For many years the Naval Postgraduate School has had research and education programs directed at unmanned and autonomous vehicles. These efforts have covered air, underwater, land, and sea surface vehicles and have spanned the field from basic research to direct support for Fleet experiments and exercises. They also have covered a range of interest from policy and concepts of operation, to modeling and simulation, and design, test, and evaluation of new vehicles. Our Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS) operates manned and unmanned aircraft (including Predator, Altus and Gnat Unmanned Aerial Vehicles (UAVs), Pelicans, and... --continued on page 2
The agile flight of birds and insects has been an inspiration to scientists for many centuries. However, since the first part of the 20th century, little effort has been directed toward understanding and exploiting the aerodynamics demonstrated by these creatures. The lack of industrial applications has relegated the study of flapping wing flight to something of a hobby-like status with very little research funding available for dedicated scientific investigations such that most notable progress has been made by model airplane enthusiasts.

However, recent interest in small, unmanned air vehicles (UAVs) and micro air vehicles (MAVs) has led to a renewed interest in flapping-wing propulsion, and an influx of research funds. The ability of the dragonfly to hover and maneuver in confined areas, as well as achieve high speeds and to fly in turbulent air has drawn significant interest, but has as yet proved to be a formidable goal for scientists to duplicate numerically or experimentally.

The work of Distinguished Professor Max

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UNMANNED AND AUTONOMOUS VEHICLE PROGRAMS, continued from page 1

a Twin Otter) to provide flight services to the scientific and research, development, test and evaluation communities. Our Aeronautics and Astronautics Department recently completed flight demonstrations of a micro-UAV which utilizes flapping airfoil propulsion. The Center for Autonomous Underwater Vehicles is currently conducting experiments in Monterey Bay with two vehicles, ARIES and REMUS. The Center for Defense Technology and Education for the Military Services (CDTEMS) is currently supporting a series of field experiments with Special Operations Forces to examine the performance of new communications systems used with multiple UAVs, ground forces, and ground sensors. This is a highly interdisciplinary effort, involving students and faculty from across the campus as well as active involvement from several companies and government laboratories. Other current efforts include the design and demonstration of autonomous landing of UAVs on ships, swarming UAVs for SIGINT, and human factors in UAV operations. NPS also offers short courses directed at current UAV technology and issues.

This wide range of research and educational activity is directly related to Navy Power 21 and supports activities at NPS in Network Centric Warfare, FORCEnet, and Sea Trial. This edition of the Research Newsletter gives an overview of many of the current programs at NPS that support improved warfighter effectiveness through the use of unmanned and autonomous vehicles.
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UNMANNED VEHICLES

A PLANNING MODEL FOR SCUD-LAUNCHING TRANSPORTER ERECTOR LAUNCHER (TEL) HUNTING WITH UNMANNED AERIAL VEHICLE-SPECIAL FORCES COOPERATION

Distinguished Professor Donald P. Gaver, Department of Operations Research
Professor Patricia Jacobs, Department of Operations Research
CDR Russell Gottfried, United States Navy
Dr. Gennady Samordnitsky, National Research Council Senior Research Associate

Introduction and Overview
Intelligence suggests that one (or more) SCUD-launch-capable TEL system(s) (Red) are in a particular region, \( R \). The SCUD objective is to target Blue or allied units. To thwart Red’s objectives, Blue assigns sensors, communication, and perhaps attack, assets to selected locations in \( R \); for example, \( S \) (e.g., -10) Special Forces (SF) personnel are emplaced at suitable Observation Points, where “suitable” implies that Red S/T (SCUD and TEL System) Hiding Places (HP) and Transit Routes (TR), e.g., roads, may be seen. It is tactically important the SFs be undetected by Red; otherwise, the TEL(s) may hide or evacuate the region (this does have suppressive effect, and thus military value). SF actions can guide strike on Red S/T assets when the latter reveal themselves to shoot.

Of particular interest is the use and usefulness of Unmanned Aerial Vehicles (UAVs) to supplement/cue the SF efforts. Their success depends upon location (near an emerging/setting-up S/T), speed of detection and location, speed of transmission to a Shooter, and speed and accuracy of Shooter response. Further, the UAV-SF combination will endeavor to conduct successful Battle Damage Assessment, and guide re-targetting if necessary. Note that Blue actions must be conducted when Red utilizes various deception devices plus communication jamming.

