing algorithm that pairs Sailors and billets. In commercial markets, supply and demand are reflected in a price mechanism. Matching Sailors to jobs to clear Navy personnel markets is more

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**The results obtained so far indicate that the Web-based detailing process explored here can improve both efficiency and effectiveness.**

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complex. Drawing on game theory and related economic theory, this research is exploring alternative assignment algorithms to establish stable matches that balance the Sailors' preferences and the Navy's needs. One potential matching algorithm involves two-sided matching markets, similar to those currently used to assign graduating medical students to residency programs. In this centralized matching process, applicants and residency programs evaluate each other based on variety of attributes. Applicants may consider location or work conditions; residency programs may consider GPA or interview performance. Applicants and residency programs submit rank ordered preference lists to the central matching program, which then places applicants into residency positions based on the indicated preferences. This matching

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# STUDENT RESEARCH

## WEB-BASED MARKETS FOR IMPROVING PERSONNEL DETAILING, *continued from page 18*

process has been in place since 1951, though it has evolved modestly over time.

To support this research, six Master's theses involving eight students from the Graduate School of Business and Public Policy have been completed to date. These theses have provided background information, analyzed the applicability of two-sided matching markets for assigning enlisted sailors to vacant billets, and tested expected performance for these algorithms, using both simulation models and preliminary economics experiments. The results from these theses may have substantial impacts on the policies and procedures the Navy uses to detail its enlisted sailors in the twenty-first century.

### The Current Navy Detailing Process

There is little debate that both Sailors and naval commands are dissatisfied with the current detailing process. However, it is important to understand the specific nature of this dissatisfaction. Without this information, research might neglect significant process shortcomings, or attempt to fix processes that are not considered broken. Two student theses provided the required background information. **LT Melissa M. Short, USN** (December 2000) reviewed the detailing current process, including the stakeholders, process flows, efficiency and effectiveness; **LCDR Richard J. Schlegel, USN** (December 2000) estimated the resources required to detail enlisted sailors under the current process.

At one level, the current detailing process works: every sailor is assigned to a job, higher priority jobs generally are filled before lower priority jobs, and the labor shortages inherent in the Navys current personnel limits are spread evenly across the major personnel end-users. However, effectiveness and efficiency are questionable. Effectiveness refers to the detailing process' cost and timeliness. Processes are more effective if they are less costly and/or more timely. Activity-based costing analysis indicates that the current enlisted detailing costs may exceed \$100 - \$200 per sailor detailed (Schlegel, December 2000). Efficiency refers to having appropriately trained personnel in key jobs at the time required. There are two sides to efficiency: supply and demand efficiency. Supply efficiency refers to assigning Sailors to the jobs best suited to their preferences; demand efficiency implies that the commands receive properly trained Sailors when needed. The ideal situation would perfectly match the Sailors' desires to the commands' needs; compromises must be made when it is impossible to obtain the ideal

situation.

To better understand the compromises inherent in the current detailing process, it helps to analyze the perceptions held by the three major stakeholders, the Sailors, the commands and the detailers (Short, Dec. 2000). In general, Sailors view the detailing process with skepticism. Some Sailors believe that detailers withhold information about assignments, or provide misleading information to coerce Sailors into undesirable billets. They want honesty and respect. Sailors understand Navy requirements and are willing to sacrifice. However, Sailors still expect detailers to consider their individual preferences.

Commands prefer properly trained Sailors at the right time to maximize fleet readiness and optimize mission accomplishment. If Sailors are not properly trained prior to arriving, activities must provide on-the-job-training or spend precious funds to provide training, adversely affecting readiness until the Sailor is properly trained. Furthermore, gapped billets negatively affect fleet readiness and operational effectiveness. Commands do not feel they have a strong voice in the detailing process.

Finally, detailing is currently a labor-intensive process in which human detailers subjectively balance Navy needs and the Sailors' preferences. Changing billet priorities and overlapping and sometimes contradictory policies complicate the process. Furthermore, the information systems detailers use are not always complete and accurate, making it impossible to make the optimal assignments.

This background indicates that a web-based detailing process, assigning sailors to billets using a two-sided matching algorithm, could improve system effectiveness and efficiency. A two-sided matching process could better balance sailors preferences and Navy needs, and increase these stakeholders voice in the process. Additional thesis research analyzed whether the two-sided matching process is applicable to Navy enlisted detailing and assessed its potential to improve the current process.

### Two-Sided Matching Markets

**Captain Paul Robards**, Australian Regular Army (March 2001) examined the characteristics of two-sided matching markets and the similarities between the National Resident Matching Program (NRMP) and the Navy's enlisted Sailor assignment process. Two critical and related characteristics of the matching process include voluntary participation and

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# STUDENT RESEARCH

## WEB-BASED MARKETS FOR IMPROVING PERSONNEL DETAILING, *continued from page 19*

stable matches. To dissuade participants on both sides of the market from circumventing the matching process, Sailors and commands must willingly participate without coercion. In other words, Sailors cannot be forced to accept undesirable billets and commands cannot be forced to accept undesirable Sailors. If either party is placed in an undesirable match, they have an incentive to arrange a match outside the matching process, causing the process to breakdown. In the NRMP, over 90 percent of residents and residency programs voluntarily participate; most of the matches made outside the NRMP involve special circumstances, such as dual career couples requiring collocated assignments.

Voluntary participation requires a stable outcome: stability implies that both the Sailor and command consider the centrally determined match to be at least as desirable as matches that could be arranged outside the two-sided matching process. A match is unstable if a Sailor and command both prefer one another to the respective command and Sailor with which they are centrally matched; the Sailor and command would both prefer to form their own agreement (e.g., the commanding officer might call the detailer to request the sailor). Stable equilibrium can emphasize the Sailor's preferences, the commands' preferences, or potentially provide an intermediate solution.

Despite many similarities between the NRMP and the Navy's detailing problem, there are important differences. In the NRMP, some candidates are unmatched; residency positions are not prioritized; and the matching process occurs annually, with candidates only participating once. In contrast, the Navy must assign all Sailors to billets; because there are more spaces than faces, the Navy must fill higher priority billets before lower priority billets; and the Navy's enlisted detailing process is conducted bi-weekly, so Sailors and billets could potentially participate in ten or twelve successive detailing exercises before being matched. These differences suggest several modifications to both the Navy's enlisted detailing process and the two-sided matching algorithm. Suggestions include: changing the frequency of assignments (currently bi-weekly); allowing variable assignment durations; expanding the Sailors' and commands' preference lists; matching higher priority billets before lower priority billets (lexicographic ordering); and providing monetary or non-monetary incentives to Sailors filling undesirable billets, where incentives can be set in advance or adjusted as needed established through an auctioning or other market-based process.

### Empirical Testing: Economic Experiments and Simulation Models

The effectiveness and efficiency of two-sided matching and potential modifications to the algorithm are largely empirical questions. Two student theses focused on these empirical questions. **Major Suan Jow Tan**, Republic of Singapore Navy and **Major Che Meng Yeong**, Republic of Singapore Air Force (March 2001) conducted economic experiments to compare the detailing outcomes expected from human detailers and a two-sided matching process; **Major Hock Sing Ng**, Singapore Armed Forces and **Major Cheow Guan Soh**, Singapore Armed Forces (March 2001) developed a simulation model to analyze how modifications to two-sided matching algorithm affected system performance.

Both theses began by constructing random lists of enlisted Sailors and billets. Sailors were described by their pay grade, training, past performance evaluations and current location. Billets were described by the desired pay grade and training, location, promotion potential and, in the simulation model, sea/shore designation. Distributions for these characteristics were specified to mimic the enlisted population and billet structure as closely as possible. Sailors' preferences over billets depended on the billet's characteristics; commands' preferences over Sailors depended on the Sailor's characteristics. In the experiments, participants were asked to match the Sailors' and billets' pay grades to the maximum extent possible; the simulation model required assignments to match pay grades. Experimental tractability required simplifying the experimental design relative to the simulation model.

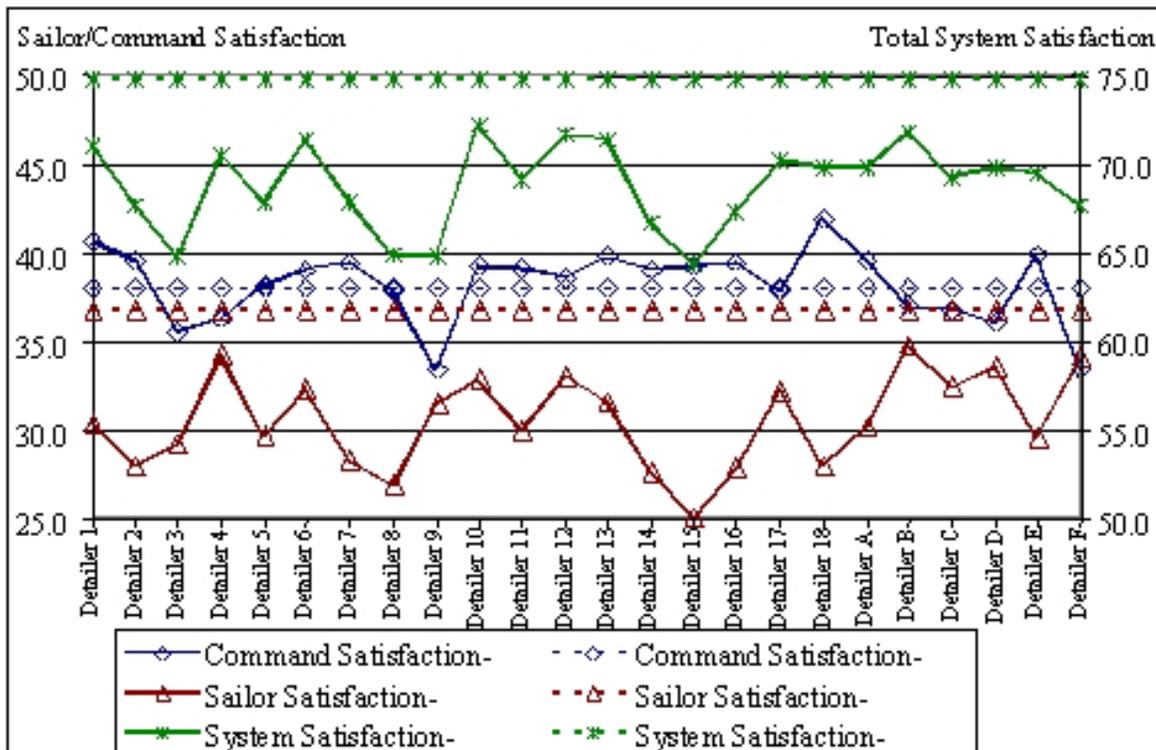
The experimental design involved up to four trials. In the trial discussed here, participants were asked to assign ten Sailors to twelve jobs, leaving two jobs vacant (reflecting the Navy's current personnel shortages). The participants received information about all ten Sailors and twelve billets at the same time. Other experimental runs involved detailing ten sailors to twelve jobs on a first-come-first-served basis, and detailing five Sailors to eight billets both as one batch and on a first-come-first-served basis. The experiments were initially conducted using 18 students from the Naval Postgraduate School (Detailers 1-18) and six practitioners involved with enlisted detailing in Millington, Tennessee (Detailers A-F). Because there was little statistically significant difference between the results for these two groups, the two groups will be treated as a single pool of participants.

Figure 1 compares Sailor and command satisfaction gener-

*--continued on page 21*

# STUDENT RESEARCH

## WEB-BASED MARKETS FOR IMPROVING PERSONNEL DETAILING, *continued from page 20*



**Figure 1. Comparison of Sailor and Command Satisfaction.**

ated by both the human detailers and the matching algorithm with ten Sailors filling twelve jobs in a single batch. The experimental results highlight several points. First, there is significant variation in Sailor and command satisfaction across human participants (left axis). This implies arbitrariness in the enlisted assignment process. On further inspection, some human participants did better by the Sailors as a group than others, but none did as well as the matching algorithm.

Though not pictured here, there is even greater variability across individual Sailors; individual Sailors fared better with some human participants than others, and some fared better with human participants than with the matching algorithm. There is similar variability on the command side. However, the human participants frequently obtained higher command satisfaction than the matching algorithm. This indicates that human participants have a strong predisposition favoring Navy needs over Sailor preferences.

Total satisfaction (right axis) indicates that the matching algorithm generated higher total satisfaction than the human participants, in all instances. Again, human performance is quite variable. Some human participants traded off Sailor and command satisfaction reasonably efficiently; others seem to have sacrificed Sailor satisfaction without generating

offsetting gains in command satisfaction. This represents inefficient performance.

Other experimental results, not pictured here, indicate that human performance is closer to the matching process results in the less complex five Sailor-eight billet trials than in the ten Sailor-twelve billet trials. Similarly, performance does not systematically improve when Sailors arrive in batches as opposed to first-come-first-served. In fact, system satisfaction is higher in the batch trials only slightly more often than in the first-come-first-served trials. This is particularly surprising because human participants have the option of duplicating the first-come-first-served assignments in the batch process trials (both trials involve the same sailors and billets, and the first-come-first-served trial was conducted right before the corresponding batch trial). These results indicate that human participants may be quickly overwhelmed by the complexity of the detailing process. This becomes more problematic considering the number of Sailors and billets involved in a typical assignment cycle; it is further compounded by the plethora of relevant personnel and billet attributes and the multiplicity of frequently overlapping and conflicting assignment process policies and procedures.

*--continued on page 24*

# STUDENT RESEARCH

## THE LEADERSHIP SUMMIT: DEVELOPING OUTSTANDING NAVAL LEADERSHIP FOR THE NEW MILLENIUM

LCDR David Nystrom, United States Navy  
Center for Executive Education

In January 2000, the Honorable Mr. Hultin, Under Secretary of the Navy, convened 19 mid-grade officers for a course at the Center for Executive Education at the Naval Postgraduate School (NPS) in Monterey, California. The course was called "30 Something." He tasked the group with envisioning their Navy/Marine Corps in the year 2020 (see *Proceedings*, September 2000). Over the course of 30 days, the group developed many ideas, but all focused around their core vision of a Navy/Marine Corps that could, "attract and retain great people." A central part of this theme was leadership. As a participant in the course, and a student at the Naval Postgraduate School at the time, I chose to do my thesis on one of our group's recommendations - 360-Degree Feedback (performance feedback from supervisor, peers, and direct reports). The thesis is, of course, an in-depth look at the use of 360-Degree Feedback for leadership development and performance appraisal in the Navy, but it also presents a different way to view and lead change. 360-Degree Feedback has efficacy for developmental and performance appraisal purposes, but by itself represents just one facet on the multi-faceted stone of leadership development in the Navy. Hence, what is required is a new, holistic change approach that engages the entire system of leadership development at once. Further, instead of gathering data about when leadership fails in the Navy, what would happen if we studied examples of leadership excellence? Instead of analyzing why things go wrong, is it possible to leverage positive change by analyzing root cause success? I believe the answer is yes and so do a lot of other people in the Navy that I have talked with. In fact, so does the Chief of Naval Operations, Admiral Clark, whom I had the opportunity to brief last October. Admiral Clark has since championed the idea as a CNO sponsored pilot project called the Leadership Summit tentatively scheduled for summer 2001.

The Leadership Summit will use a new change methodology called a Large Group Intervention (LGI). LGIs are designed for large-scale change. Although there are varying forms of LGIs, all have six assumptions in common:

- Organizations are seen as "whole systems."
- Viewing organizations as whole systems requires the

creation of dialogue among all organizational stakeholders.

- Organizations do not exist but organizing processes and procedures do.
- What we perceive as our collective organizational reality becomes the organization that is created.
- Individuals within organizations have the capacity to self-organize and redefine their reality.
- Humanity shares a set of universal values that are inherently "good" and these values will ultimately influence voluntary collective action.

Since high quality leadership is such a fundamental component of everything the Navy does, addressing the challenges of

leading in the 21st Century Navy is the right place to start. The Leadership Summit will bring together a mini-microcosm of our Navy in order to assemble a whole system representation in the room, vertical and horizontal cross-sections of the

Navy with key stakeholder leadership. This allows for ideas and initiatives to be fully discussed and to take hold because all of the stakeholders are present. LGIs are designed for rapid change in rapidly changing times.

The summit will use Appreciative Inquiry as its framework. Appreciative Inquiry is a positive change methodology that keeps people focused around a clear vision of the future, which serves as common ground. Participants are not there to conduct problem solving or conflict management. Task is clear, and focus is on the future, although keeping historical and global perspectives in mind. Self-management and dialogue facilitates a broad feeling of empowerment, "something is different this time."

The summit will provide an environment that redefines the way we traditionally approach change by focusing on the visible and tacit strengths of our Navy, and then leveraging that positive core to reshape the future. The Appreciative Inquiry Summit model is an intense exploration of when an organization is at its best. In our case, when Naval leadership is at its best. One of the unexpected consequences of the 30 Something course was the thrill of being asked by senior leadership to make a difference. Using Appreciative Inquiry, the summit captures this experience and brings it to the Fleet.

**...what is required is a new, holistic change approach that engages the entire system of leadership development at once.**

# STUDENT RESEARCH

## STUDENTS FELLOWSHIPS AWARDED BY THE SPACE AND NAVAL WARFARE SYSTEMS CENTER-SAN DIEGO

The Space and Naval Warfare Systems Center-San Diego (SSC-SD) sponsors a Research Fellowship Program at the Naval Postgraduate School (NPS). The program was instituted to promote NPS partnership with SSC-SD, address SSC-SD's research focus areas, lay the groundwork for future technical and project management assignments, and foster long-term professional associations with SSC-SD's technical personnel and management. There are two rounds of awards each year, one in early spring, the other in the fall. NPS students submit proposals that are reviewed by the technical staff of SSC-SD and approved by the SSC-SD Commander, CAPT Ernest Valdes.

The latest awards were just announced. These students join the previous 38 receiving fellowship awards. The fellowship includes a \$10,000 award to support the student's thesis research. The most recent recipients are LCDR David Bermingham, USN, LT Frank Dugie, USN, LT Darin Evenson, USN, LCDR Mark Glover, USN, LT Tobias Lemerande, USN, LCDR Scott Margulis, USN, and LT Kevin Smith, USN.

LCDR Bermingham is working with Professor Tri Ha of the Department of Electrical and Computer Engineering, on the "Performance Analysis and Evaluation of Architectures Using Asynchronous Transfer Mode Protocols for Communication of TCP/IP Based Voice, Video and Data over Long Delay Wireless Links." LCDR Bermingham is pursuing a Master of Science in Engineering Science.

Pursuing both a Master of Science in Electrical Engineering and an Electrical Engineers Degree, LT Dugie is working with

Assistant Professor Todd Weatherford of the Department of Electrical and Computer Engineering on "Modeling and Experimental Testing of Radiation Effects in the SPAWAR Systems Center Silicon on Insulator Process."

LT Evenson is working with Professor Carl Jones of the Information Systems Academic Group and Charles Racoosin, the Space Systems Academic Chair Professor, on "Special Warfare in a Network Centric Environment Using the Mobile Exploration System." LT Evenson is pursuing a dual degree, Mater of Science in Space Systems Operations and Master of Science in Information Technology Management.

LCDR Glover, working with Associate Professor Cynthia Irvine of the Department of Computer Science, is pursuing the Master of Science in Computer Science. His research topic is "Integrating a Trusted Computing Base Extension Server and Secure Session Server into the Linux Operating System."

LT Lemerande is working with Research Professor Tom Muir of the Department of Physics on "High Frequency Components in Dolphin Echolocation Signals." LT Lemerande's studies will lead to a Master of Science in Applied Physics.

Working with Associate Professor Geoffrey Xie of the Department of Computer Science, LCDR Margulis is also pursuing the Maaster of Science in Computer Science. LCDR Margulis research topic is "MAGMA: A Liquid Software Approach to Fault-Tolerant and Survivable Networking."

LT Smith is also working with Professor Irvine on "A Method for the Development of Security Requirements within an Advanced Computing System." LT Smith's studies will lead to a Master of Science in Computer Science.