Models
The mathematical models proposed and analyzed depend on specific service-time (e.g., detection, communication, failure propensity, maintenance, etc.) capabilities that must be specified as parameters and stochastic processes. The models must incorporate realistic S/T evasive and decoy actions, again as parameters and stochastic processes. These must all be estimated from auxiliary information and experimentation, and can only be known approximately. Further, they will tend to vary with environmental conditions (e.g., fog cover, day or night, operator skill, training, and fatigue, and enemy/Red actions).

An integrated modeling approach subsequently will illustrate the role of the various parameters and Red and Blue assets as CONOPS in affecting the damage that can be done by the S/Ts, and the defensive power of Blue forces of different size and composition.
The Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS) is a research center at the Naval Postgraduate School. The Office of Naval Research established CIRPAS in the spring of 1996 for the scientific community. CIRPAS provides measurements from an array of airborne and ground-based meteorological, aerosol and cloud particle sensors, radiation and remote sensors. The data are reduced at the facility and provided to the user groups as coherent data sets. The measurements are supported by a ground-based calibration facility. CIRPAS also conducts Unmanned Aerial Vehicle (UAV) and surrogate UAV flight activities in support of a wide range of government activities, including field experimentation and Fleet exercises. CIRPAS conducts payload integration, reviews flight safety, and provides logistical planning and support as a part of its research and test projects around the world. The center operates a variety of manned aircraft and Unmanned Aerial Vehicles (UAVs). The facility provides unique flight operation and scientific measurement services by:

- Providing access to manned aircraft, UAVs and support equipment, as well as to scient-

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**UV-18A ‘Twin Otter’**: The CIRPAS UV-18A ‘Twin Otter’ has a large useful load which makes it ideal for carrying instrumentation for atmospheric/oceanographic research. It is also utilized as a platform to permit NPS faculty and students to demonstrate some of the latest technologies with the Fleet as they transit along the Monterey coastline. The twin turboprop Short Takeoff and Landing (STOL) aircraft can cruise at very low speeds for long durations. The aircraft has a maximum takeoff weight of 13,500 pounds.

**Pelican**: The Pelican is a highly modified Cessna 337 Skymaster originally developed by the Office of Naval Research for low-altitude, long-endurance atmospheric and oceanographic sampling. With additional support from NASA’s ERAST Program, the air vehicle has been configured to operate as a UAV surrogate. In the UAV surrogate role, Pelican provides a low-risk, low-cost test and evaluation platform by avoiding the airspace restrictions and other complications associated with unmanned aircraft operations. CIRPAS’s second Pelican air vehicle is a converted Cessna O2-A. It is operated without the Predator avionics equipment and is available for use in support of a variety of generic payload demonstrations.
Altus Single Turbo (ST) UAV: The Altus Single Turbo (ST) UAV was developed by General Atomics ASI to support high-altitude atmospheric monitoring requirements of NASA’s Environmental Research Aircraft and Sensor Technology Program. The Altus™ UAV is based on the proven Predator® and GNAT™ line of unmanned aircraft. The Department of Energy’s Sandia National Labs funded the fabrication of a single-stage turbocharged Altus™ UAV to support the Atmospheric Radiation Measurement (ARM) Science Campaign. As a result of a cooperative agreement with DOE, CIRPAS provides the vehicle’s services during the remainder of the year to other users.

Predator UAV (above): CIRPAS maintains and operates the U.S. Navy’s only two Predator UAVs. One air vehicle is configured with the EO/IR, SAR and Ku-band SATCOM payloads; the other aircraft has the EO/IR payload only. The Predators and payloads were provided to CIRPAS as a result of the Center’s Tactical Control System (TCS) developmental and operational test support. The air vehicles and payloads provide support for U.S. Joint Forces Command and are also available for other RDT&E or CONOPS development activities on a not-to-interfere basis with the TCS Program Office objectives.

GNAT-750 UAV (below): The GNAT-750 UAV was developed by General Atomics ASI to support unmanned, medium altitude, endurance surveillance and other sampling requirements. The GNAT-750 is the predecessor to the Predator UAV.
specifications.

- Integrating auxiliary payloads, as required, and handling flight safety and logistics tasks, allowing the user to concentrate on his specific mission goals.

CIRPAS is also a National Research Facility of the University National Oceanographic Laboratory System (UNOLS).

CIRPAS Maintenance and Operation Facilities: CIRPAS is based at the Marina Municipal Airport (former U.S. Army's Frizsche Field). The hangar facility provides a 30,000-sq. ft. floor with offices and workrooms on two levels. The facility includes a machine shop, electronics room and a calibration lab for the upkeep of scientific instrumentation. McMillan Airfield, Camp Roberts, CA (shown at right), provides CIRPAS with a unique base of operations for UAV flight activity. The Camp Roberts California Army National Guard Training Site is 90 miles south of the Marina facility and approximately 25 miles east of the Pacific Ocean. McMillan Airfield provides the opportunity for local area flights with reduced deployment costs. The airfield is remote from populated areas. The Camp Roberts' weather pattern allows for a high number (250 or more) of flight days per year. The airfield is within restricted area designated R-2504 (surface to 15kft MSL). A restricted area designated R-2513 lies within the boundaries of nearby Fort Hunter Liggett. R-2513 is designated a restricted area from surface to 23kft MSL.

Ground Control Station: The General Atomics ASI Ground Control Station (GCS) provides aircraft control functions for the CIRPAS-operated UAVs. The GCS has redundant Pilot/ Payload Operating Stations and is housed in a rugged, 18-ft long wheeled container. CIRPAS currently owns two GCSs and associated Ground Data Terminals capable of operating Predator/Altus/GNAT-750/Pelican air vehicles. GCS #1 includes a UHF and dual VHF radios for communication to other aircraft, range or ATC personnel. Additional radios provide direct communication between flight crew and other personnel if requirement exists. GCS #1 also has a video closed-captioning system to overlay aircraft and target position data on imagery before transmission to user.
NPS has been charged with developing shipboard autoland capability for the Advanced Ceramics Research (ACR) Silver Fox (SF) Unmanned Aerial Vehicles (UAV). Needless to say shipboard recovery is an essential capability for at sea operations of UAVs. Figure 1 illustrates the shipboard recovery concept developed by NPS in cooperation with ACR and ONR.

This concept calls for SF to capture and track a stabilized glideslope that ends in a net placed across the ship’s stern. The net is equipped with two high precision DGPS receivers that provide the SF with information on the ship’s motion. While DGPS is capable of providing lateral (x-y) position information to within 1m, vertically the achievable accuracy is only 3m. Therefore, in addition the net contains a barometric altimeter that measures the net’s altitude with respect to sea level. This measurement is used to compute the SF’s relative barometric altitude by comparing it with SF’s barometric measurement. This approach leads to vertical errors on the order of 1m - sufficient for the autoland task at hand.

Figure 2 shows the autoland system architecture. This architecture was selected for the development stage of the project. It also complies with the requirement imposed by ONR that no hardware changes shall be done to SF avionics.

As can be seen from Figure 2 NPS has developed an additional ground station that collects all the additional sensor data required for shipboard autoland. It also hosts the autoland guidance, navigation and control (GNC) algorithms. Interface with SF avionics is done via a full duplex serial port. To date the following capabilities have been developed: a complete 6DOF dynamic nonlinear model of SF; autoland GNC algorithm that takes SF from an arbitrary initial position all the way to net trap; complete NPS ground station with all the sensors as well as an interface with SF ground station. We expect to test this interface in the near future, followed by both ground and flight tests. A demonstration of autolanding on a ship is being planned for FY04.
Autonomous Underwater Vehicles (AUV) or Unmanned Underwater Vehicles (UUV) are quickly becoming important assets for the Navy in Mine and Expeditionary Warfare. Specifically, they are well adapted to work in covert or clandestine fashion for Mine Countermeasures and Intelligence, Surveillance and Reconnaissance missions. To that end, future Navy leaders need to be well versed in the capabilities and limitations of the vehicles. At the Center the focus is to educate NPS students in the development and use of technologies needed for AUVs through coursework, research and hands-on experimentation with the vehicles.

The Center research focus is primary in four areas: 1) Navigation, Control and Communication; 2) Obstacle Avoidance through Forward Looking Sonar; 3) Collaborative Multi-Vehicle Operation; and 4) Tactical Decision Aids. To accomplish these research objectives the center has two AUVs, the Acoustic Radio Interactive Exploratory Server (ARIES) and the Remote Environmental Monitoring UnitS (REMUS).

The ARIES vehicle was built at NPS by the Center Director, Professor Anthony Healey. The 10-foot, 500 lb. vehicle features an open system architecture that makes interchanging of sensors straightforward. It also has a number of sensors and systems for accurate navigation and control;
they include an Acoustic Doppler Current Profiler (ADCP), acoustic modem, GPS receiver, Inertial Navigation System and video camera. It has a top speed of 4 knots and four-hour battery duration. During typical operations, the vehicle is controlled via a land-based command post where commands are relayed via a FreeWave radio modem to the surfaced ARIES or via a support boat that relays the radio modem signal through an acoustic modem to the underwater ARIES. According to Professor Healey, “One of the nice aspects of the ARIES is that it permits us to change the mission parameters and recompile software while the vehicle is at sea. This saves time and allows students interesting opportunities for experimentation.”