## ENVIRONMENTAL IMPACT ON MINE HUNTING IN THE YELLOW SEA USING THE CASS/GRAB MODEL

LT Carlos J. Cintron, United States Navy  
Master of Science in Physical Oceanography – March 2001  
Advisors: Associate Professor Peter C. Chu, Department of Oceanography, and Steve D. Haeger, Naval Oceanographic Office

The purpose of this work is to determine the necessity of a near real-time ocean modeling capability such as the Naval Oceanographic Office's (NAVOCEANO) Modular Ocean Data Assimilation System (MODAS) model in shallow water (such as the Yellow Sea) mine hunting applications using the Navy's Comprehensive Acoustic Simulation System/Gaussian Ray Bundle (CASS/GRAB) model. Sound speed profiles inputted into the CASS/GRAB were

calculated from observations (MOODS) and climatological (GDEM) data sets for different seasons and regions of four different bottom types (sand, gravel, mud and rock). The CASS/GRAB model outputs were compared to the outputs from corresponding MODAS data sets. The results of the comparisons demonstrated in many cases a significant acoustic difference between the alternate profiles. These results demonstrated that there is a need for a predictive modeling capability such as MODAS to address the mine warfare (MIW) needs in the Yellow Sea region. There were some weaknesses detected in the profiles the MODAS model produces in the Yellow Sea, which must be resolved before it can reliably address the MIW needs in that region. (LT Cintron won the Surface Navy Association's Award for Excellence in Surface Warfare Research. This award is presented quarterly to a graduating student from any curriculum whose thesis topic and quality of supporting research demonstrate the greatest potential for contribution to the Surface Navy.)

# STUDENT RESEARCH

## WEB-BASED MARKETS FOR IMPROVING PERSONNEL DETAILING, *continued from page 21*

As described above, Major Ng and Major Soh (March 2001) developed a computerized simulation model to test two-sided matching process performance under various Navy-specific scenarios. The model operator can specify the number of Sailors, number of high and low priority billets, and the maximum number of billets (Sailors) that Sailors (commands) can include on their preference lists. The simulation model was used to examine the impact of varying the assignment interval (i.e., increasing batch size) and lengthening preference lists.

The simulation results indicate that making assignments less frequently increases the satisfaction that Sailors and commands obtain from the match. However, capturing this benefit requires that Sailors and commands submit longer preference lists as the batch size increases. Increasing batch size without increasing preference lists fails to capture the benefits of the larger batch size if the added flexibility is not reflected in the preference lists. Submitting longer preference lists increases information requirements; Sailors must rank more billets and commands must consider more Sailors (though Sailors would likely be ranked for commands using a decision support system incorporating value focused thinking).

The simulation results also indicate that specifying more preferences, for a given assignment interval or batch size, increases the percentage of Sailors and billets matched. However, increasing the preference lists has minimal impact after a point, unless the batch size is also increased. As expected, the effective preference list length depends on the assignment interval. As the batch size increases, preference lists must be longer before exhausting the impact on the percentage of Sailors matched.

### Conclusions

The results obtained so far indicate that the Web-based detailing process explored here can improve both efficiency and effectiveness. A two-sided matching algorithm can make more efficient matches because it methodically assimilates a extensive range of attributes and preferences when assigning Sailors to billets. The complexity of this process clearly taxes human capabilities. A two-sided matching algorithm also systematically considers Sailors' preferences and the Navy's needs, with the flexibility to emphasize one or the other in the final match, or to select an intermediate solution. The resulting assignments are stable and free from personal bias.

### References

- Gates, William R. and Mark E. Nissen, "Designing Agent-Based Electronic Employment Markets," *Electronic Commerce Research Journal*. Special Issue on Theory and Application of Electronic Market Design, forthcoming 2001.
- Ng, Hock Sing, Major, Singapore Armed Forces and Major Cheow Guan Soh, Singapore Armed Forces, *Agent-Based Simulation System: A Demonstration of the Advantages of an Electronic Employment Market in a Large Military Organization*, Naval Postgraduate School, Masters Thesis, March 2001.
- Robards, Paul A., Captain, Australian Regular Army, *Applying Two-Sided Matching Processes to the United States Navy Enlisted Assignment Process*, Naval Postgraduate School, Masters Thesis, March 2001.
- Schlegel, Richard J., LCDR, USN, *An Activity Based Costing Analysis of the Navy's Enlisted Detailing Process*, Naval Postgraduate School, Masters Thesis, December 2000.
- Short, Melissa M., LT, USN, *Analysis of the Current Navy Enlisted Detailing Process*, Naval Postgraduate School, Masters Thesis, December 2000.
- Tan, Suan Jow, Major, Republic of Singapore Navy and Major Che Meng Yeong, Republic of Singapore Air Force, *Designing Economics Experiments to Demonstrate the Advantages of an Electronic Employment Market in a Large Military Organization*, Naval Postgraduate School, Masters Thesis, March 2001.

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## INFLUENCE NET MODELING: THE NARCOTICS NETWORK IN COLOMBIA

LT Joshua C. Himes, United States Navy

Master of Science in Systems Technology – June 2001

MAJ Mark W. Garrett, United States Army

Master of Science in Information Systems and Operations – March 2001

Thesis Advisors: LT Raymond R. Buettner, USN, Information Warfare Academic Group, and Visiting Professor Jeanne K. Giraldo, Department of National Security Affairs

The purpose of this thesis is to conduct the research necessary to develop a situational influence assessment model to identify critical indicators that will assist the USSOUTHCOM in identifying potential key centers of gravity in the fight against illicit drug production and

*--continued on page 25*

# STUDENT RESEARCH

## THE EFFECT OF GRADUATE EDUCATION ON THE RETENTION AND PROMOTION OF MARINE CORPS OFFICERS

Major Gregory A. Branigan, United States Marine Corps

Master of Science in Management – March 2001

Advisors: Professor Stephen Mehay and Research Associate Professor Julie Filizetti, School of Business and Public Policy

This thesis analyzes the factors associated with retention to the 0-5 promotion point and selection for promotion to 0-5. In particular, this thesis focuses on the economic returns to graduate education and specifically Naval Postgraduate School (NPS) education. In theory, the payoff to the Marine Corps is the increased productivity of the officer with a graduate degree. This thesis analyzes the differences in retention and promotion rates between officers with and without graduate degrees. Data from the FY1998 through FY2001 lieutenant colonel promotion boards and data for the corresponding accession cohorts, who entered the Marine Corps between FY1980 and FY1984, are merged with Automated Fitness Report System (AFRS) data. Non-parametric analysis and simple Probit techniques are used to estimate retention and promotion models. The results suggest that, in addition to other factors, graduate degrees from NPS and from sources other than NPS both have a positive effect on the retention and promotion of Marine Corps officers. Several statistical techniques are applied to correct for potential biases due to self-selection and sample selection. However, results from these techniques prove sensitive to slight changes in model specification and, therefore, are not conclusive.

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## INFLUENCE NET MODELING, *continued from page 24*

narcotrafficking in Colombia. Efforts to combat the narcotics network directly support the USSOUTHCOM mission and are integral to U.S. National Security. Unlike the traditional military threats of the Cold War and previous decades, to include Operation Desert Storm, this problem set is far more complex and complicated with roots and foundations that date back to the development of Colombia as a nation-state. It is the strategic dilemma that is posed by this asymmetric threat that reflects the type of problems that will be encountered by the military of the 21st century. Unlike the traditional land/sea/air combined warfare that the U.S. dominates globally, the threats of the 21st century will look much like Colombia – small, packetized, networked organizations with the ability to operate and inflict casualties below the threshold of our traditional military mechanisms. Improved decision support systems to model this type of problem are needed. This thesis suggests a number of modifications to an existing model, SIAM, in order to enhance its usefulness both for decision makers and intelligence collectors. (LT Himes is the recipient of the Inman Award for Excellent Student Research in Intelligence.)

## ANALYSIS OF PORT CONGESTION UPON SEALIFT OPERATIONS USING SIMULATION

Captain Peter Mahoney, USMC (M.S. in Management, December 2000) briefed his thesis to VADM G. Holder, Commander of the Military Sealift Command (MSC) on March 5, 2001 at MSC Headquarters in Washington, D.C. He applied modeling and simulation to analyze closure times and the impact of port congestion on time-critical sealift operations. His thesis was developed as part of Associate Professor Keebom Kang's (School of Business and Public Policy) research project sponsored by the Military Sealift Command. Captain Mahoney received the Systems Management outstanding thesis award in December 2000.

Strategic sealift plays a vital role in the U.S. Navy's concept of battlespace sustainment and projecting maritime power. Factors such as port congestion, however, can constrain the ability of sealift system assets to provide sustainment support when and where needed to meet mission objectives. Capt Mahoney's thesis describes the design and employment of a modeling and simulation framework, the Materiel Transport and Resource Allocation Decision-support System (MTRADS), to assess the potential impact of port congestion on time-critical sealift system operations. He employed MTRADS to provide advance planning information regarding the expected effects of congestion, alternate force structures, and resource allocation decisions at the port of Pusan, Republic of Korea (ROK), on the ability of the Korean Flag Shipping (KFS) Program to execute an actual TPFDD-based sealift deployment plan generated by the Military Sealift Command (MSC). The analysis, experimentation, and conclusions indicate certain sealift system or port assets can impose significant constraints on the KFS Programs ability to meet specific closure time objectives. It was recommended that MSC build upon the foundation MTRADS provides to further explore the potential effects of congestion-specific and other port access and denial issues affecting strategic sealift operations.

# PROJECT NOTES

## NPS PROFESSOR SUPPORTS NAVY SHIPBOARD POWER INITIATIVES

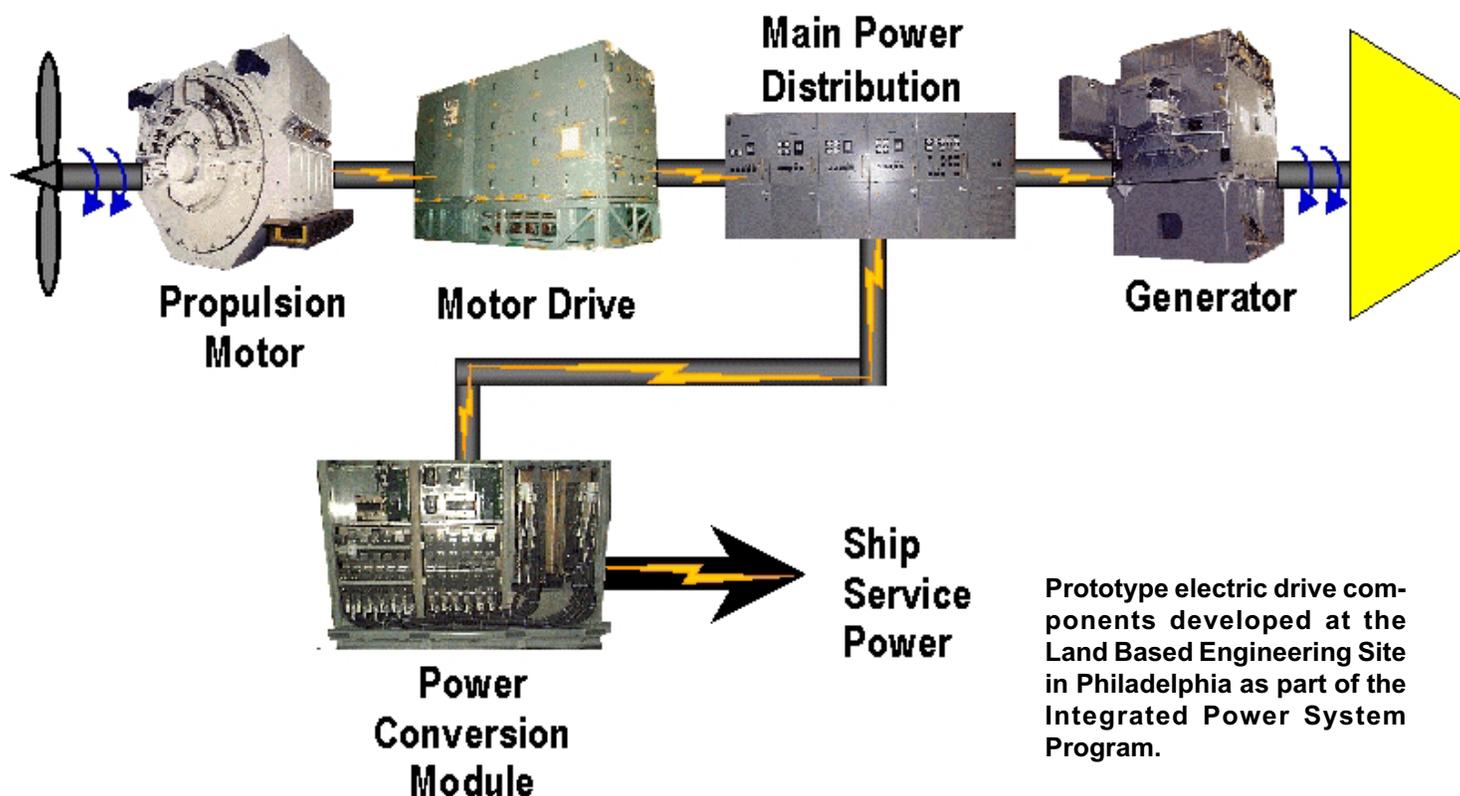
It was announced in January 2000 that the new land-attack destroyer, DD-21, would contain an electric drive. This bold initiative has been compared with the transition from sail to steam and capitalizes on more than 20 years of power electronic drive experience in the commercial marine industry. The term "electric drive" refers to the fact that the ship will be propelled through the water by a direct-drive variable-speed motor. To be more accurate, DD-21 is planned to employ an Integrated Power System (IPS), where both ship service and ship propulsion power are derived from a common set of prime movers (gas, steam or diesel). The prime movers drive large synchronous generators and the resultant AC power is directed both to the electric drive and to shipboard distribution. The advantages of electric drive and IPS are manifold including: a reduction in the number of prime movers, optimization of fuel efficiency, a mechanical decoupling of the prime mover and the shaft, cross-connect capability, enhanced ability to reconfigure engineering spaces, and a pool of electric power that can be used for multi-megawatt pulsed-power loads and directed energy weapons.

Advanced distribution schemes are also being considered for DD-21 and future surface combatants, including a DC Zonal

Electric Distribution System (DC ZEDS). In DC ZEDS, the AC power is rectified and distributed along a port and starboard bus. The ship is sectioned into electrical zones delineated by watertight compartments. An electrical zone is supplied power from each bus through a power conversion module. Through diode-auctioneering the port and starboard bus converters, near-instantaneous transfer of power from primary to secondary source is achieved. Thus, power continuity is significantly enhanced and the platform is more survivable. The inter-zonal DC power is then converted to other levels of DC, high-fidelity fixed-frequency AC, or variable-frequency AC as required by the shipboard electrical loads. DC ZEDS is predicated on the design and development of a whole class of power conversion modules that satisfy the surface combatant requirements on ruggedness, shock, EMI and reliability.

The U.S. Navy has several program offices supporting the evolution of the technology required for IPS and DC ZEDS including the IPS Program and the Integrated Fight Through Power (IFTP) Program. Working together with industrial vendors, the IPS program has developed a Land Based

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Prototype electric drive components developed at the Land Based Engineering Site in Philadelphia as part of the Integrated Power System Program.

# PROJECT NOTES

## A STOCHASTIC PROGRAM FOR OPTIMIZING MILITARY SEALIFT SUBJECT TO ATTACK

**Professor Kevin Wood** and **Research Assistant Professor Javier Salmeron**, Department of Operations Research, and **Professor David Morton**, University of Texas Austin, have collaborated on applying stochastic programming to planning the wartime, sealift deployment of military cargo. The cargo moves on ships from U.S.-controlled seaports of embarkation through in-theater seaports of debarkation (SPODs) where it is unloaded and sent on to final destinations. The question asked is: Can a deployment-planning model successfully hedge against enemy attacks on the SPODs

at uncertain times and/or locations? A specialized, multi-stage stochastic program has been developed and answers that question in the affirmative.

For one hypothetical Middle-East deployment with potential biological attacks, the stochastic solution achieves a 35% reduction in expected cargo lateness, measured in weighted ton-days, compared to the expected cost of a simulated manual solution. Furthermore, the stochastic solution incurs little "penalty" when no attack occurs. An iterative heuristic based on the stochastic model achieves similar improvements but much more quickly.

## NPS PROFESSOR SUPPORTS NAVY SHIPBOARD POWER INITIATIVES, *continued from page 26*

Engineering Site (LBES) in Philadelphia, PA which demonstrates both prototype electric drive components and prototype DC ZEDS power converters. **Associate Professor Robert Ashton**, Department of Electrical and Computer Engineering, has been actively engaged as a technical advisor for the Navy, working with various vendors on diagnosing problems with current LBES technology and developing the next-generation equipment for the facility. His efforts have involved multiple site visits to the following companies: SatCon of Cambridge, MA, Eaton of Milwaukee, WI, General Atomics of San Diego, CA, Rockwell Automation of Milwaukee, WI, SAIC of Washington DC, and Alstom of Rugby, England. Each of these companies is responsible for different and/or competing components of the system demonstrator. As part of the IFTP, Professor Ashton was selected to be the technical representative for Code 81 of the Naval Surface Warfare Center (NSWC) at the Integrated Working Group (IWG) meetings. The purpose of these meetings (every couple months) is to assess proposed designs, evaluate technical progress, establish interface and stability requirements for interconnected components, and provide direction where necessary.

Dr. Ashton has been working closely with the manufacturer of the 19MW 15-phase induction machine drive, Alstom, at diagnosing recent failure modes in the IGBT-based H-bridge inverter. The resulting analysis of the damaged unit is being used by Alstom to implement hardware and software fixes.

Being the largest of its kind (by a factor of 3), this power electronic inverter provides invaluable information to the Navy regarding fabrication and operation issues. The technology and architecture of the selected DD-21 electric drive will be announced later this summer when the winner of the Blue and Gold competition is determined.

The design and demonstration of various power electronic converters and motor controllers is pivotal to the application of these devices shipboard. The Navy has contracted with a number of vendors to demonstrate required topologies and control strategies. Unfortunately, unplanned delays and units that malfunctioned upon delivery have caused the Navy to reassess how to best supervise these initiatives. Recently, Professor Ashton suggested forming a team of seasoned engineers to visit vendor sites and work with the vendor teams at alleviating operational problems and minimizing delivery delays. The "team" is funded out of multiple interested programs and is working to maximize the government's investment in product development. Dr. Ashton's team has already achieved a success by helping an East Coast vendor with a long overdue converter.

The U.S. Navy is transitioning to IPS and perhaps DC ZEDS technology to exploit the many advantages highlighted above. Naval Postgraduate School faculty are integrally involved in designing, prototyping, validating, and supervising the evolution of this cutting-edge equipment and, in the process, creating opportunities for relevant and unique thesis projects.

# PROJECT NOTES

## AEROSOL CHARACTERIZATION EXPERIMENT (ACE)-ASIA FIELD EXPERIMENT

The Aerosol Characterization Experiments (ACE) were designed to increase our understanding of how atmospheric aerosol particles affect the Earth's climate system. The ACE-Asia field experiment (the third ACE experiment) took place during April off the coast of China. There the atmosphere contains aerosol particles of varying composition and sizes derived from both human activities and wind-blown dust. The main goal of the ACE-Asia intensive experiment was to survey the air leaving Eastern Asia to characterize aerosol physical, chemical, and optical properties and their variation with time and space, emphasizing variations with altitude and distance from the continent.

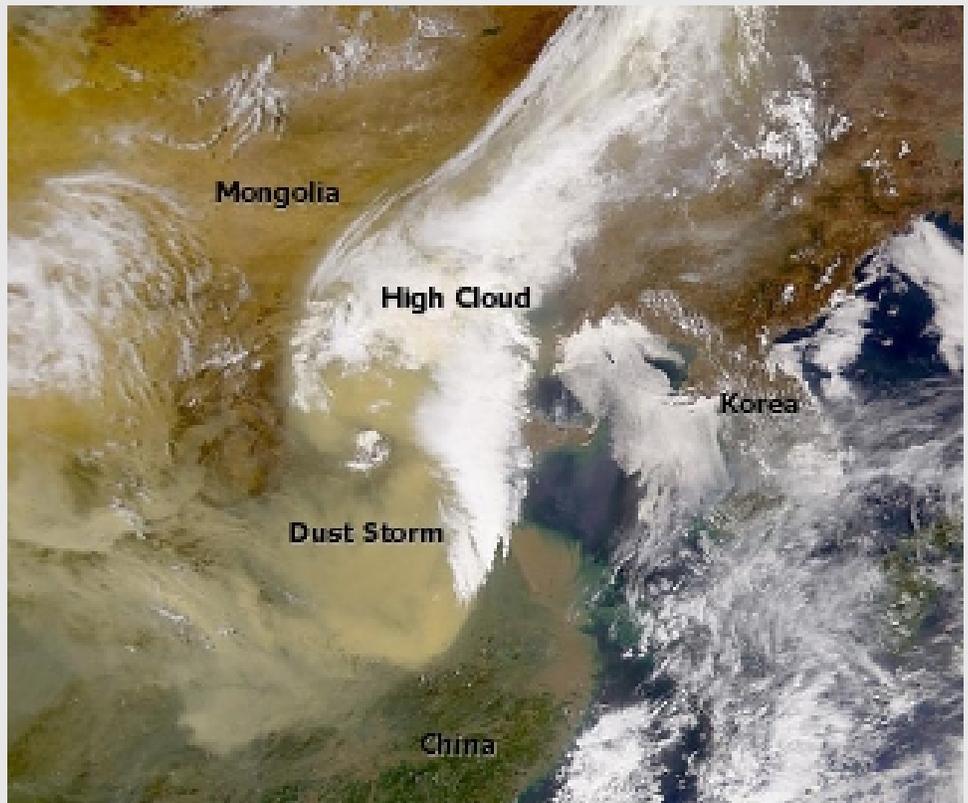
A multi-national team of scientists and resources participated in the ACE-Asia experiment. Among them was a group

from the Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS) at the NPS. This group brought the fully instrumented CIRPAS Twin Otter to Japan to provide in-situ measurements of various atmospheric properties. Aerosol size distributions were measured on the Twin Otter with an array of instruments, spanning the diameter range of 5 nm to 1000  $\mu\text{m}$ . Aerosol chemical composition was measured with 5-stage MOUDI cascade impactors and an aerosol mass spectrometer. Four nephelometers and a Particle Soot Absorption Photometer measured aerosol extinction and absorption at three different wavelengths and at controlled humidity. Size distribution and hygroscopicity of the sub-micron particles were measured with two sets of tandem differential mobility

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**Professor Phil Durkee and Research Associate Kurt Nielsen** of the Department of Meteorology also participated in ACE-Asia. Professor Durkee and Nielsen participated in previous ACE experiments in locations such as Tasmania and the Canary Islands. NPS collected satellite data from 8 satellites using the Remote Sensing Laboratory ground station that was transported and operated at MCAS Iwakuni. These data were critical to planning research aircraft and ship operations during the experiment. Preliminary results include observations of pollution aerosol from the industrial centers of eastern Asia and the dust storms that originate in China and are transported across the Pacific Ocean to North America and beyond. Analysis of satellite measurements collected by NPS will provide understanding of the regional-scale effects of these particles on climate. In addition, satellite analysis of the effects of aerosol particles on visibility will improve planning of DoD operations in the region.

Professor Durkee and Nielsen also traveled to the METOC center at Yokosuka, Japan to describe the early results and to communicate new analysis techniques to former students now stationed at the center.

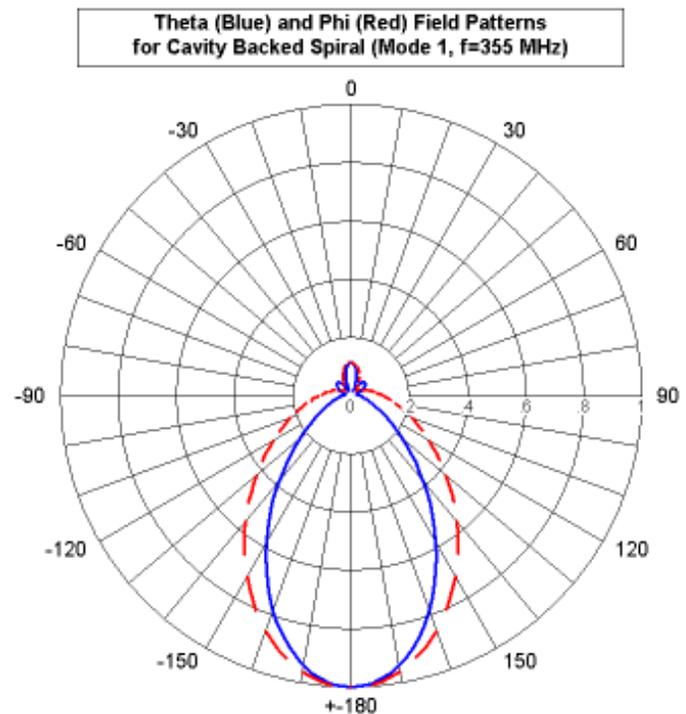
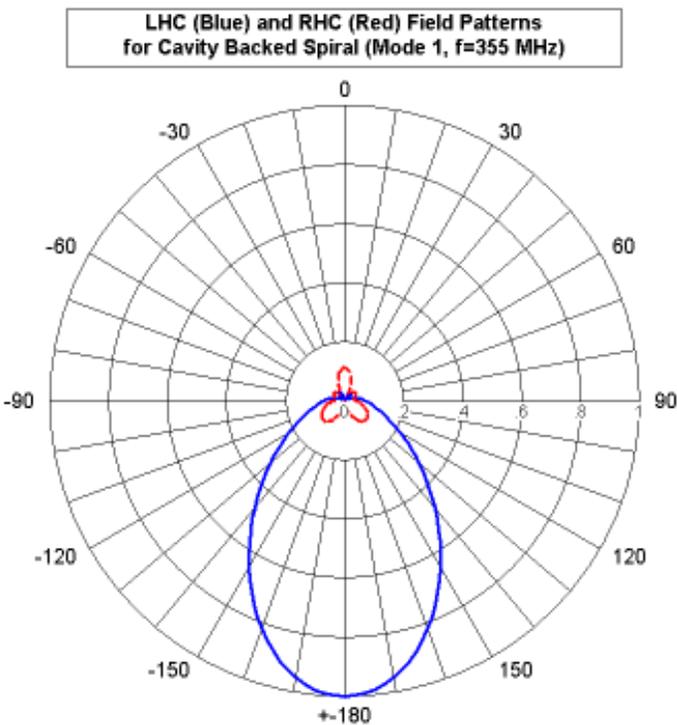


This SeaWiFS (Sea-viewing Wide Field-of-view Sensor) image shows the development of a large dust storm in China and its interaction with a meteorological system that carried the dust far out into the Pacific Ocean.

# PROJECT NOTES

## COMPUTING THE FAR FIELD PATTERNS AND OTHER CHARACTERISTICS OF ANTENNAS

GNEC (a product of Nittany Scientific, <http://www.nittany-scientific.com>) is a numerical electromagnetic code for computing the far field patterns and other characteristics of antennas. A graphical user interface permits easy display of antenna far field patterns but cannot currently display right and left-hand field patterns for circularly polarized antennas. **Professor Jeffrey B. Knorr**, Department of Electrical and Computer Engineering, and **Professor Beny Neta**, Department of Mathematics, developed a technique for computing and displaying right hand and left hand field patterns by



processing the GNEC output data normally used to plot the patterns for the theta and phi components of the field. This provides an important new capability for circularly polarized antennas such as spirals and helices which are commonly used in military applications requiring broad bandwidth. Professors Knorr and Neta are currently working with **Research Associate Professor Dick Adler**, Department of Electrical and Computer Engineering, and Nittany Scientific to implement this new capability in the next release of GNEC. The two figures illustrate the significant difference between the linearly and circularly polarized field patterns.

## AEROSOL CHARACTERIZATION EXPERIMENT, *continued from page 28*

analyzers (TDMA). A 14-wavelength sun-tracking photometer continuously measured the optical depth of the column of air between the aircraft and the top of the atmosphere, providing the essential data to evaluate the extent of column radiative closure achievable. High Resolution Spectral Radiometers measured the up- and down-welling radiative fluxes providing quantitative data on the role of aerosol particles in climate. The CIRPAS Twin Otter Team included **Research Assistant Professor Hafidi Jonsson**, CIRPAS Chief Scientist, Dr. John Seinfeld, California Institute of Technology, along with investigators

from the University of Washington, Texas A&M, and NASA Ames.

The Twin Otter flew 19 research flights out of the Marine Corps Air Station at Iwakuni, Japan. Many were coordinated with satellite overpasses, or with an overflight by NASA's DC-8, or with NOAA research ship *Ron Brown*, or with NCAR's C-130. These coordinated flights tied the CIRPAS measurements into the global climate monitoring schemes at the Jet Propulsion Laboratory and NOAA, and provided a base for intercomparison of similar measurements made from different platforms.

# RELATIONSHIPS

## UNITED STATES NAVAL ACADEMY TRIDENT SCHOLAR PROGRAM

Professor Joyce Shade

Deputy Director of Research and Scholarship

United States Naval Academy



The Naval Postgraduate School and the United States Naval Academy regularly get together to discuss research that is conducted by faculty and students in order to foster increased knowledge of each other's programs and collaboration. This collaboration should increase the awareness of naval officers to the continuum of education that is available to them and to a broader range of research that is directed at naval applications. We also hope to increase the research interaction between our faculties. To foster this increased collaboration and knowledge exchange the NPS Research Newsletter initiates in this issue a new USNA Research Page.



The United States Naval Academy instituted the Trident Scholar Program in 1963 to provide an opportunity for a limited number of exceptionally capable students to engage in independent study and research during their senior year. Under this program, midshipmen in the top 10 percent of their class at the end of the first semester of their junior year are invited to submit proposed research projects and programs of study for evaluation. Midshipmen selected to participate are afforded an unusually exciting educational experience, and there has been a gratifying response to the program. The number of scholars selected has ranged from a low of three to a high of sixteen. Nine scholars were in the Class of 2001 and fifteen scholars are in the newly appointed Class of 2002. Each Trident Scholar's academic program for the year is modified to substitute research courses and thesis for traditional courses within the major. Each scholar has one or more Naval Academy faculty advisors who are well acquainted with the field of study and who serve as research mentors to the scholar. Scholars may request to have scientists and area specialists from neighboring laboratories or universities serve as consultants for their research efforts, and in some cases, the scholars may travel to nearby facilities such as the Naval Research Laboratory (NRL) or the National Institute of Standards and Technology (NIST) to use equipment not available at the Naval Academy. A Trident Scholar Committee, made up of faculty members with special interests in scholarship and research, administers the program under the guidance of the Director of Special Academic Programs and the responsibility of the Academic Dean and Provost.

As the fall semester draws to a close, each Trident Scholar submits an interim report, describing the project background and results obtained thus far, to the faculty advisor(s) and to the Trident Scholar Committee. In April of the spring semester, each Trident Scholar presents the results of his or her research in a final written report, a lecture at an Academy conference, and by participating in a poster session prior to a formal dinner. The dinner brings together for critical discussion the entire spectrum of Naval Academy research - graduating as well as newly selected scholars, their advisors and sponsors, members of the Trident Scholar Committee, and invited guests.

Following an assessment of each scholar's project accomplishments, and an evaluation of his/her final written report, poster and conference

*-- continued on page 31*

### FORMER TRIDENT SCHOLARS WHO HAVE ATTAINED FLAG RANK

ADM Donald Lee Pilling, USN (ret) (1965)  
Vice Chief of Naval Operations

VADM John Scott Redd, USN (ret) (1966)  
Director, Strategic Plans and Policy  
Office of the Joint Chiefs of Staff

RADM Robert Michael Nutwell, USN (1966)  
Deputy Director, Space, Information Warfare  
Command and Control

ADM Richard Willard Mies, USN (1967)  
Commander in Chief  
United States Strategic Command

VADM George Peter Nanos, Jr., USN (1967)  
Commander, Naval Sea Systems Command

RADM Jay Martin Cohen, USN (1968)  
Chief of Naval Research

RADM Jeffrey Alan Cook, USN (1968)  
Vice Commander, Naval Air Systems Command

RADM (sel) Paul John Ryan, Jr., USN (1973)  
Director, Warfare Programs and Readiness  
U.S. Atlantic Fleet

RADM Joseph Ambrose Sestak, Jr., USN (1974)  
Director, Navy Quadrennial Defense Review

# RELATIONSHIPS

## USNA TRIDENT SCHOLAR PROGRAM, *continued from page 30*

presentation, the Trident Scholar Committee has the difficult task of identifying the single scholar to be recommended to the Academic Dean and Provost to receive the Office of Naval Intelligence Harry E. Ward Trident Scholar prize. Recipients of the Trident prize, awarded to the midshipman producing the most outstanding Trident project for that graduating class, are indicated by a trident symbol beside their name.

While every midshipman at the Naval Academy learns standard research methodology in the fundamental and advanced courses within the academic majors, it is through participation in the Trident Scholar Program that a midshipman has the opportunity to contribute his or her thoughts, intuition, creativity and enthusiasm into a substantial, non-textbook problem. The freedom from a normal classroom routine requires a responsible student - one committed to excellence and one who will call upon personal, professional and technical expertise - to establish the elements of the project, to identify the resources required, and to bring the project full circle from inception to results, explanations and conclusions.

Trident Scholars frequently present their research results at local, regional and national

*-- continued on page 32*

### TRIDENT SCHOLARS, 2000-2001

#### PETER GEORGE BRERETON

*Complex Impedance Studies of Optically Stimulated Strontium Barium Niobate*

Faculty Advisors: Associate Professor Steven R. Montgomery and Assistant Professor Charles A. Edmondson, Physics Department

#### DANIEL ROBERT JOHN ESTES

*Assessment of Radio Frequency Propagation in a Naval Shipboard Environment*

Faculty Advisors: Professor Antal A. Sarkady and Commander Thaddeus B. Welch, III, USN, Electrical Engineering Department

#### CHARLES PATRICK FERRER

*Optimizing the Strength and Stress Corrosion Cracking Resistance of Aluminum Alloys Used for Refurbishing Aging Aircraft*

Faculty Advisors: Associate Professor Angela L. Moran and Assistant Professor Michelle G. Koul, Mechanical Engineering Department

#### ROBERT MATTHEW GALLAGHER

*Radiation-Induced Processing of Hydrocarbons in Environments Relevant to Pluto*

Faculty Advisor: Professor Robert F. Ferrante, Chemistry Department

#### RICHARD CLIFTON HERRON

*Investigation of Flat Plate Evaporator for a Capillary Pumped Loop as a low Temperature Heat Transfer Device*

Faculty Advisors: Associate Professor Mark J. Harper and Associate Professor Martin R. Cerza, Mechanical Engineering Department

#### BENJAMIN PETER MALAY

*Celestial Navigation on the Surface of Mars*

Faculty Advisor: Dr. Richard P. Fahey, Visiting Professor, Naval Space Command Research Chair, Aerospace Engineering Department

#### KEVIN DAVID VALENTINO SMITH

*The Development of an Inverse Ultrasonic Radiative Transfer Technique*

Faculty Advisor: Assistant Professor John A. Burkhardt, Mechanical Engineering Department

#### JONATHAN JOSEPH VANECKO

*Advanced Shipboard Control Systems*

Faculty Advisors: Assistant Professor Edwin L. Zivi and Commander Bradley D. Taylor, USNR, Weapons and Systems Engineering Department

#### JOHN LINDSAY YOUNG, III

*Determination of Atmospheric Density in Low-Earth Orbit Using GPS Data*

Faculty Advisor: Professor Daryl G. Boden, Aerospace Engineering Department

# RELATIONSHIPS

## USNA TRIDENT SCHOLAR PROGRAM, *continued from page 31*

meetings of their discipline. Several are co-authors with their faculty mentors on presentations, refereed journal articles and patents. Many are awarded graduate scholarships, with some of the recent scholars accepted to the Cambridge University, England and the Stanford University. Statistically, Trident Scholars are more likely to achieve success in their naval

professions than their Academy classmates. Over thirty of the previous Trident Scholars with the requisite years of Naval Service have been promoted to the rank of CAPTAIN and nine have been promoted to the rank of Admiral.

[Additional information about the Trident Scholar Program can be found at <http://www.usna.edu/TridentProgram/>]

## TRIDENT SCHOLAR PROGRAM: CLASS OF 2002

**Steven R. Burns** (Systems Engineering major)  
Advisors: Assistant Professor Richard T. O'Brien, Jr. and Assistant Professor Jenelle L. Piepmeier  
Topic: Driver Assistance Steering Control Compensation of Accelerating Vehicle Motion

**Daniel F. Chiafair** (Systems Engineering major)  
Advisor: Assistant Professor Edwin L. Zivi  
Topic: Survivable Control Algorithms for the Integrated Power System

**Joshua B. Datko** (Computer Science major)  
Advisors: Assistant Professor Margaret M. McMahon and Assistant Professor Donald M. Needham  
Topic: Developing a Joining Algorithm for the Network-Centric Infrastructure in Tactical Targeting Networking Technology

**John D. Dirk** (Physics major)  
Advisors: Professor Martin E. Nelson and Visiting Professor James F. Ziegler  
Topic: Investigation into Variation of the Thermal Neutron Flux due to Cosmic Rays Interacting with Different Environmental Conditions

**Amanda L. Donges** (Quantitative Economics major)  
Advisors: Assistant Professor Matthew J. Baker and Associate Professor Gary O. Fowler  
Topic: A Multinational Empirical Analysis of Humanitarian Assistance

**Benjamin A. Drew** (Systems Engineering major)  
Advisor: Associate Professor Carl E. Wick  
Topic: Autopilot and Search Pattern Control for Miniature Mine Detection

**Tarek S. Elmasry** (Electrical Engineering major)  
Advisors: Assistant Professor R. Brian Jenkins and Associate Professor Deborah M. Mechtel  
Topic: The Design of an Optical Demodulator Employing Differential Phase Shift Keying in the Absence of a Local Oscillator

**Edward H. L. Fong** (Computer Science major)

Advisors: Assistant Professor Frederick L. Crabbe and Dr. Alan C. Schultz (Naval Research Laboratory)  
Topic: Localization and Map Building in Mobile Robots to Assist Outdoor Military Operations in Urban Terrain

**Benjamin M. Heineike** (Mathematics major)  
Advisors: Professor Reza Malek-Madani and Associate Professor Sonia M. Garcia  
Topic: Reaction-Diffusion Equations and Morphogenesis

**Peter D. Huffman** (Chemistry major)  
Professor Jeffrey P. Fitzgerald and Dr. James S. Shirk (Naval Research Laboratory)  
Topic: Improved Optical Limiters

**Pritha M. Mahadevan** (Chemistry major)  
Advisor: Assistant Professor Virginia F. Smith  
Topic: Biophysical Characterization of a Bifunctional Iron-Binding Enzyme

**Jonathan P. Nelson** (Systems Engineering major)  
Advisors: Associate Professor John M. Watkins and Associate Professor George E. Piper  
Topic: Active Noise Control Inside Pipes and Ducts Using Magnetic Bearings

**Noah F. Reddell** (Electrical Engineering major)  
Advisors: Associate Professor Erik M. Bollt and CDR Thaddeus B. Welch, III, USN  
Topic: Development of a Digital Signal Processor (DSP) Based Chaotic Communications System with Emphasis of Military Communication

**Brian J. Vogel** (Mechanical Engineering major)  
Advisors: Assistant Professor Paulius V. Puzinauskas and Dr. Steven Buckley (University of Maryland)  
Topic: An Investigation into the Effects of Dilution Conditions in Particulate Matter Measurement

**Jeremiah J. Wathen** (Physics major)  
Advisors: Assistant Professor James J. Butler and Dr. James S. Shirk (Naval Research Laboratory)  
Topic: Characterization of the Limiting Qualities of Nonlinear Compounds Housed Within Capillary Waveguides

# RELATIONSHIPS

## COMMANDER THIRD FLEET NPS DESK ON THE *CORONADO*

NPS Point-of-Contact: Distinguished Professor David Netzer, Associate Provost and Dean of Research

The Commander Third Fleet (C3F) and NPS have recently established a "C3F-NPS Desk" on the *CORONADO*, the Flagship of the Third Fleet in San Diego. NPS has a desk and bunk on the ship. The purpose is to provide a continuous NPS presence at 3F which will accomplish two primary objectives: (1) provide an opportunity for our faculty to expand their research capabilities while becoming more familiar with 3F activities and technology needs and (2) provide technology assistance to 3F, in addition to other application of NPS expertise and talent. This can/will take many forms.

The first occupant is **Assistant Professor Mark Nissen** of the School of Business and Public Policy. He spent the first week of May on the *CORONADO*. Professor Nissen rapidly became acquainted with the ship and staff and his stay was well received. He initiated an experiment design which will be conducted onboard during the upcoming JTFEX in June. As we hope with all of the faculty occupants of the Desk, Dr. Nissen will continue to interact in the future with the 3F staff in the areas of information systems, process innovation and knowledge flow. He was onboard again for the week of 21 May and will then participate in the JTFEX from 4-15 June. After a "teaching break" during the summer quarter Professor Nissen will return in October to fill the Desk again.

NPS's current efforts are directed at trying to get the schedule set up that will provide the continuous presence while meeting the two primary objectives of the endeavor. This is especially difficult in the last half of the fiscal year because of financial requirements and faculty schedules that have been largely



**Mark E. Nissen**

determined by that time. As we work up to a smooth running program we will be attempting to include additional features that could provide value to the Third Fleet. One possibility is regularly scheduled lectures on emerging technologies of importance to 3F. Another possibility that will take considerably more thought and planning would be to have ships operate off of the Monterey coast in order to utilize some of NPS's unique assets to help evaluate the capabilities and vulnerabilities of various systems.

This valuable new program is off to a good start and is looking forward to a continuous and long-term relationship between Third Fleet and the Naval Postgraduate School.



# RELATIONSHIPS

## **NPS AND AIR UNIVERSITY FORM PARTNERSHIP TO ADVANCE DISTRIBUTED LEARNING PROGRAMS**

**NPS Point-of-Contact: Professor Carson Eoyang, Director, Office of Continuous Learning**

This memorandum of agreement (MOA) establishes a working partnership between the Naval Postgraduate School (NPS) and Air University (AU), and defines the relationship and responsibilities of and among these organizations. The intent of this action is to create an environment that initiates interactions between these institutions to foster, encourage, and facilitate resource-sharing activities (programs, projects, courses, faculty, infrastructure, capabilities) consistent with each institution's extension education and distributed learning objectives.

## **NPS JOINS THE ACADEMIC ADVANCED DISTRIBUTED LEARNING CO-LAB**

**NPS Point-of-Contact: Research Assistant Professor Tom Hazard, Director of Distributed Learning, Office of Continuous Learning**

NPS entered into a Statement of Intent with the University of Wisconsin to add NPS as a member of the Academic Advanced Distributed Learning (ADL) Co-Laboratory. In January 2000, the Office of the Secretary of Defense, the Institute for Defense Analyses, the University of Wisconsin System, and the Wisconsin Technical College System entered into a Memorandum of Agreement to establish the Academic Advanced Distributed Learning Co-Laboratory (also known as the Wisconsin ADL Co-Lab). This agreement is an outgrowth of the DoD Strategic Plan for Advanced Distributed Learning which was developed to ensure that DoD personnel have access to the highest quality education and training that can be tailored to their needs and delivered cost effectively, anytime and anywhere.

## **JOINT INTERACTIVE PLANNING TOOLS STUDY PROJECT AND GLOBAL INFORMATION GRID OPERATIONS STUDY**

**NPS Point-of-Contact: Associate Professor Alex Bordetsky, Information Systems Academic Group**

This Statement of Intent defines support that the Western Disaster Center, Inc. (WDC) intends to provide to the Naval Postgraduate School (NPS) on the Joint Interactive Planning Tools Study Project and Global Information Grid (GIG) Operations Study. WDC is a not-for-profit research center that has been established to provide for increased public safety by improving disaster and emergency management capabilities.

## **ESTABLISHMENT AND SUPPORT OF THE COMBAT SYSTEMS SCIENCE AND TECHNOLOGY CHAIR AT THE NAVAL POSTGRADUATE SCHOOL**

**NPS Point-of-Contact: Senior Lecturer William Maier, Chair, Department of Physics**

This Memorandum of Understanding (MOU) documents an agreement between the Naval Postgraduate School (NPS) and the Naval Sea Systems Command (NAVSEA) for the establishment and support of the NAVSEA Combat Systems Science and Technology (CSST) Chair in the Department of Physics at NPS. The objective of the MOU is to provide for the sponsorship, funding and administration of the NAVSEA CSST Chair Professorship.

Close relations between the Combat Systems Curriculum and its sponsor, NAVSEA, are in the best interests of the Curriculum and the Navy. Insight into current navy technical problems will enhance Department of Physics' efforts to educate Navy students in current Combat Systems challenges. It is also highly desirable to obtain Navy speakers for courses and colloquia, monitor up-to-date developments on current Navy technical programs, and establish contacts in program offices having specific research interests.

Recruitment for the Chair will be among NAVSEA and related Program Executive Offices researchers who have discharged senior responsibilities in systems-related positions or from academia, government, and/or industrial laboratories. The incumbent will be responsible for coordination of Combat Systems development activities at NPS including facilitating visits to NAVSEA and related organizations, planning and executing combat systems workshops and symposia, and managing selected CSST research programs.

This is accomplished through research and the application of advanced computer, information, and communication technologies and the development and applications of methods for public/private partnering.

Effective disaster information dominance through an all-source, all-hazard, integrated United States Disaster Infor-

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# RELATIONSHIPS

## MASINT CHAIR PROFESSOR SELECTED

Colonel David Trask, USAF (ret), is the new Measurement and Signatures Intelligence (MASINT) Chair. He has a B.A in Business Economics from University of California, Santa Barbara and a M.S. in Aeronautical Management from Embry-Riddle Aeronautical University. Col Trask accumulated over 3000 flying hours in B-52s and RC-135 aircraft to include RIVET JOINT, COBRA BALL, and the COMBAT SENT program. His assignments included Future Reconnaissance Plans, Headquarters, Strategic Air Command; Operations Officer and Squadron Commander, 343 Reconnaissance Squadron and Chief, Architecture and Integration, Defense Airborne Reconnaissance Office, Pentagon, Washington, DC. His final assignment was Director, Central MASINT Organization (CMO) Technology Coordination Office, responsible for all MASINT R&D programs. Col Trask brings extensive experience in intelligence and reconnaissance operations to the NPS.

His vision for the MASINT Chair is to establish a permanent presence at the NPS to engage faculty and students in MASINT issues, and to focus curriculum and research and development activities at the NPS toward activities that will benefit MASINT capabilities. He plans to do this through course development and by fostering relationship with various NPS departments as well as working with military organizations to sponsor research activities at NPS for both faculty and students. Another program thrust will be to grow a network of universities conducting leading-edge research applicable to MASINT. This network will provide the basis for furthering MASINT capabilities through cooperative R&D projects.

The MASINT Chair Professorship and Research Center were established by a Letter of Intent initiated in 1999 between the Central MASINT Organization and the Naval Postgraduate School.

## INTERACTIVE PLANNING TOOLS STUDY PROJECT AND GLOBAL GRID STUDY,

*continued from page 34*

mation Network (US-DIN) is today considered the key element in the country's future emergency and disaster management process. Timely, nation-wide, reliable, near-real-time access to all-source data and information resources will quickly seize the advantage in any disaster situation. Access to this virtual network, together with the ability to rapidly process and exploit all-source data and information at the local level, will provide for swift command and control decisions based on the comprehensive understanding of the current situation. The WDC believes that DoD technologies and capabilities for providing a secure collaborative work environment to be essential components of the US-DIN concept.

## NEW NRO CHAIR PROFESSOR JOINS NPS

CDR David F. T. Kretzmann, USN (ret) joins the Naval Postgraduate School as the second National Reconnaissance Office (NRO) Chair Professor. He brings 28 years of experience as a naval cryptologist, specializing in space system requirements, architectures, operations, and product dissemination to support naval and joint warfare.

CDR Kretzmann is an NPS alumnus, having earned an M.S. in Information Systems, with distinction, in 1982. His last active duty assignment was in the Communications Directorate of the National Reconnaissance Office. He served as chief systems engineer for global dissemination and as customer support manager for the NRO Communications Architecture Group.

The NRO Chair was established in 1999 to strengthen the relationship between the NPS and the national security space community. The position is staffed by The Aerospace Corporation, a federally funded research and development center, which provides technical and programmatic support to both the NRO and to the Air Force Space and Missile Systems Center.

CDR Kretzmann's role will include teaching, advising students, acting as a liaison between the NPS and the NRO, and making Aerospace Corporation expertise available to NPS faculty and students. He looks forward to working with the next generation of space warriors.

# RELATIONSHIPS

## NPS TENANT WORKING ON LAND WARRIOR SYSTEM

The TRADOC Analysis Center-Monterey (TRAC-MTRY) has teamed with Project Manager-Soldier Systems (PM-Soldier) in the design and development of software for the Land Warrior System. The Land Warrior (LW) System is a computer-based system that brings situational awareness to the dismounted infantry soldier. It provides the dismounted soldier with an array of state-of-the-art equipment to give him a distinct advantage over his opponent on the battlefield. The LW system provides critical situational awareness to the individual soldier through the use of cutting-edge technology. The main components of the LW system are the wearable computers, a helmet-mounted display, a weapon video display, and the Soldier Computer Interface (SCI).

This project developed out of a need for PM-Soldier to have a training tool to ease the testing and evaluation requirements of the LW system at the Joint Contingency Force - Advanced Warfighter Exercise (JCF-AWE). Soldiers who had never

been exposed to computers or the concept of the Land Warrior system required assistance in using the new technology. PM-Soldier needed to provide this assistance to the troops assigned with the task of using the equipment in the JCF-AWE. TRAC-MTRY used a commercial-off-the-shelf

(COTS) acquisition strategy and evaluated several COTS products that could be modified to serve as a training tool. The COTS software provided the basic simulation to immerse the soldiers in a virtual battlefield. To train the soldiers on the Land Warrior functionality, the SCI needed to be included in the simulation.

The project, called the Dismounted Simulation & Acquisition System or DSAS, takes the

selected COTS simulation software and integrates the Land Warrior SCI. This allows the soldiers to interact with the virtual battlefield and use the Land Warrior SCI for situational awareness. The COTS software provides the virtual terrain and manmade structures, the soldier entities, and

adjudicates the interactions between objects and entities. The Land Warrior SCI provides the situational awareness in the form of maps with soldier position icons, messaging functions to send messages between soldiers, and weapon video feed to the helmet-mounted display.

Since the project uses two different applications, the COTS software and the LW software, several unique opportunities were presented. Using a "plug and play" approach, the simulation can be used as a Simulation-Based Acquisition (SBA) effort to support PM-Soldier in the development of the real combat system. The data connection between the two applications provides a set architecture and is designed to minimize

**NPS is host to the TRADOC Analysis Center-Monterey, an Army research activity. TRAC-Monterey provides a permanent Army presence on campus with a research program primarily focused on advanced computer simulation research. TRAC-Monterey is one of four elements located throughout the United States. The presence of TRAC on the NPS campus provides the opportunity for collaborative faculty and student research.**



Dismounted Simulation & Acquisition System (DSAS) Interface.

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# RELATIONSHIPS

## NPS TENANT WORKING ON LAND WARRIOR SYSTEM, *continued from page 36*

code changes. If one application had to be changed, the data required to stimulate the other is still passed in the same manner. Therefore, the Land Warrior software can go through several generations of changes, while the COTS software remains unchanged.

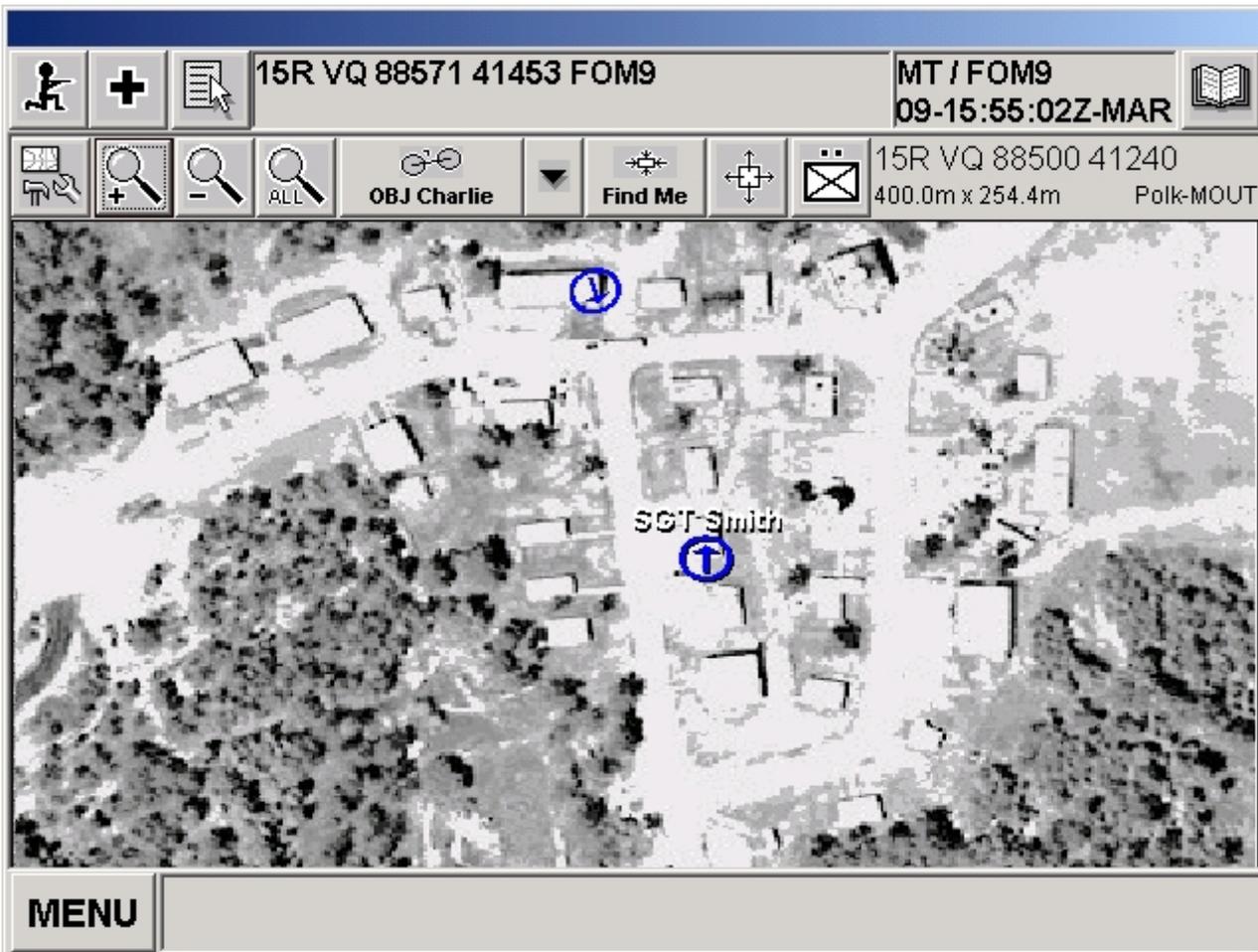
PM-Soldier can now evaluate the Land Warrior software without loading it on the Land Warrior hardware. Prior to the DSAS project, software modifications had to be applied to the Land Warrior hardware. Soldiers using the Land Warrior system in the field would then test the modified software. This process is time-consuming and resource intensive. Using DSAS as the simulated environment, the modified software can be "plugged" into the simulation and evaluated by the soldiers in a classroom environment first. The DSAS approach is less time-consuming and less resource intensive.

The DSAS project allows PM-Soldier to evaluate several key aspects of the software required for the Land Warrior system.

Specifically, the:

- Ease of use of the GUI by the soldier;
- Mapping interface and map functions;
- Messaging interface and message connectivity;
- Ergonomic evaluation of soldier input devices; and
- Proper military terminology and symbols.

The project employs a "User Jury" approach to evaluate these aspects of the system. The "User Jury" consists of Subject Matter Experts (SMEs) from the United States Army Infantry School at Fort Benning, Georgia as well as computer programmers from the software developer, Exponent. Feedback from the "User Jury" is evaluated and modifications to the software are made. The resulting software is then plugged back into the simulation and re-evaluated. This evaluation cycle is repeated until the software reaches an acceptable level of approval from both the SMEs and the computer programmers.



Land Warrior Map Screen with GPS Icons.

# TECHNOLOGY TRANSFER

## NPS INITIATES FIVE NEW COLLABORATIVE EFFORTS

The Cooperative Research and Development Agreement (CRADA) is one of the principal mechanisms used by federal laboratories to engage in collaborative efforts with non-federal partners to achieve the goals of technology transfer. Although NPS is not a federal laboratory, its extensive research program in support of its graduate education mission has fostered this form of technology transfer. NPS has recently finalized five new CRADAs. These collaborative efforts are briefly described below.

### **ADVANCED ROTORCRAFT TECHNOLOGY, INC.**

**NPS Project Manager: Professor E. Roberts Wood, Department of Aeronautics and Astronautics**

NPS and ART have mutual interests in the advancement of rotorcraft technology and initiated a cooperative effort to make effective use of synergism in their respective programs. ART and NPS worked together to develop the basic elements of a rotorcraft simulator and demonstrated the technology at the 57th Annual American Helicopter Society Forum in May 2001. ART and NPS jointly interfaced the control loader platform with the OH-6 sticks and grips, seats, and instrument console and test the computer interface to these systems. NPS pilots assisted ART in evaluating the control loading, visual cues and math model fidelity for a helicopter of mutual interest. This open platform demonstrator will provide an effective evaluation of rotorcraft simulator technology and will help define the specifications for a reconfigurable motion base simulator to support research and development at NPS.

### **APRISMA MANAGEMENT TECHNOLOGIES, INC.**

**NPS Project Manager: Associate Professor Alex Bordetsky, Information Systems Academic Group**

NPS and Aprisma will collaborate on research efforts focused on the next-generation management techniques, with special focus on the management of Internet2 Giga POPs and wireless networks. This research will evaluate the functionality of Aprisma developed Spectrum and SpectroWatch to monitor and implement the rules of intrusion detection in the management of C4ISR networks. The objective is to determine the feasibility of implementing Aprisma technology to provide adaptive Quality of Service (QoS) and intrusion detection capabilities. The research will evaluate Aprisma Management Information Base (MIB) data collected during attack and non-attack scenarios, algorithms to generate intrusion detection rules, and capability of SpectroWatch rules to predict the attack. This research will contribute directly to the Navy Information Superiority objective by providing vital knowledge for such Global Information Grid Operation tasks as: 1) Automatic adaptive information conditioning, 2) Adaptive network management and control, and 3) QoS management of C4ISR networks.

### **INTREPID INCORPORATED DBA QUICK REACTION CORPORATION**

**NPS Project Manager: Associate Professor David Jenn, Department of Electrical and Computer Engineering**

QRC is the recipient of a Small Business Innovative Research (SBIR) Award from the U.S. Army Research Office on Broadband Focused Radar at Ground Penetrating Frequencies for Detecting Mines, Unexploded Ordnance, or Mobility Related Surface Areas. This SBIR program is primarily an investigation into the effectiveness of several broadband antenna designs for use in ground penetrating radar applications. The antennas must be capable of operating over an extremely wide frequency range (10 MHz to 1 GHz). The antenna must illuminate a spot on the ground a distance of several meters from the antenna. A well-defined compact spot must be maintained over the entire range of frequencies.

Two antenna types that have the potential to achieve the bandwidth are the contra-wound quadrafil helix and contra-wound conical spiral. Previous designs of these antennas have demonstrated bandwidths up to a decade, with well-behaved input impedance characteristics.

The various aspects of the program include analysis and design of the antennas, simulation of their input and radiation characteristics using computational electromagnetics codes, and development of prototype hardware.

# TECHNOLOGY TRANSFER

## NPS INITIATES FIVE NEW COLLABORATIVE EFFORTS, *continued from page 38*

### **MICROSOFT CORPORATION**

**NPS Project Manager: Associate Professor Cynthia Irvine, Department of Computer Science, and Director of the Center for INFOSEC (Information Systems Security) Studies and Research**

NPS will perform research in developing a security-enhanced version of one or several versions of Microsoft Windows CE operating system (Windows CE). NPS will conduct research in Windows CE with the objective of identifying opportunities for system security and integrity enhancements, conducting a penetration analysis of Windows CE, and designing and implementing a prototype of initial security enhancements to Windows CE. Microsoft will support NPS activities by contributing certain resources and technical expertise with respect to embedded operating systems and related devices, as defined in this Agreement. The Parties desire, through this collaborative effort, to: (a) benefit the NPS research program from faculty and students working on current applied problems in secure systems, operating systems, and high assurance software engineering; and, (b) benefit Microsoft by having penetration studies, self-protection and subversion resistance studies, design analysis and prototype security enhancements, all of which could be utilized in a military-oriented product line.

### **GMF, INC.**

**NPS Project Manager: Research Associate Professor Lonnie Wilson, Department of Electrical and Computer Engineering**

NPS and GMF, INC. jointly intend to investigate the applicability of certain passive identification techniques to determine new approaches and device concepts for cooperative and non-cooperative identification of both military and non-military vehicles and platforms. The principals involved with this investigation at NPS and GMF, INC. have been responsible for major research and development advances in passive identification techniques, production of military systems utilizing passive identification technology, and their use in field operations.



**Associate Professor Cynthia Irvine looks on while NPS Superintendent, RADM David R. Ellison, signs a Cooperative Research and Development Agreement with Microsoft Corporation.**

# TECHNOLOGY TRANSFER

## PHASE 1 SBIR PROGRAM DEVELOPS WEATHER PROCESSORS FOR RADAR

A Phase I SBIR Program has been initiated to develop weather processors for two radars that have been obtained jointly by **Research Associate Bob Bluth**, Director of the Center for Interdisciplinary Remotely Piloted Aircraft Studies, and **Professor Jeffrey B. Knorr**, Chair of the Department of Electrical and Computer Engineering (ECE). **Paul Buczynski**, Staff Director of the ECE Department Radar Laboratory, has assisted with the acquisition of the radars and has brought one, the AN/MPQ-64, to operational status (Figure 1). The second radar, the AN/TPQ-37, has been partially delivered (Figure 2). The SBIR Program will begin the process of converting these rapid scanning, phased array radars for research that will lead to an add-on capability that will provide battlefield and battlegroup weather products to tactical commanders. The project will also provide civilian atmospheric scientists with a significantly improved severe storm observational capability.



Figure 1 (above). AN/TPQ-37 Firefinder Counter Mortar/Counter Artillery Radar.



Figure 2 (below). AN/MPQ-64 Sentinel Forward Area Defense Radar.

## CONFERENCES/SHORT COURSES

### THE TECHNICAL COOPERATION PROGRAM AEROSPACE SYSTEMS GROUP TECHNICAL PANEL AER-TP3 MEETS AT NPS

The 15th Annual Meeting of The Technical Cooperation Program (TTCP) Aerospace Systems Group, Technical Panel AER-TP3 was hosted by the Department of Aeronautics and Astronautics, May 7-11, 2001. The meeting brought together technical representatives of the governments of Australia, Canada, New Zealand, United Kingdom, and the United States in TCCP related to Propulsive and Mechanical Systems Condition Monitoring and Diagnostics. Andy Hess of Naval Air Systems Command chaired the meeting. Ted Fecke from Wright-Patterson Air Force Base represented the Air Force. **Professors Ray Shreeve** and **Garth Hobson** of the Department of Aeronautics and Astronautics coordinated arrangements for NPS, which included a two-hour tour of the Turbo-Propulsion (TPL) and Gas Dynamics Laboratories. The High-Cycle Fatigue/Spin Test Research project at TPL is directly relevant to this panel's interests.

### THE ADVANCED TECHNICAL WORKSHOP 2001 PRESENTED TO THE SWEDISH DEFENCE COLLEGE

**Professor Phillip Pace** of the Department of Electrical and Computer Engineering chaired the Advanced Technical Workshop 2001 for students of the Swedish Defence College. The three-week course was provided to over 30 officer personnel. This year's program titled "Revolution in Battlespace Technology" is significant in that it marks the fifth technical workshop. Courses in decision modeling and tactical analysis serve to provide an introduction to the special methodologies of command and control. Special emphasis is given to the newest developments in unmanned aerial vehicles (UAVs), cruise missile technologies and synthetic aperture radar (SAR) image compression techniques. High-speed

networking, wideband receiver design methods as well as wireless antennas are also presented. Ultra wideband impulse methods are discussed, as well as atmospheric predictions, weapons effects and radar and laser cross section engineering. The Advanced Technical Workshop 2001 presents the latest in these battlespace technologies supporting the current revolution in military affairs.

NPS faculty instructors included **Professor Kenneth Davidson** (Meteorology), **Associate Professor Richard Howard** (Aeronautics and Astronautics), **Research Associate Professor Susan Hutchins** (C4I), **Associate Professor Rama Janaswamy** (Electrical and Computer Engineering), **Associate**

**Professor David Jenn** (Electrical and Computer Engineering), **LCDR Robert Ives**, USN (Electrical and Computer Engineering), **Associate Professor John McEachen** (Electrical and Computer Engineering), **Professor Phillip Pace** (Electrical and Computer Engineering), **Professor Murali Tummala** (Electrical and Computer Engineering), **Capt Scott Tyo**, USAF (Electrical and Computer Engineering), **Emeriti faculty Wayne Hughes** and **Kai Woehler**.



Faculty and students of the 2001 Advanced Technical Workshop

# CONFERENCES/SHORT COURSES

## WORKSHOP ON ATMOSPHERIC PREDICTABILITY

**Associate Professor Wendell Nuss** of the Department of Meteorology, along with representatives from the Naval Research Lab in Monterey and the National Center for Atmospheric Research (NCAR), hosted a workshop examining fundamental limits to atmospheric predictability and their implications for research and operational forecasting. Participants came from numerous organizations including the European Center for Medium Range Weather Forecasting, Oxford University, the National Center for Environmental Prediction, Pennsylvania State University, and other universities and government labs.

The workshop focused on what we presumably understand about atmospheric predictability on a variety of time and spatial scales and how this impacts operational forecasting, data assimilation, and the setting of appropriate research goals. General consensus among participants indicates that the deterministic predictions of atmospheric structure and weather systems on the larger scales cannot realistically extend much beyond 7-8 days. Smaller scale weather systems such as convective cloud systems and terrain-enhanced precipitation have much shorter ranges of predictability, which is highly dependent on weather regime. Considerable research is needed to define these limits to a broad spectrum of weather events and parameters of interest to users. The need to incorporate these fundamental uncertainties into the weather forecasts was another area of general agreement and call for research.

## NATIONAL WEATHER SERVICE MARINE FORECASTERS TRAINING WORKSHOP

**Associate Professor Wendell Nuss** also hosted the National Weather Service's (NWS) Marine Forecaster Training Workshop for the fourth year in a row. This workshop was initiated by Professor Nuss four years ago in conjunction with the NWS Western Region Headquarters to meet a clear need to train NWS operational forecasters in coastal weather and ocean wave forecasting. The workshop has reached over 60 NWS forecasters in the past 4 years coming from 7 NWS Forecast Offices along the U.S. West Coast. The success of this workshop, sponsored by NPS and NWS Western Region, has been the model for workshops started this year by three other NWS regions. The workshop has been an excellent outreach opportunity for NPS to share our recognized expertise in coastal and marine meteorology by using various faculty in the Meteorology Department as speakers. In addition, the exchange of information and forecast techniques have benefited NPS students in the Meteorology Department as many of these topics have been incorporated into our Operational Forecasting course.

## TECHNOLOGY REVIEW AND UPDATE - A SUCCESS FOR THE 18TH YEAR

The Naval Postgraduate School presented the 18th Technology Review and Update Course for Technical Personnel the week of 23-27 April 2001. **Professor Rudolf Panholzer**, Dean of Science and Engineering and Chair of the Space Systems Academic Group, coordinated the course. There were over 35 attendees from various government agencies, academia, and industry. The course was also open to NPS faculty and students.

The success and popularity of this short course is ensured by recruiting outstanding experts from industry, academia and the government and by constantly finetuning the contents. The course is intended for military and civilian technical personnel interested in refreshing and updating their technical knowledge. The course provided an excellent overview and stresses the more practical aspects of the topics listed. The course was presented at the unclassified level. Sessions covered included:

- Internet Security Opportunity or Oxymoron
- Electro-Optical and Infrared Systems
- Micro Electro-Mechanical Systems (MEMS)
- Optical Sensing Technology
- Military Satellite Communications Technologies
- Satellite Communication Technologies and Trends
- Computational Intelligence

NPS will host the Third Annual Classified Advanced Technology Update (CATU) Short Course the week of 23-27 July 2001. Additional information can be found at <http://www.sp.nps.navy.mil/catu>.

## NPS WILL HOST RIDESHARE CONFERENCE

The Rideshare Conference will be held at NPS on May 30-31, 2001. The meeting provides the opportunity where industry, government, and academia can discuss and address issues related to the goal of maximizing access to space. Topics include payload brokering, launch vehicles, orbital maneuvering vehicles, spacecraft, and their associated ridesharing capabilities. The conference is co-hosted by the National Reconnaissance Office and the Naval Postgraduate School.

# FACULTY RECOGNITION

## AWARDS FOR EXCELLENCE IN TEACHING AND INTERDISCIPLINARY ACHIEVEMENT ESTABLISHED IN MEMORY OF DR. RICHARD W. HAMMING

Awards for Excellence in Teaching and Interdisciplinary Achievement have been established in memory of Dr. Richard W. Hamming. Funding for the awards is provided from a grant given to the Naval Postgraduate School Foundation by Mrs. Wanda Hamming.

The purpose of the Richard W. Hamming Award for Excellence in Teaching is to recognize teaching at a graduate school which encompasses many aspects including: lecturing in the classroom, providing an environment in which the students learning is maximized, supervision of a graduate student's thesis, organizing laboratory sessions and contributing to the students education beyond the classroom. A faculty committee, formed under the auspices of the Faculty Council, conducts interviews and reviews theses and course journals to select a winner. The award is presented annually.

The recipient of the 2000 Richard W. Hamming Award for Excellence in Teaching is **Senior Lecturer Alice Crawford** of the School of Business and Public Policy. Dr. Crawford is honored as a member of the Naval Postgraduate School faculty who is recognized by her students and faculty peers alike, for excellence in the classroom and for her instructional leadership and innovation. Dr. Crawford designed and implemented the Leadership and Education Development Program at the Naval Academy that provides a masters degree for Company officers. Her innovative efforts in the NPS

Executive Education 30-Plus Program were highly visible at the uppermost levels of the Navy.

The purpose of the Richard W. Hamming Award for Interdisciplinary Achievement is to recognize excellent interdisciplinary research and teaching at the Naval Postgraduate School that is vital if the School is to meet the unique educational requirements of the military services. A faculty committee appointed by the Provost and formed under the auspices of the Faculty Council selects the recipient. This award is also presented annually.

The recipient of the 2001 Richard W. Hamming Award for Interdisciplinary Achievement is **Distinguished Professor Donald Gaver** of the Department of Operations Research. Professor Gaver has been an NPS faculty member for over thirty years, and throughout that time has been an active member of nearly all interdisciplinary groups on campus. His

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**Richard W. Hamming**

## NORTHROP GRUMMAN AWARD FOR EXCELLENCE IN SYSTEMS ENGINEERING AND INTEGRATION

This award was established through an agreement between Northrop Grumman, the Naval Postgraduate School, and the Naval Postgraduate School Foundation. Funding for the award is provided from a grant given to the Naval Postgraduate School Foundation by Northrop Grumman. The purpose of the award is to recognize faculty for outstanding support to educational and research programs in Systems Engineering and Integration. Criteria for the award and selection are made by the Northrop Grumman Professor in residence at NPS. The current Northrop Grumman Professor is **Distinguished Professor William B. Colson** from the Department of Physics.

The first two awards were presented at March 2001 graduation. The first recipients of the Northrop Grumman Faculty Award for Excellence in Systems Engineering are **Senior Lecturer Robert Harney**, Department of Physics, and **Senior Lecturer Bard Mansager**, Department of Mathematics. Professors Harney and Mansager are recognized for excellence and innovation in program development, teaching, and research in support of the Systems Engineering and Integration Curriculum.

# FACULTY RECOGNITION

## ALLEN W. GRIFFIN AWARD FOR EXCELLENCE IN TEACHING AWARDED TO MECHANICAL ENGINEERING PROFESSOR

Associate Professor Ashok Gopinath of the Department of Mechanical Engineering is the recipient of the Allen Griffin Award for Excellence in Teaching. The award was established by the Community Foundation of Monterey County in 1982 to reward and stimulate superior teaching. The award was made possible by a bequest from the late COL Allen Griffin, USA, who was founder and long-time publisher of the Monterey Herald.

The Award Interview Committee looks for teachers who have demonstrated sustained excellence in classroom teaching and have made a significant impact outside the classroom. The qualities they are looking for are strong positive feedback and improved performance from students, outstanding presentation in lectures, discussions and written materials, as well as commitment to maximizing all students performance and involvement in faculty development issues.

Dr. Gopinath is also the recipient of the 2000 RADM John J. Schieffelin Award for Excellence in Teaching presented annually by the NPS Foundation.

## NPS SELECTED AS SITE FOR THE NATIONAL SCIENCE FOUNDATION'S FEDERAL CYBER SERVICE CORPS SCHOLARSHIP PROGRAM

The Center for INFOSEC (Information, Systems and Security) Studies and Research (CISR) has been selected as one of the sites for the National Science Foundation's Federal Cyber Service Corps Scholarship Program. Through this high profile program, CISR will select ten students a year for four years to earn their Masters Degree in Computer Science with an emphasis in Information Assurance (IA). Upon completion of the program, students will be placed, to serve for two years, in positions within the Federal Government. As a National Center of Excellence in Information Assurance, NPS CISR under the direction of Associate Professor Cynthia Irvine is an ideal site for training future IA professionals seeking a career with the Federal Government. (Additional information can be found at <http://cizr.nps.navy.mil/scholarship.intr.html>.)

## NPS PROFESSOR RECEIVES OFFICE OF NAVAL RESEARCH YOUNG INVESTIGATOR AWARD

Assistant Professor Mark E. Nissen of the School of Business and Public Policy Naval recently received an Office of Naval Research (ONR) Young Investigator award. The Young Investigator Program (YIP) supports outstanding research in a wide range of science and engineering fields that are critical to the evolution of a first-rate Navy and Marine Corps. Dr. Nissen received his award to develop and test a knowledge-flow theory, applicable to very large organizations, which can be used to design improved systems and operational processes within such organizations.

The YIP supports basic research by exceptional faculty at U.S. universities who received a Ph.D. or equivalent degree within the preceding five years. Grants to their institutions provide up to \$100,000 per year for three years. Additional funds may be made available for a variety of research costs, including salary, graduate student support, laboratory supplies, and operating costs. Young Investigator grants are awarded each year that the YIP program is in effect.

Young Investigators are selected by ONR based on: 1) past performance, demonstrated by the significance and impact of previous research, publications, professional activities, awards and other recognition, etc.; 2) a creative research proposal, demonstrating the potential for making progress in an important, naval-relevant scientific area; and 3) a long-term commitment by the university to the applicant and the research. This is a very competitive program. Of the 191 proposals that were submitted in response to this year's program announcement, 26 were selected.

Dr. Nissen was also the 2000 recipient of the Carl E. and Jessie W. Menneken Faculty Award for Excellence in Scientific Research (see *NPS RESEARCH*, Vol. 11, No. 1).

## DR. RICHARD W. HAMMING AWARDS FOR EXCELLENCE, *continued from page 43*

current involvement is with modeling and simulation and information warfare. Over the years, his contributions have focused on curriculum structure and effective instruction as well as working with thesis students to further knowledge about interdisciplinary phenomena. Professor Gaver is adamant about the need to provide students with the highest quality education that will enable them to serve as insightful defense analysts.

# FACULTY RECOGNITION

## NPS FACULTY ARE RECOGNIZED FOR OUTSTANDING RESEARCH ACHIEVEMENT

The Annual Research Recognition Evening is held to honor the recipient of the Carl E. and Jessie W. Menneken Award for Excellence in Scientific Research and to recognize NPS faculty for their outstanding contributions to research.

**Assistant Professor Mark Nissen** of the School of Business and Public Policy was the 2000 recipient of the Menneken award (see *NPS RESEARCH*, Vol. 11, No. 1).

Individuals recognized for outstanding achievement in 2000 within the academic departments and groups are identified below along with a brief description of their

achievement.

**Professor Luqi** of the Department of Computer Science has continued building an impressive internationally recognized program in software engineering. An amazing total of 26 conference papers and two journal papers appeared with her name as co-author in the year 2000. Her recent work covers such topics as software reuse to save on programming costs, re-engineering of current software systems, risk assessment of software, and computer-aided

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Faculty honored for their outstanding research contributions include (from left to right, front row): Garth Hobson, Tom Hofler, David Yost, Murali Tummala, Chris Olsen, Luqi, Andres Larraza, Shelly Gallup (for Nelson Irvine); (back row) Robert McNab, Wei Kang, Keith Snider, John Hiles, Phil Pace, Russ Elsberry, Al Washburn, Morris Driels, Lester Carr, Mark Nissen, and Scott Tyo.

## FACULTY RECOGNITION

### FACULTY RECOGNIZED FOR OUTSTANDING RESEARCH ACHIEVEMENT, *continued from page 45*

prototyping systems. These topics are all critical to the efficient management of the many large military software systems.

**Captain Scott Tyo, USAF**, of the Department of Electrical and Computer Engineering is recognized for outstanding research achievement in the Information Warfare Academic Group. Captain Tyo is at the forefront of the electromagnetics and antennas field conducting research in the areas of ultra wide-band (UWB) antenna design. This research is fundamental to the optimization of polarimetric sensors for remote sensing applications, and the integration of such information is a requirement for Information Superiority with applications to both terrestrial and space-based capabilities. Captain Tyo has been involved in the design and testing of UWB antennas, the most challenging area in antenna design advancing technology to the limit in both radiated power and spectral coverage. He was a major contributor in the successful fielding and testing of the USAF UWB Advanced Concept Technology Demonstration (ACTD) in conjunction with the Air Force Research Laboratory/Phillips Lab which was the first transition of a High Power Microwave (HPM)/UWB capability to the field in an operational application in support of a theater warfighting CinC. Captain Tyo is without peer as a young researcher at the leading edge of antennas and electromagnetic radiation research.

**Research Professor John Hiles** of the Modeling, Virtual Environments, and Simulation (MOVES) Academic Group is recognized for his work on the adaptive and autonomous behavior of software agents and their ability to portray and explain complex adaptive systems. Since coming to NPS, Professor Hiles has become one of the world leaders in agent-based simulation and a key researcher in the MOVES Academic Group. His work on agent-based simulation and game-based learning is a significant component of several projects including the Army Game Project, SimSecurity, SimClinic, RELATE, and the new StoryLine Engine project. He has co-advised seven M.S. theses and three Ph.D. theses in the last year.

**Associate Professor Chris Olsen** of the Department of Physics is recognized for outstanding research achievement in the Space Systems Academic Group. The research Professor Olsen has conducted on remote sensing has attracted attention at a national level. The Director of the Central MASINT (Measurement and Signatures Intelligence Organization) considers his work critical to their

future success as an organization. His research spans a wide variety of projects including remote infrared spectral imagery, multi-temporal image fusion, thermal imagery to track submarine wakes, new technology for satellite sensors and remote-sensing satellite design. His students and associated faculty perform high-quality research that brings credit to the Naval Postgraduate School, the Department of Physics and the Space Systems Academic Group. It is entirely appropriate that he be recognized for his outstanding research contributions to the space community.

**Associate Professor Andres Larraza** of the Department of Physics is recognized for outstanding research achievement in the Undersea Warfare Academic Group. Professor Larraza has established a highly productive experimental research program in acoustics, providing innovative and timely thesis topics for our undersea warfare students. For example, during the past year, Professor Larraza supervised two theses of students in the USW Curriculum. One was on an experimental realization of an underwater acoustic communication technique for which the student received an outstanding thesis award. The other analyzed a concept for a mine countermeasure that was submitted to ONR for funding by a private company. The importance of this later thesis is that it provided ONR with an unbiased evaluation of the merits of the design based on physical principles.

The work on acoustophoresis, sonar, and acoustic communications that is conducted in his lab has been briefed to researchers from other universities and research labs as well as an impressive list of high ranking visitors to NPS.

**Professor Garth Hobson** is recognized for outstanding research achievement in the Department of Aeronautics and Astronautics. Since 1990, Professor Hobson has conducted a number of air-breathing propulsion-related research programs that have involved his students in the development of new test facilities; in the use of the most advanced laser flow diagnostic techniques; in the operation of subsonic and supersonic wind tunnels; and in the testing of compressors, turbines and micro-turbojet engines. However, he has also involved thesis students (sometimes the same students) in the use of the most advanced computational methods, using the nation's most advanced computers. The unusual combination of both experimental and computational research interests has led

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## FACULTY RECOGNITION

### FACULTY RECOGNIZED FOR OUTSTANDING RESEARCH ACHIEVEMENT, *continued from page 46*

to his becoming widely recognized professionally for his contributions to the validation of computational predictions of flows in axial compressors and turbines. He has published ten papers, largely in ASME and AIAA journals, and supervised 35 theses. His principal sponsor has been the NAVAIR Propulsion and Power Group (who have consistently sought his advice), with other support coming from Defense Airborne Reconnaissance Office, NASA and NAVSEA. The wide spectrum of Professor Hobson's research activities has been instrumental in keeping both the experimental and computational laboratories in the Aero/Astro Department current, active, and well used in instruction.

**Professor Murali Tummala** and **Professor Phil Pace** are recognized for outstanding research achievement in the Department of Electrical and Computer Engineering. Professor Tummala is recognized for his leadership of the research and development effort to modernize the Navy's Beartrap System for fleet anti-submarine warfare. He has led a five-year program to redesign the system, develop and test modern digital signal processing algorithms, develop C++ code and contract to implement the new System 2000 (S2K). S2K is a PC-based system that was developed over a five-year period. The project involved two other faculty members, one project engineer, twelve MSEE students and one Ph.D. student. It consists of COTS hardware and software that is estimated to contain over 300,000 lines of code in 600 source files that provide the operator with the ability to identify signals of interest, perform analysis of those signals, and to generate an estimated track of the target submarine.

Beartrap missions are flown by specially equipped P-3 patrol aircraft and ship based LAMPS helicopters to gather acoustic data on submarines. This data is input to the S2K system and the S2K output is forwarded to the Office of Naval Intelligence for detailed processing and inclusion in the national database. The goal is to provide near real-time information to help operational and tactical commanders. System 2000 is currently undergoing beta testing at five Beartrap sites. Once the testing is completed, S2K will undergo a certification process and then be deployed in the fleet where it will replace a collection of outdated systems that do not meet the Navy's projected requirements. Professor Tummala is congratulated for his leadership of this long-term project that will have significant benefit and impact for fleet operations for many years in the future.

Professor Pace is recognized for a highly productive year in which he worked on five research projects funded by the Naval Air Systems Command, Johns Hopkins University, Naval Research Laboratory, the Office of Naval Research and DARPA. These projects led to six journal articles, six presentations, two technical reports and a patent award produced in collaboration with his faculty colleagues and students. Professor Pace's projects, all in the area of radar, electronic and network centric warfare, address problems such as digital techniques for countering advanced synthetic aperture and inverse synthetic aperture radars, airborne electronic attack, anti-ship missile defense and photonic architectures for signal collection and analysis. He is to be congratulated not only for another productive year but also for his ability to strike a remarkable balance between scholarship of discovery and application. His research is both innovative and, at the same time, applicable to the solution of important Navy and DoD warfare problems.

**Associate Professor Wei Kang** of the Department of Mathematics is honored for his continued research into Normal Forms and Bifurcations of Control Systems. Professor Kang is internationally recognized as the founder of and a leading researcher in this important area of applied mathematics. He recently received the Best Paper Award at the 6th International Conference on Control, Automation, Robotics and Vision. His work has both deep theoretical importance and valuable practical applications. Of particular interest to DoN/DoD are applications of Professor Kang's methods to the control of submersible vehicles and to the control of rotating stall in compressors. In addition, Professor Kang has contributed valuable applied research in the coordinated control of multi-satellite systems.

**Professor Morris Driels'** research into the delivery accuracy of both unguided and recently fielded guided air-to-ground weapons is praiseworthy. This research has involved both the development and the application of new statistical methods, and has been put to immediate use in algorithms currently employed by the Navy, Marine Corps, Air Force and Army aviation communities in the real-time computation of weapon delivery accuracy. He also recently initiated new investigations into statistical issues involved in the detection of targets. In the course of this investigation he has flown with both Navy and Air Force operational units to gain an operational perspective on the problem of target detection. As a result of the foregoing initiatives, Professor

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## FACULTY RECOGNITION

### FACULTY RECOGNIZED FOR OUTSTANDING RESEARCH ACHIEVEMENT, *continued from page 47*

Driels has initiated a new 4000 level course in Weaponing which has attracted more than 20 students in its second offering this past Winter Quarter (see *NPS RESEARCH*, Vol. 10, No. 3). Professor Driels is a member of the Department of Mechanical Engineering.

**Distinguished Professor Russell Elsberry** and **Research Associate Professor Lester Carr** of the Department of Meteorology are international leaders in the field of tropical cyclone research. This past year alone Professor Elsberry published nine articles and Professor Carr four articles in the leading peer-reviewed journals in the atmospheric sciences. Professor Elsberry is the Principal Investigator of the U.S. Weather Research Program's Hurricane Landfall Research Program. In addition, Professors Elsberry and Carr developed and deployed a prototype expert system called the Systematic Approach Forecasting Aid to assist typhoon forecasters predict tropical cyclones over the Western North and South Pacific and Indian Oceans. CAPT Terry McPherson, Commanding Officer of Naval Meteorology and Oceanography Center-Pearl Harbor and Joint Typhoon Warning Center, comments that this NPS effort has been a major factor in the Center producing two record breaking years with a reduction in the 72 hour tropical storm position forecast error of over 25 percent. This is a remarkable achievement in tropical cyclone forecasting and directly contributes to the safety and efficiency of U.S. Navy fleet operations (see *NPS RESEARCH*, Vol. 10, No. 3).

**Research Associate Professor Julie McClean** of the Department of Oceanography has significantly advanced the science of global ocean forecasting for Naval operations by her research in applying a model developed at Los Alamos National Laboratory. Building on her detailed evaluations of that model using satellite data, she has conducted simulations with the highest spatial detail ever employed with the model for the North Atlantic; and she guided an NPS student in evaluating the model against voluminous buoy data, culminating in a major paper demonstrating the exceptional skill of the ocean model. With the strong encouragement of the Office of Naval Research, Professor McClean has been leading a multi-institutional project to make the model the centerpiece of a fully global ocean forecast system at Fleet Numerical Meteorology and Oceanography Center. She was awarded Grand Challenge computing resources from the Department of Defense, and she is now running and evaluating a huge global simulation on a 10-km 40-level grid using 600 processors of an IBM

supercomputer at the Naval Oceanographic Office. She is coordinating computational efforts from Los Alamos, ocean data contributions from Scripps, and data assimilation efforts from Navy scientists to put a completed system into place at FNMOC; and all signs point to a having a successful operational system there very soon.

**Professor David Yost**, Department of National Security Affairs, received sponsored funding and executed five separate research projects in 2000: European Security and the Revolution in Military Affairs sponsored by the Under Secretary of Defense for Policy, Alternative Futures for NATO-Russia Relations sponsored by the U. S. Air Force, Europe and Information Warfare sponsored by the Naval Information Warfare Activity, NATO's New Role in International Security sponsored by a United States Institute of Peace Fellowship, and NATO's New Role and Implications for the U.S. Navy sponsored by the Chief of Naval Operations (N81). He has supervised 15 student theses in these research areas. During the past year, he prepared four conference presentations, one book chapter, and one journal article.

**Professor Al Washburn's** research covers a wide variety of core areas of practical value to DoD. As a member of the Department of Operations Research, his recent projects have included a truly scientific study of the value of military information, an analysis of the flaming datum problem from anti-submarine warfare, and a theater-level combat model combining simulation and optimization to model a realistically scaled conflict in only a few minutes of computer time. This project combined the Air Force's preferred air-to-ground theater optimization model with the Army's preferred ground-to-ground Lanchester simulation model. Professor Washburn has published, in the guise of short texts and classroom notes, works that have become standard references in search and detection, firing theory, orbital dynamics, game theory, Kalman filtering, and more. Professor Washburn enlivens these topics with a crisp, direct style of writing that makes his work attractive to a wide audience.

**Associate Professor Tom Hofler**, Department of Physics, is an active member in the thermo-acoustic research community. In addition to having been awarded a patent for the large-scale heat driven thermo-acoustic refrigerator he designed and built, Professor Hofler has worked on the numerical modeling of thermo-acoustic drivers. Under Professor Hofler's guidance, **LT Eric Purdy, USN**, was able

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## FACULTY RECOGNITION

### FACULTY RECOGNIZED FOR OUTSTANDING RESEARCH ACHIEVEMENT, *continued from page 48*

to design a flexible numerical model of a thermo-acoustic refrigerator entitled DSTAR. LT Purdy was awarded the NAVSEA award for his exceptional thesis. Recently, Professor Hofler has become involved in teleonar, which lead to a greater understanding of piezoelectric sonar transducers. Application of this understanding has proved useful in current research done in collaboration with Rockwell Science Center on miniature thermo-acoustic refrigerators. The ultimate goal of the project is to provide spot cooling of integrated circuits to prevent their malfunction or failure. He has directed two theses by Turkish Naval students on this project.

**Professor Joseph San Miguel and Assistant Professor Keith Snider** are recognized for outstanding achievement in the Department of Systems Management. Professor San Miguel is recognized for his notable contribution to the issue of security and financial matters of personnel entrusted with sensitive information. Recent events of high profile security breach have heightened interest in this research. Over the past twelve years, Professor San Miguel has assisted the Department of Defense's Security Research Center in cost analysis and financial analysis of national industrial security costs. In addition to DoD, this research involved sponsorship from the Department of Energy, the National Reconnaissance Office, and the Central Intelligence Agency. Since 1998 he has provided financial expertise to the National Security Agency, U.S. Customs, and the Central Intelligence Agency on the design and evaluation of employee financial disclosures for identifying unexplained affluence and financial stress. Professor San Miguel's research encompasses a broad range of issues in financial analysis and reporting, cost analysis and control, and strategic enterprise management.

Professor Snider is recognized for his work on pragmatic theory and its applications in public administration and management, with emphasis on defense systems acquisition. His articles on pragmatism and public administration appeared in two refereed journals, and he also prepared papers for presentation at three academic conferences. One of his papers was featured in a journal series on the work of John Dewey and his contributions to administrative theory. Professor Snider's theoretical work provided a conceptual foundation for his reimbursable applied research project in the area of acquisition lessons learned. This project, sponsored by the Army Acquisition Executive, entailed design and development of an internet-based capability for lessons learned sharing by members of the defense acquisition

community. A distinctive feature of this project's design is its integration of acquisition theory and practice through a focus not only on lessons learned by practitioners through experience, but also on lessons learned through scholarly acquisition research. The benefits of this research are evident in the Army's decision to integrate this project within its Center for Army Lessons Learned at Fort Leavenworth, Kansas, and to expand its efforts to include active collection of lessons from on-going acquisition projects.

**Assistant Professor Robert McNab** of the Defense Resources Management Institute has made several significant research contributions in the past year in the area of transitional economics, publishing two articles in refereed journals and three book chapters. In the first journal article, he and his co-authors examined multi-year budgeting practices in several OECD countries and drew five lessons that they argued were relevant for developing and transitional economies. In a second article, Professor McNab and his co-author examined the tax reform efforts in Eastern Europe and the Newly Independent States and evaluated whether the advice proffered by international institutions and public finance experts was heeded by these countries. From the experience of these countries, they drew lessons on the pace, structure, and breadth of tax reform and how these lessons can be applied in other developing and transitional economies. They developed a static microsimulation model using taxpayer data for the City of Moscow and illustrated how a microsimulation model can be used to estimate the incidence of taxes and the potential revenue impact of structural changes. Professor McNab's work is highly relevant to public finance and budgeting in transitional economies and well-aligned with the Institute's interests in resource management and international involvement. The health of transitional economies is directly relevant to the management of their defense resources.

**Research Assistant Professor Nelson Irvine** is recognized for outstanding research achievement as a member of the Institute for Joint Warfare Analysis. IJWA conducts the data capture and analysis for Fleet Battle Experiments. Capturing and analyzing the electronic data extant in the various hardware and information systems is a crucial part of this effort. To date, detailed requirements for this information have not been available and the information itself has been difficult to obtain. Professor Irvine has taken on the challenge of rectifying this situation at both the requirements front end and the analysis back end. His efforts have significantly improved Fleet Battle Experiment results.

# FACULTY NEWS

## AERONAUTICS AND ASTRONAUTICS

**K.D. Jones** and **M.F. Platzer**, "On the Use of Vortex Flows for the Propulsion of Micro-Air and Sea Vehicles," NATO/RTA Applied Vehicle Technology Panel Symposium, Loen, Norway, 7-12 May 2001.

**J.C.S. Lai** and **M.F. Platzer**, "Characteristics of a Plunging Airfoil at Zero Freestream Velocity," *AIAA Journal*, Vol. 39, No. 3, 531-534, March 2001.

## COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS AND INTELLIGENCE (C4I)

**S.P. Hocevar**, **W.G. Kemple**, and **S.G. Hutchins**, "Self-Synchronization: Preliminary Simulation-Based Research in Where it Effectively Occurs and Key Enablers," 69th Military Operations Research Society Symposium, U.S. Naval Academy, Annapolis, MD, 12-14 June 2001.

**S.G. Hutchins** and **W.G. Kemple**, "Adaptation in Command and Control Organizations," 9th International Telecommunications Systems Conference, Southern Methodist University, Dallas, TX, 15-17 March 2001.

**S.G. Hutchins**, **W.G. Kemple**, **J.A. Poirier**, and **S.P. Hocevar**, "Use of a Novel Organizational Structure to Support Complex Decision Making During Global Wargame 2000," *Proceedings of the 6th International Command and Control Research and Technology Symposium*, U.S. Naval Academy, Annapolis, MD, 19-21 June 2001.

**S.G. Hutchins**, **W.G. Kemple**, **J.A. Poirier**, **S.P. Hocevar**, **D.L. Kleinman**, and **M.G. Sovereign**, "Use of Information Technology to Develop a Collaborative Decision-Making System for Command and Control," *Proceedings of the 6th International Command and*

*Control Research and Technology Symposium*, U.S. Naval Academy, Annapolis, MD, 19-21 June 2001.

**S.G. Hutchins**, **S.P. Hocevar**, **W.G. Kemple**, **D.L. Kleinman**, and **G.R. Porter**, "Enablers of Self-Synchronization for Network-Centric Operations: Planning the Conduct of a Complex Command and Control Experiment," *Proceedings of the 6th International Command and Control Research and Technology Symposium*, U.S. Naval Academy, Annapolis, MD, 19-21 June 2001.

**S.G. Hutchins**, **J.A. Poirier**, **W.G. Kemple**, **S.P. Hocevar**, and **D.L. Kleinman**, "Functionality Required for a Collaborative Command and Control Decision-Making System," 69th Military Operations Research Society Symposium, U.S. Naval Academy, Annapolis, MD, 12-14 June 2001.

**S.G. Hutchins**, **W.G. Kemple**, **J.A. Poirier**, and **S.P. Hocevar**, "Effectiveness of a Novel C2 Organizational System Used During Global Wargame 2000," 69th Military Operations Research Society Symposium, U.S. Naval Academy, Annapolis, MD, 12-14 June 2001.

**W.G. Kemple** and **S.G. Hutchins**, "Collaborative Support for Joint Experimentation," 69th Military Operations Research Society Symposium, U.S. Naval Academy, Annapolis, MD, 12-14 June 2001.

## ELECTRICAL AND COMPUTER ENGINEERING

**M.J. Baretela** and **J.S. Tyo**, "Increasing Prompt Response from an IRA, Using Aperture Shaping," 17th International Radio Science Union Commission B International Symposium, Victoria, BC, Canada, 13-17 May 2001.

**D.J. Fouts** and **P.E. Pace**, "Digital

Target Imaging Architecture for Multiple Large-Target Generation," Office of Naval Research Electronic Warfare S&T Gathering, 9 May 2001.

**D. Jenn**, **P. Pace**, and **J.P. Powers**, "High-Resolution Acoustic Arrays Using Optimum Symmetrical-Number-System Processing," *Acoustic Imaging*, Vol. 24, Hua Lee, ed., Kluwer Academic/Plenum Publishers, New York, 57-64, 2000.

**J.C. McEachen** and **A. Cay**, "Masking Compressed Video Connection Utilization in ATM Networks," *Proceedings of the 2001 IEEE International Symposium on Circuits and Systems (ISCAS 2001)*, Sydney, Australia, May 2001.

**J.C. McEachen**, **K.C. Ow**, and **C.T. Lim**, "A System Level Description and Model of Signaling System," *Proceedings of the 2001 IEEE International Symposium on Circuits and Systems (ISCAS 2001)*, Sydney, Australia, May 2001.

**J.C. McEachen** and **B. Braswell**, *Vulnerabilities in the Control and Management Functions of IEEE 802.11 Wireless Local Area Networks*, Naval Postgraduate School Technical Report, NPS-EC-01-01, February 2001.

**P.N. Pham**, **J.P. Ridder**, and **P.E. Pace**, *Users Guide: Advanced Reactive Electronic Warfare Simulation (ARES) Version 1.12*, Naval Postgraduate School Technical Report, NPS-EC-01-002, March 2001.

**S. Michael** and **R. Pieper**, "A VLSI Implementation of a Universal Programmable Low Sensitivity Sampled Data Filter," IEEE International Symposium on Circuits and Systems, Sydney, Australia, 6-9 May 2001.

**R. Pieper** and **F. Dellsperger**, "Personal Computer Assisted Tutorial for Smith Charts," *33rd Southeastern Symposium on System Theory Proceedings*, Athens, OH, pp. 139-144, March 2001.

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# FACULTY NEWS

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**R. Pieper**, "Laboratory and Computer Tests for Carsons FM Bandwidth Rule," *33rd Southeastern Symposium on System Theory Proceedings*, Athens, OH, pp. 145-150, March 2001.

**R. Pieper** and **S. Michael**, "Application of a Robust Algorithm for Predicting Freeze-Out and Exhaustion Under a Variety of Nontrivial Conditions," *33rd Southeastern Symposium on System Theory Proceedings*, Athens, OH, pp. 289-292, March 2001.

**R. Pieper** and **S. Michael**, "Application of a Robust Algorithm for Predicting Freeze-out and Exhaustion Under a Variety of Nontrivial Conditions," *IEEE International Symposium on Circuits and Systems*, Sydney, Australia, 6-9 May 2001,

**R. Pieper**, **C. Robertson**, **N. DeLeo**, and **P. Buczynski**, "A Missile Aim-Point Sensitivity Study Based on the Mosaic Simulation Package," *Fiestacrow 2001*, San Antonio, TX, 23-25 April 2001.

**J.S. Tyo**, "Optimization of the TEM Feed Structure for 4-Arm Impulse Radiating Antennas," *IEEE Transactions on Antennas and Propagation*, Vol. 49, April 2001.

**J.S. Tyo** and **T.S. Turner**, "Variable Retardance, Fourier Transform Imaging Spectropolarimeters for Visible Spectrum Remote Sensing," *Applied Optics*, Vol. 40, pp.1450-1458, 2001.

**J.S. Tyo** and **C.J. Buchenauer**, "Measurement of Prompt IRA Responses Under Different Focused Aperture Configurations," *Sensor and Simulation Notes #454*, C.E. Baum, ed., USAF Research Lab, Kirtland AFB, NM, March 2001.

**J.S. Tyo**, **M.J. Baretela**, **C.J. Buchenauer**, **L.H. Bowen**, and **E.G. Farr**, "Increase in the Prompt Radiated Field from an IRA by Aperture Design," *SPIE AEROSENSE 2001*, Orlando, FL, 16-20 April.

## INFORMATION SYSTEMS

**A. Borkdetsky**, **K. Brown**, **L. Christianson**, "Feedback Control Model for Managing Quality of Service in Multimedia Communications," *Telecommunications Systems Modeling and Analysis Journal*, 2001 (forthcoming).

**Prof. A. Borkdetsky** was session chair for the Panel on Adaptation in Telecommunications Infrastructure Management, 9th International Conference in Telecommunication Systems, 16-18 March 2001.

The IEEE Computer Society Publications Board has named **Prof. N. Schneidewind** to the Editorial Board and Associate Editor of the *IEEE Transactions on Software Engineering*.

**N.F. Schneidewind**, "Software Maintenance," *Encyclopedia of Computer Science*, 4th ed., Anthony Ralston, Edwin D. Reilly, David Hemmendinger, eds., Nature Publishing Group, London; *Grove's Dictionaries*, USA, 2000, pp. 1624-1627.

**N.F. Schneidewind**, "Investigation of Logistic Regression as a Discriminant of Software Quality," *Proceedings of the 7th International Software Metrics Symposium*, London, England, 328-337, 4-6 April 2001.

**N.F. Schneidewind**, "Data Analysis of Software Requirements Risk," *Proceedings of the 12th European Software Control and Metrics Conference*, London, England, 443-451, 2-4 April 2001.

**N.F. Schneidewind**, "Introduction to Software Reliability with Space Shuttle Example," 2001 Reliability and Maintainability Symposium, IEEE Reliability Society, Philadelphia, PA, 23 January 2001.

**N.F. Schneidewind**, "On the Repeatability of Metric Models and Metrics Across Software Builds," *Proceedings of the Eleventh International Symposium on Software Reliability Engineering*, IEEE Computer Society Press, Los Alamitos,

CA, pp.234-245, 8-10 October 2000.

**N.F. Schneidewind**, "Measuring and Evaluating the Development and Maintenance Process Using Reliability, Risk, Test, and Complexity Metrics," *Eleventh International Symposium on Software Reliability Engineering*, IEEE Computer Society Press, Los Alamitos, CA, 8-10 October 2000, 30 pages.

**N.F. Schneidewind**, "The Interaction of Software Reliability Engineering (SRE) and Maintenance: Opportunities for Collaboration and Integration," *Proceedings of Industry Day, International Symposium on Software Reliability Engineering and International Conference on Software Maintenance*, San Jose, CA, pp. 121-122, 11 October 2000.

**N.F. Schneidewind**, "Can Metrics be Applied Across a Set of Releases or Sites?" *The International Workshop on Empirical Studies of Software Maintenance '2000*, San Jose, CA, 14 October 2000.

**N.F. Schneidewind** and **M. Sahinoglu**, "New Advances in Software Reliability Modeling," *Proceedings of the Fifth Biennial World Conference on Integrated Design and Process Technology*, Dallas, TX, 6 June 2000.

## MATHEMATICS

**Prof. W. Kang** (with Dr. Mumin Song of Ford Motor Company) won the Best Paper Award at the 6th International Conference on Control, Automation, Robotics and Vision, in Singapore, December 2000. The paper, "Manufacturing Based on Information Feedback," was selected from 360 papers submitted.

**W. Kang**, "Normal Forms, Invariants, and Bifurcations of Nonlinear Control Systems," 3rd Nonlinear Control Network (NCN) Workshop.

## MECHANICAL ENGINEERING

**A. Gopinath**, "Thermoacoustic

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## FACULTY NEWS

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Streaming on a Sphere," *Proceedings of the Royal Society*, London (series A), 456(2002), 2419-2439, October 2000.

**A. Gopinath** and E. H. Trinh, "Compressibility Effects on Steady Streaming from a Non-Compact Rigid Sphere," *Journal of the Acoustical Society of America*, 108(4), 1514-1520, October 2000.

**T. Sarpkaya**, "Breakup of Bow Sheets and the Physics of the Spray Formation," Special ONR meeting held at the California Institute of Technology on Ship Technology, 17-19 April 2001.

**T. Sarpkaya**, "On the Force Decompositions of Lighthill and Morison," *Journal of Fluids and Structures*, Vol. 15, 132-140, 2001.

**Prof. T. Sarpkaya** delivered an 8-hour lecture at the Nuclear Regulatory Commission on "Time-Dependent Flow About Perforated Bodies and Strainers," in connection with the assessment of the safety of Nation's nuclear reactors.

**Prof. T. Sarpkaya** was a member of the Aircraft and Vortex Spacing System (AVOSS) Team that has been selected to receive the 2001 Administrator's Award for Turning Goals into Reality (TGIR) from NASA. The team supports the Terminal Area Productivity Project of NASA's Aviation Systems Capacity Program.

### NATIONAL SECURITY AFFAIRS

**R. Looney**, "Economic Effects of Naval Presence in a Globalized World," National Defense University Conference on Globalization and Naval Forward Presence: Issues and Insights from Ongoing Research, Washington, DC, 19 April 2001.

### OCEANOGRAPHY

**P.C. Chu**, J. Lan, C.W. Fan, "Japan/East Sea (JES) Circulation and Thermo-

haline Structure," Part 1 Climatology, *Journal of Physical Oceanography*, 31, 244-271, 2001.

**P.C. Chu**, J. Lan, C.W. Fan, "Japan/East Sea (JES) Circulation and Thermo-haline Structure," Part 2 A variational P-Vector method, *Journal of Physical Oceanography*, 2001.

**P.C. Chu** and X.S. Chen, "Comparison Between Wavenumber Truncation and Horizontal Diffusion Methods in Spectral Models," *Monthly Weather Review*, 129, 152-158, 2001.

**P.C. Chu** and C.W. Fan, "A Three-point Sixth-order Accuracy Progressive Finite Difference Scheme," *Journal of Atmospheric and Oceanic Technology*, 2001.

**P.C. Chu**, S.H. Lu, and Y.C. Chen, "Evaluation of the Princeton Ocean Model Using the South China Sea Monsoon Experiment (SCSMEX) Data," *Journal of Atmospheric and Oceanic Technology*, 2001.

**P.C. Chu** and C.W. Fan, "A Low Salinity Cool-Core Cyclonic Eddy, Detected Northwest of Luzon During the South China Sea Monsoon Experiment (SCSMEX), July 1998," *Journal of Oceanography*, 2001.

**P.C. Chu**, Y.C. Chen, and S.H. Lu, "Evaluation of Haney-Type Surface Thermal Boundary Condition Using a Coupled Atmosphere and Ocean Model," *Advances in Atmospheric Sciences*, 2001.

**P.C. Chu**, "Toward Accurate Coastal Ocean Prediction," *Advances in Mathematical Modeling of Atmosphere and Ocean Dynamics*, Kluwer Scientific Publishing Co., 2001.

**P.C. Chu**, S.H. Lu, and C.W. Fan, "An Air-ocean Coupled Nowcast/forecast System for the East Asian Marginal Seas," *Advances in Mathematical Modeling of Atmosphere and Ocean Dynamics*, Kluwer Scientific Publishing Co., 2001.

**P.C. Chu**, "Hydrodynamics of Mine Impact Burial," ONR Workshop on Mine Impact Burial, Stennis Space Center, MS, 5-7 February 2001.

**P.C. Chu**, "Toward Accurate Coastal Ocean Modeling," Coastal Coupling Workshop, International Council of Scientific Unions/Scientific Committee for Oceanic Research, Miami, FL, 6-9 April 2001.

**P.C. Chu** and **L. Ivanov**, "Kinematic Boundary Condition for Semi-enclosed Sea," ONR Workshop on Ocean Predictability, Cambridge, MA, 1-4 May 2001.

**P.C. Chu** and **L. Ivanov**, "First Passage Time as the Quantitative Measure of Ocean Prediction Skill," ONR Workshop on Ocean Predictability, Cambridge, MA, 1-4 May 2001.

**P.C. Chu** and S.H. Lu, "A Coastal Atmosphere and Ocean Coupled System (CAOCS) for Data Assimilation and Prediction," 11th Conference on the Interaction of the Sea and Atmosphere, American Meteorological Society, San Diego, CA, 14-18 May 2001.

**P.C. Chu** and **L. Ivanov**, "Backward Fokker-Planck Equation for Determining Model Predictability with Uncertain Initial Errors," American Geophysical Union Spring Meeting, Boston, MA, 29-31 May 2001.

### OPERATIONS RESEARCH

**R.E. Looney**, **D. Schradly**, et al, "Estimating Economic Benefits of Naval Forward Presence: A Brief Summary," Chapter 3, *Proceedings of Conference on Globalization and Naval Forward Presence: Issues and Insights from Ongoing Research*, Institute for National Strategic Studies, National Defense University, Washington, DC, 19 April 2001.

**Prof. R. Rosenthal** was invited to attend the April 26th meeting of the

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# FACULTY NEWS

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board on Mathematical Sciences of the National Academy of Sciences. Board members and DoD leaders discussed how the military's interface with the mathematical sciences research community can be improved. According to the Board's Director, Scott Weidman, "the Board is very interested in helping to ensure that the nation has the benefit of the best mathematical thinking when relying on statistical methods, operations research, computational modeling, visualization and pattern recognition data analysis, search techniques, etc. [The Board] can help create links between mathematical science researchers and the DoD user community, and give important technical advice to help the user community achieve its goals. The emphasis of the April 26th sessions was on the operational military rather than on those segments of the acquisition pipeline where ties to the research community already exist.

**S.M. Sanchez**, D. Ferrin, T. Ogazon, J. Sepulveda, and T. Ward, "Emerging Issues in Healthcare Simulation," *Proceedings of the 2000 Winter Simulation Conference*, 1999-2003, 2000.

**S.M. Sanchez**, "Robust Design: Seeking the Best of All Possible Worlds," *Proceedings of the 2000 Winter Simulation Conference*, pp. 69-76.

**D. Schrady**, "Combat Logistics," Commander Naval Forces Korea Commander's Conference, Port Hueneme, CA, 10 February 2001.

**K. Wood**, "A Stochastic Program for Optimizing Military Sealift Subject to Attack," Workshop on Decision-Making Under Uncertainty, Molde, Norway, May 2001.

## PHYSICS

**Prof. C. Olsen** and two of his students, **LT J. Reese** and **LT J. Alfieri**, visited the Southern Command, Special

Operations Command and the Joint Interagency Task Force, East 9-11 May 2001 briefing on their sensor fusion work with National Technical Means (NTM).

## SCHOOL OF INTERNATIONAL GRADUATE STUDIES

**Prof. D. Angelis** completed a study for the Air Force Materiel Command Directorate on requirements of "Value of Program Management."

**Prof. D. Angelis** was appointed as group leader for the Consortium on Advanced Manufacturing - International (CAM-I) study on cost information requirements of program managers.

## SCHOOL OF BUSINESS AND PUBLIC POLICY

J.J. Bartholdi, III and **K.R. Gue**, "Reducing Labor Costs in an LTL Crossdocking Terminal," *Operations Research*, 48(6), 823-832, 2000.

**E.J. Barrett** and R. Peterson, "Apprentive Learning Cultures: Developing Competencies for Global Organizing," *Organization Development Journal*, Vol. 18, No. 2, Summer 2000.

**M.W. Boudreau**, "Transitioning from Fielding to Steady-State Sustainment," *Army AL&T*, January-February 2001.

**W.R. Gates** and **M.J. McCarthy**, "United States Marine Corps Aerial Refueling Requirements Analysis," *Proceedings of the 2000 Winter Simulation Conference*, 1075-1081.

**D.R. Henderson**, "How (some) Socialists Become Capitalists: The Cases of Three Prominent Intellectuals," *Critical Review*, Vol. 13, Nos. 3-4.

**S. Hocevar**, **J. Cuskey**, and J. Gray, "New Directions in Defense Contracting: A Customer Focus," 62nd National Conference of the American Society for Public Administration, Newark, NJ, 10-13 March 2001.

**Prof. K. Kang** was the Program Chair

for the 2000 Winter Simulation Conference held in Orlando, FL, 10-13 December 2000. He received the distinguished service award from the Winter Simulation Conference Board of Directors during the conference.

J.A. Joines, R.R. Baton, **K. Kang** and P.A. Fishwick, eds., *Proceedings of the 2000 Winter Simulation Conference*, Vols. 1-2.

**L.R. Jones**, et al., "Learning from International Public Management Experience," *Learning from International Public Management Reform*, J. Guthrie and P. Steane, eds., Vol. 11A, Oxford, JAI-Elsevier Science, 2001.

**L.R. Jones**, J. Guthrie, and P. Steane, eds., *Learning from International Public Management Reform*, Volumes 11A and 11B, Oxford, JAI-Elsevier Science, 2001.

**L.R. Jones**, and R. Mussari, "Management Control Reform within a Responsibility Framework in the U.S. and Italy," **L.R. Jones**, J. Guthrie, and P. Steane, eds., *Learning from International Public Management Reform*, Vol. 11B, Oxford, JAI-Elsevier Science, 2001.

**L.R. Jones** and R. Mussari, "Public Management Reform in the U.S. and Italy: Accounting, Measurement and Financial Reporting," *The International Public Management Review*, Vol. 1, No. 1, 91-137, 2000.

**L.R. Jones** and F. Thompson, "Lessons from the Private Sector for Public Sector Reform," *Proceedings of the International Applied Business Research Conference*, Cancun, Mexico, 1 March 2001.

**L.R. Jones** and F. Thompson, "Un Modelo para a Nova Gerencia Publica," *Rivista do Servico Publico*, 51, 41-79, 2000.

**L.R. Jones** has been appointed Senior Editor of *The International Public Management Review*.

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## FACULTY NEWS

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**I. Lewis**, "Defense Acquisition University External Acquisition Research Program," 62nd National Conference of the American Society for Public Administration, Newark, NJ, 10-13 March 2001.

**I. Lewis** and **D.Y. Coulter**, "The Voluntary Intermodal Sealift Agreement: Strategic Transportation for National Defense," *Transportation Journal*, 40(I), 26-34, Fall 2000.

**M.E. Nissen**, "Agent-Based Supply Chain Disintermediation vs. Re-intermediation: Economic and Technological Perspectives," *International Journal of Intelligent Systems in Accounting, Finance & Management* 9, 2000.

**M.E. Nissen**, "An Experiment to Assess the Performance of a Redesign Knowledge System," *Journal of Management Information Systems*, 17:3, Winter, 2000-2001.

**M.E. Nissen**, "An Intelligent Tool for Process Redesign: Manufacturing Supply Chain Applications," *International Journal of Flexible Manufacturing Systems*, 12:4, 321-339, 2000.

**M.E. Nissen**, "Intelligent Agent Intermediation of Patient/Physician Relationships," *Proceedings of the International Conference on Information Systems*, Brisbane, Australia, December 2000.

**N. Roberts**, "Coping with Wicked Problems: The Case of Afghanistan," **L.R. Jones, J. Guthrie, and P. Steane, eds.,** *Learning from International Public Management Reform*, Vol. 11B, Oxford, JAI-Elsevier Science, 2001.

**N. Roberts**, "Review of

Charting Chicago School Reform: Democratic Localism as a Lever for Change," *Administrative Science Quarterly*, December 2000.

**N. Roberts** and **L. Jones** have been selected as co-editors of a new book series: *Public Management*, by Information Age Press, Greenwich, CT. The first book in the series will be published in 2001.

**M.B. Rodrigues, M. Karpowicz and K. Kang**, "A Readiness Analysis for the

Argentine Air Force and the Brazilian Navy A-4 Fleet via Consolidated Logistics Support," *Proceedings of the 2000 Winter Simulation Conference*, 1068-1074.

**J.K. Shank, J. San Miguel, and L. Carr**, "ERP as a Strategic Management Tool: Six Evolutionary Stages," Chapter A7, *Handbook of Cost Management*, Warren, Gorham, and Lamont, Boston, MA, 2001.

**K.F. Snider**, "Integrating Individual and Organizational Learning: The Case Study Approach in Teaching Public Administration and Agency Lessons Learned Systems," 24th Annual Conference, Teaching Public Administration, Tempe, AZ., 4-5 February 2001.

**K.F. Snider**, "Lessons Learned Systems as Resources for Acquisition Training, Education, and Research," Defense Acquisition University Conference 2000, University of Maryland, 14-17 November 2000.

**K.F. Snider**, "Studying Defense Acquisition as Public Administration," 62nd National Conference of the American Society for Public Administration, Newark, NJ, 10-13 March 2001.

**J. Suchan**, "The Effect of Interpretive Schemes on Videotelecommunications Conception, Implementation, and Use," *Journal of Business and Technical Communication*, Vol. 15, No. 2, April 2001.

**G.F. Thomas**, "Forging Our Own Path: Building Synergy from Opposing Forces: Response to Pomerence and Rogers," *Journal of Business Communication*, 38(1).

### PROMOTION AND TENURE ACTIONS FOR ACADEMIC YEAR 2001

Promotions and awards of tenure were recently announced by the Provost.

#### Promotion to Associate Professor and Award of Tenure:

**Donald Brutzman**, Undersea Warfare Academic Group

**Fariba Fahroo**, Department of Mathematics

**Jim Felli**, Defense Resource Management Institute

**Susan Hocevar**, Graduate School of Business and Public Policy

**Cynthia Irvine**, Department of Computer Science

**Qing Wang**, Department of Meteorology

#### Award of Tenure:

**Bill Gates**, Graduate School of Business and Public Policy

#### Promotion to Professor:

**Indranath Dutta**, Department of Mechanical Engineering

**Garth Hobson**, Department of Aeronautics and Astronautics

**Jim Wirtz**, Department of National Security Affairs

**Jim Luscombe**, Department of Physics

**Philip Pace**, Department of Electrical and Computer Engineering

#### Promotion to Senior Lecturer:

**Ahmad Ghorieshi**, Department of National Security Affairs

**Wally Owen**, Graduate School of Business and Public Policy

#### Promotion to Research Associate Professor

**Wieslaw Maslowski**, Department of Oceanography

**Julie McClean**, Department of Oceanography

*Congratulations!*

# STUDENT PROJECT

## SEA LANCE, *continued from page 5*

manning concept.

The weapons suite of the craft (Figure 3) is capable of detecting, classifying and engaging aircraft, missiles and small surface combatants. The combatant has a 4-cell Harpoon/SLAM launcher capable of engaging both surface and land targets. It also has a 51-cell surface-to-surface and surface-to-air missile system that is outfitted with active, semi-active and infrared guided missiles. Additionally, it has (2) 30 mm guns similar to those proposed on the AAV and LPD-17 class.

The combat systems suite of the combatant (Figure 4) is capable of operating in a wide range of environments. The air/surface search radar has a range of 54 Nm while the infrared search and track (IRST) as well as the fire control radar have a range of 20 Nm. The electro-optical suite has a range of 10 Nm and the mine-avoidance sonar has a detection range of approximately 350 yards. Additionally it is equipped with an ESM suite and phased array communications antennas. The entire suite is enhanced by the use of an advanced enclosed mast. The key search sensors are nominally located 28 to 34 feet above the water line. However, the search radar, IRST and ESM systems are mounted on a partially telescoping mast that can extend them to a nominal 42 to 48 feet above the water line. This extends the horizon well beyond the 10 Nm for a

nominal 3-m altitude target. It also provides for decreased radar cross section (RCS) when the mast is retracted within the advanced enclosed mast.

The radar cross section of the SEA LANCE was controlled  
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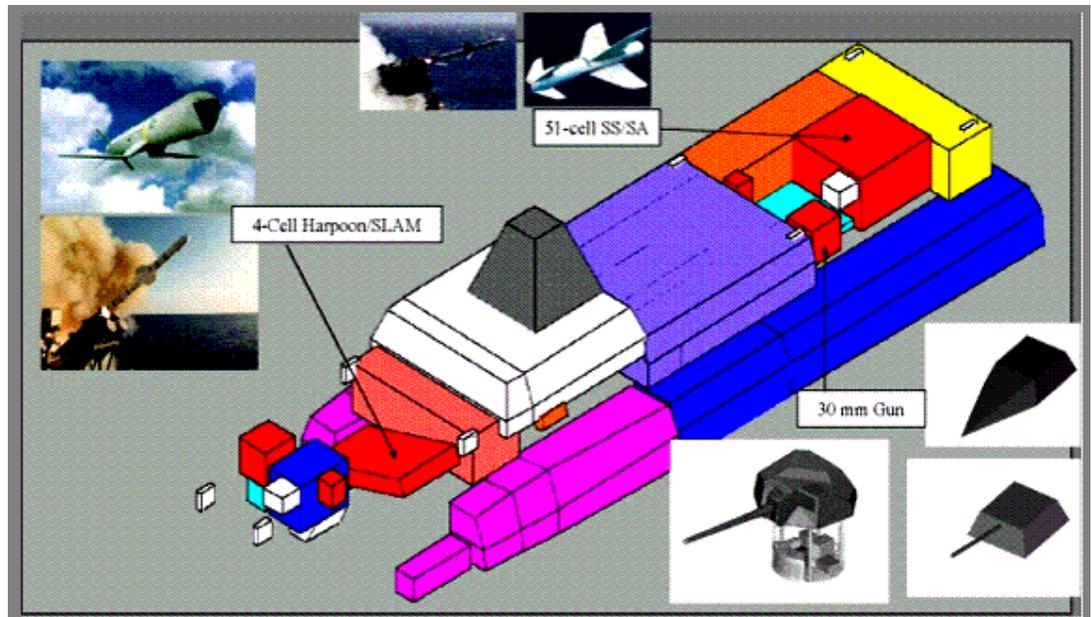


Figure 3. Weapons Suite of the SEA LANCE Combatant.

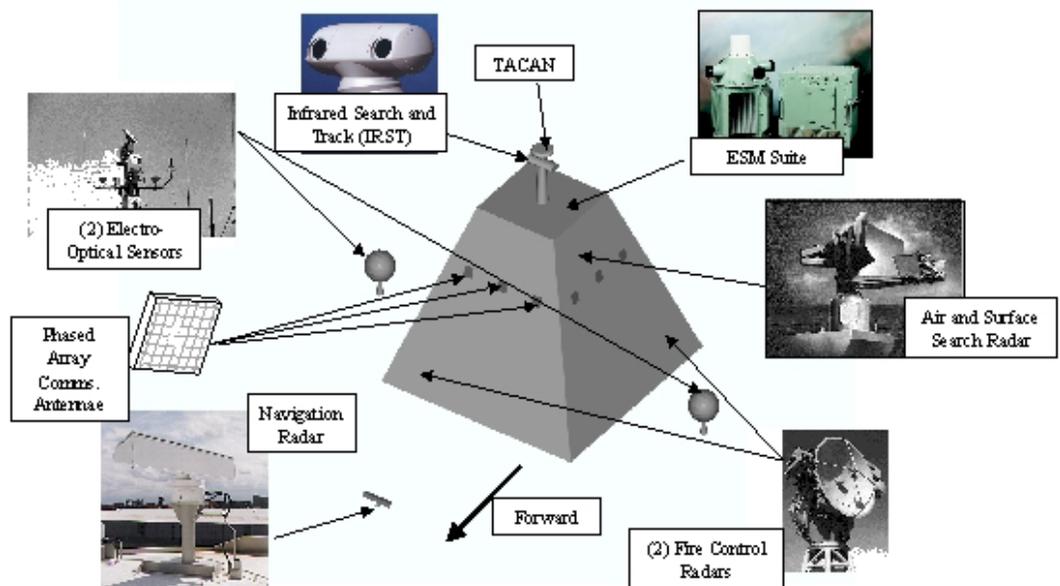


Figure 4. Arrangement of Sensors within the Mast of the Combatant.

# STUDENT PROJECT

## SEA LANCE, *continued from page 55*

by careful geometric shaping and elimination of all topside clutter. All unnecessary topside clutter was housed within the ship. The cleats were modeled after those onboard submarines. The boat deck and rigid hull inflatable boat (RHIB) were housed inside the skin of the ship to increase survivability and reduce RCS. A RCS prediction program evaluated the cross section at roughly 1/10 that of a conventional 450 LT combatant. With addition of radar absorbing coatings, the cross-section could be reduced even further. With a resulting cross-section smaller than most fishing boats or coastal merchant craft, SEA LANCE will be difficult to target. Exhausting engine effluents between the twin hulls and restricting heat-generating electronics to the interior of the center hull reduce the infrared signature.

The acquisition costs for SEA LANCE was estimated using available parametric cost estimating relationships. The acquisition costs were estimated at approximately \$83.9 million dollars for the first combatant and grid deployment module pair. Assuming a learning curve through the first ten ships, the cost of the 11th and subsequent pairs will be \$82.7 million. The first squadron will cost \$914 million with follow-on squadrons at \$827 million. That is, each squadron of SEA LANCE pairs would cost roughly the same as a single DDG-51. Deployment cost (acquisition cost plus cost of expendable weapons and crew training) is expected to average about \$100 million per Combatant/GDM pair. These cost estimates do not include the cost of the Expeditionary Grid components, as they are not yet adequately defined.

SEA LANCE is a robust system of vessels that will ensure

the deployability, flexibility, versatility, lethality and survivability necessary within the contested littorals to provide the operational commander with the awareness and access assurance capability lacking in the fleet of the POM. SEA LANCE in conjunction with the Expeditionary Warfare Grid will allow gaining, maintaining, sustaining and exploiting access to the littorals, in order to project power into enemy territory.

SEA LANCE embodies the capabilities discussed in the Mission Needs Statement. The design meets or exceeds all of the requirements set forth in the Operational Requirements Document. The relatively low cost, flexible and stable hull form as well as the high degree of combatant capability makes SEA LANCE a very effective choice for deployment of the Expeditionary Warfare Grid. The combatant is capable of operations in the contested littoral environment against a wide range of threats without posing undue risk to the power projection assets of the fleet of the POM. The GDM has the flexibility to accept a multitude of diverse payloads. This increases the versatility of SEA LANCE far beyond those outlined in the requirements documents.

A complete copy of the report can be found at the TSSE website located at <http://www.nps.navy.mil/tsse/>. The site also includes all of the previous work for the ten-year history of the TSSE program, as well as the program points of contact. Additionally, you can view the ongoing efforts of Professor Fotis Papoulias to expand the programs naval architecture and HM&E integration courses into the distance-learning environment.

## SMALL SATELLITE DESIGN PROGRAM, *continued from page 17*

Astronautics, NPSAT1 was brought to the forefront of course work as the design project for the Space Systems II (AA4831) course and the Spacecraft Attitude Determination and Control (AA3818) course, during the fall quarter, 2000. The former course, AA4831, largely defined the concept of operations (CONOPS) of the spacecraft mission. The major challenge for the design team was to maximize operation of the payloads while maintaining a very tight power budget. Mission operations were defined in an iterative process of analysis and design trades, followed by more analysis. Two of the design team members, both in the Space Systems Operations Curriculum, LT Chuck Reuer, USN, and LT Todd Zirkle, USN,

have taken on thesis topics related to NPSAT1; performing detailed CONOPS work and attitude control subsystem design, respectively.

The AA3818 course provided a comprehensive look at the NPSAT1 attitude control subsystem (ACS) design. The ACS design offers autonomous attitude control using only a 3-axis magnetometer as a sensor input and magnetic torque rods for actuators. On-board processing provides information of the location of the satellite through an orbit propagator in software. Coarse pointing requirements of  $\pm 15$  degrees were well exceeded by the design with pointing capability of less than a degree and very low rotational rates as well.

# FEATURED PROJECT

## ESTIMATING NEAR-SURFACE ATMOSPHERE PROPERTIES, *continued from page 13*

propagation field tests off Wallops Island, VA (Figure 6) designed to evaluate estimation of near-surface profiles from routine measurements and to support the Interactive Adaptation of Fire Control Sensors to the Environment by collecting the pertinent data in environments that approximate those encountered by ships at sea. Radar propagation collection included propagation versus range at three frequencies and two radar heights and SPY-1 sea clutter data. The objective of this project is to develop the means to allow ships to remotely sense low altitude propagation and clutter using shipboard fire control sensors and local meteorological measurements, and to use this information to improve sensor and combat system performance through adaptation to existing conditions.

Preliminary evaluations of the NPS refractivity model during the Wallops 1998 and 2000 tests have demonstrated

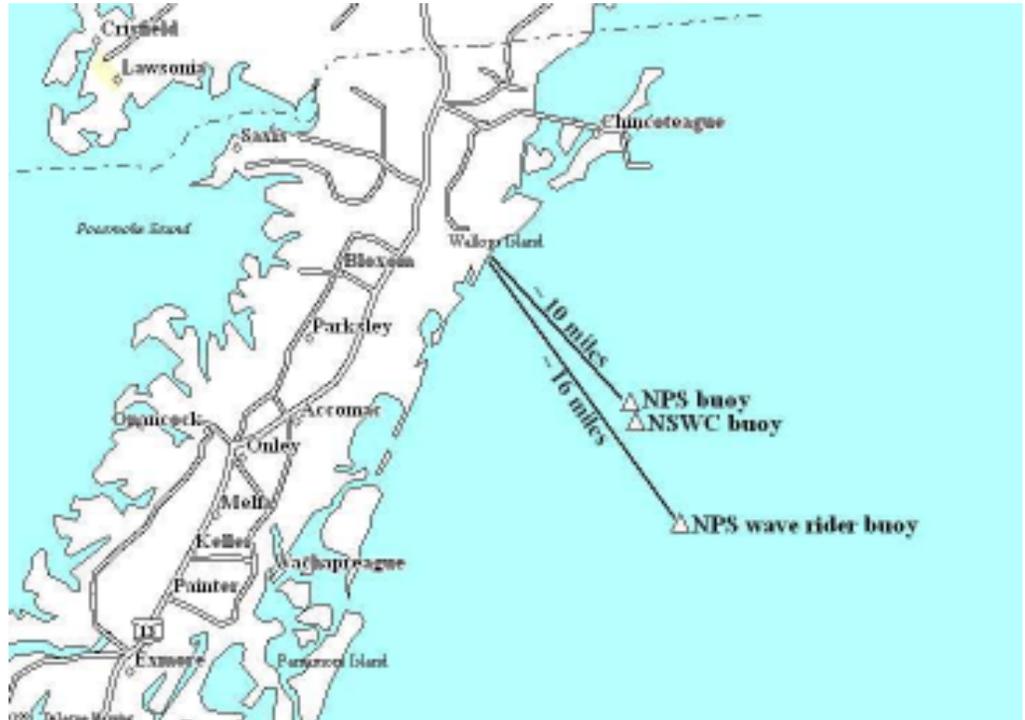


Figure 6. Wallops Island propagation field-test location.

that modifications to the model and improved integration with radar propagation assessment tactical decision aids (TDAs) are necessary to maximize its benefits to the war

fighter. In particular, the TDAs require continuous refractivity descriptions from the surface throughout the boundary layer, which requires merging shipboard and upper-level measurements. Figure 7 shows differences between observed and calculated field strengths for two different range intervals between

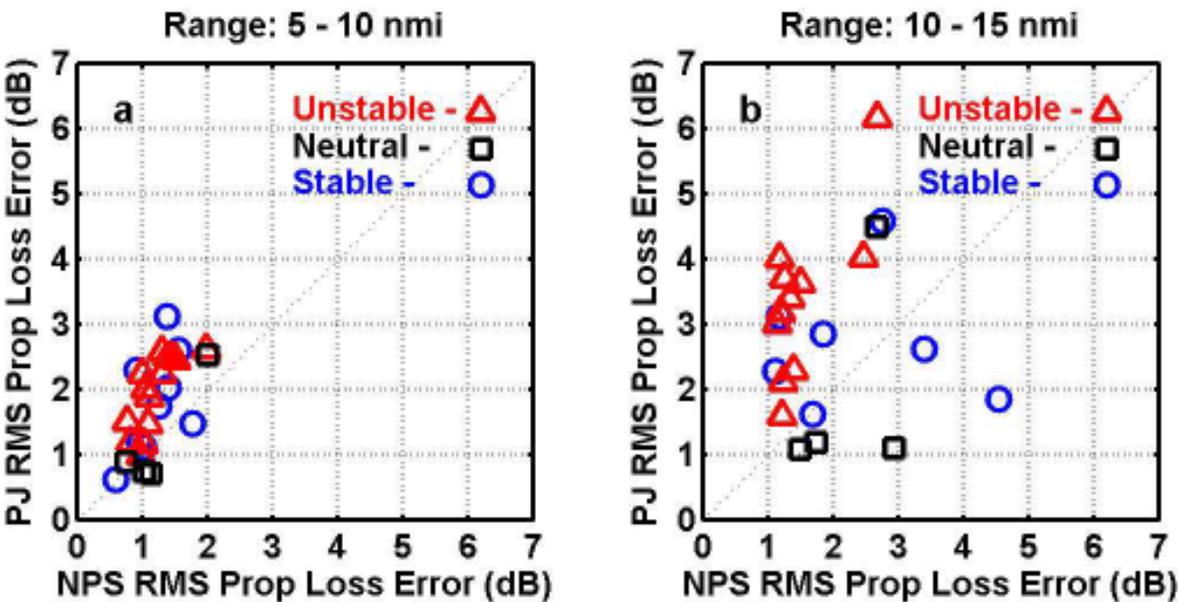


Figure 7. Comparison of observed/models radar.

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## FEATURED PROJECT

### ESTIMATING NEAR-SURFACE ATMOSPHERE PROPERTIES, *continued from page 57*

the NPS and an existing operational evaporation duct model. Depending on the air-surface temperature difference (unstable, neutral, or stable). The NPS model provides 1-2 dB improvements at 5-10 nm range and 2-3 dB improvements at 10-15 nm range, which are critical amounts for low fast-moving target detections.

#### Present Research Activities

An important experiment on the affect of the atmospheric surface layer as well as the surface itself on propagation this coming year is the Rough Evaporation Duct (RED) Experiment to be conducted off Hawaii. RED is funded by ONR and organized by SPAWAR Systems Center (SSC), San Diego. NPS is involved in RED since it addresses both radar and IR objectives with respect to the marine wave, surface and boundary layers to 1) determine the extent to which ocean surface roughness modifies both extinction and the distribution of EM (radar and IR) refractivity, and 2) evaluate and validate new parameterizations, accounting for surface roughness, of meteorological quantities and aerosol distributions.

RED is part of an evaluation/formulation of models for radar performance being influenced by surface roughness as well as near-surface refraction conditions and of models for IR extinction and refraction with relatively high sea states and sea surface temperature/humidity conditions. RED will occur over a one-month period this summer, mid-August to mid-September, 2001 offshore of Oahu, Hawaii with the Scripps Institute of Oceanography R/P FLIP and NPS Department of Meteorology mid-path buoy, and the NPS Center for Remotely Piloted Aircraft Studies (CIRPAS) Twin Otter aircraft being principal platforms. R/P FLIP is the key platform because of it being at the ends of both the radar (Rf) and IR (EO) paths, moored 10 km off the NE coast of Oahu (Figure 8). Certainly, R/P FLIP is crucial to the RED success as it is fully instrumented for near-surface profiles and turbulence and is at the end-points of a 35 km radar path and a 15 km IR path. Equally crucial is the NPS buoy since it will provide information at the critical mid-path or near-horizon location.

#### Interaction with Fleet

Recently a Mobile Environmental Team embarked on the *USS PORT ROYAL* during an operational deployment to examine methods of integrating the METOC and Surface Warfare battle spaces. A report by the Port Royal CO and the METOC team officer, "Exploiting the Environment to Win

in the 21st Century," resulted from this deployment. This White Paper stressed the need to inject METOC considerations into the tactical picture to optimize sensor coverage for the current environment and to benefit operational decision-making. An important White Paper recommendation was to create a joint SWO/METOC technology package in which combat systems algorithms and atmospheric assessment/predictive tools are inclusive of environmental conditions and radar specifications and are fully compatible. This technology package would consist of components to a) determine what the current atmospheric conditions are; b) assess how the environmental conditions affect radar detection of various threats; and c) recommend radar settings to optimize sensor coverage for the current environment.

The NPS Department of Meteorology is unusually well situated to perform the necessary tasks required to maximize the environmental/propagation assessment tools benefits to the war fighter, due to just described unique capabilities and experience in basic research on near-surface refractivity and turbulence modeling, and in applied research in at-sea radar and IR propagation assessment with mid-path buoy measurements. Further, NPS has the student participation, e.g. Sommer (2000). An initial task for NPS in cooperation with JHU/APL was to prepare a Rules of Thumb document that would help folks from different cultures, i.e. METOC AGs and Radar Systems Controller, to be more effective in working together.

#### References

- Frederickson, P. A., K. L. Davidson, C. R. Zeisse, and C. S. Bendall, 2000a "Estimating the Refractive Index Structure Parameter (Cn<sup>2</sup>) Over the Ocean Using Bulk Methods," *Journal of Applied Meteorology*, Vol. 39, pp. 1770-1783, October 2000.
- Frederickson, P., K. Davidson, and A. K. Gorch, 2000b, *Operational Bulk Evaporation Duct Model for MORIAH*, Naval Postgraduate School Technical Report, NPS-MR-2000-002, 5 May 2000, 69 pages.
- Jensen, D. R., S. G. Gathman, C. R. Zeisse, C.P. McGrath, G. Del Leeuw, M. H. Smith, P. A. Frederickson, and K. L. Davidson, 2001, "Electroptical Propagation Assessment in Coastal Environments (EOPACE) Summary and Conclusions," *Optical Engineering*, (in press).
- Sommer, William L., 2000, *Difficulties in Identifying and Evaluating Surface-based and Evaporative Duct Impacts*, NPS Masters Thesis, December 2000, 139 pp.

# CONFERENCE CALENDAR

## UPCOMING CONFERENCES/SHORT COURSES/MEETINGS AT NPS

<i>Date</i>	<i>Title</i>	<i>Sponsor</i>
2-7 Jun 01	Joint Meetings of the ACM Symposium on Access Control Models and Technology (SACMAT) and ACM International Conference on Policies for Distributed Systems and Networks (Policy 2002)	Naval Postgraduate School; Office of Naval Research
5-8 Jun 01	The Technical Cooperation Program (TTCP)	Office of Naval Research
22-23 Jun 01	36th Annual Colonel Allyn D. Burke Memorial Dental Symposium	Colonel Allyn D. Burke Memorial Dental Study Club
26-28 Jun 01	Concepts to Technologies Wargame (CONTECH 01)	Office of Naval Research
27-29 Jun 01	NATO Conference	Office of the Secretary of Defense
23-27 Jul 01	Classified Advanced Technology Update	Naval Postgraduate School
28-30 Aug 01	Modeling, Virtual Environments and Simulations (MOVES)	Naval Postgraduate School
23-25 Jan 02	AIAA Strategic and Tactical Missile Systems Conference	American Institute of Aeronautics and Astronautics
10-15 Mar 02	Hardened Electronics and Radiation Technology Conference	Defense Threat Reduction Agency, Sandia National Laboratories, U.S. Army Space & Missile Defense Command, Navy Strategic Systems Program Office
22-25 Apr 02	5th International Technology and the Mine Problem Symposium	Naval Postgraduate School, Defense Advanced Research Projects Agency

NPS has excellent facilities for hosting conferences, workshops, symposia, and meetings. The wide range of facilities can accommodate both small and large groups. Additional rooms are available for smaller functions or breakout sessions. Conferences classified through SECRET can be accommodated on the NPS campus. Sensitive Compartmented Information Facility (SCIF) facilities exist and may be available for small groups on a more restricted basis. For more information, contact the NPS Conference Coordinator, Eileen Hamilton, at 831-656-2426 or by e-mail, eehamilt@nps.navy.mil.

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