The NPS REMUS vehicle was built by Hydroid Inc. The REMUS vehicles are currently in use by the Naval Special Warfare and EOD communities for Very Shallow Water Mine Countermeasure. The vehicle is five feet long and weighs 80 lbs. It has a top speed of 5 knots and battery duration of 22 hours at 3 knots. It comes with a side scan sonar, an upward and downward looking ADCP, Conductivity, Temperature and Depth sensor and Optical Backscatter Sensor (OBS). Instead of GPS fixes it navigates using pre-placed, long baseline acoustic transponders. The vehicle is designed for mapping in shallow water.

A common thread in the Center’s research is the ability of the vehicle to communicate underwater. This facilitates multi-vehicle operations, data dissemination and autonomous discovery of underwater nodes. For the last two years, extensive testing of acoustic modems has been conducted to categorize the modems ability to communicate with a AUV in the very shallow water environment. According to PhD Doctoral Candidate CDR Bill Marr, USN, “Acoustic communications in the VSW regime are difficult and not well understood. Improvements in this area will dramatically increase the utility of AUVs in very-shallow water mine countermeasure operations.”

In August, NPS will participate in the Office of Naval Research sponsored Autonomous Oceanographic Sampling Network II experiment in Monterey Bay. The exercise seeks to improve prediction methods of ocean events through networked adaptive sampling of underwater, surface and aerial collection assets. During the event, in conjunction with the NPS Department of Oceanography, the Benthos Telesonar® modem will be used aboard the ARIES to collect bathymetry data from a moored ADCP in 80 meters of water. Next year the hope is to extend the experiment by delivering the data from the AUV to an Unmanned Aerial Vehicle (UAV) via 802.11 Wireless LAN.

In summary, the NPS Center for AUV Research conducts state-of-the-art research which affords students greater operational and technical understanding of AUVs. The Center maintains a close relationship with the Navy through Fleet Battle Experiments and ONR Sponsored AUV Fests and serves as a centrally repository for AUV technical data and historical archives. For more information, please see www.cs.nps.navy.mil/research/auv/auvframes.html.
The Naval Postgraduate School hosted the first in a series of short courses on Unmanned Aerial Vehicles (UAVs). The week-long event covered a wide range of topics with presenters from the academic, military, and industrial community.

Professor Phillip Pace, Department of Electrical and Computer Engineering, introduced the course by first reviewing the use of UAVs during recent conflicts in Kosovo, Afghanistan and Iraq. Operational and mission concept issues with Global Hawk and Predator were reviewed in order to focus the course outline on solving important problems that exist with the command, control and use of UAV systems. The future of UAV technology was also reviewed.

The MASINT (Measurement and Signals Intelligence) presentation by Col David Trask, USAF (Ret.), MASINT Chair Professor, covered six major categories of MASINT information. This information was described by unclassified examples to give the students an understanding of the types of information required to ascertain certain performance characteristics. The information requirements were then tied to possible UAV applications. This provided the rationale for a number of sensors proposed for UAV deployment and a context for why those sensors are needed. In addition, the briefing covered the current management structure for MASINT activities, and discussed the new management structure implemented by the Department of Defense.

While the primary focus of the course was on the theory and technology involved in construction and utilizations of UAVs, the module entitled ‘The Role of the Human in Unmanned Aviation’ reminded the students of relevant human factors issues. Mr. Jeff Goldfinger, Director, UAV Programs at Brandes Associates, began by reviewing the need for humans in a UAV system followed by a review of the job descriptions for each position. He then discussed the qualifications, selection and training for each of the positions by highlighting the disparity among all four U.S. Services.

LTJG Philip Fatolitis, USN, gave
a presentation on a study commissioned by the Navy to develop a computer-based hand-to-eye coordination test that would be used to pre-select Pioneer UAV Internal Pilots (IP). The study compared scores on the software test against scores given by instructors in the squadron. The results showed that the software test was a better than average predictor of their subjective performance. Unfortunately, now that the Pioneer program has been canceled for the Navy, any further improvements or application of the software has been suspended.

Without human limits of flight endurance and the need for life-support systems, Unmanned Aerial Vehicles can take a spectrum of design shapes and sizes to meet particular mission requirements. Yet all air vehicles fly within the domain of physics, and maintain common features. In this section, the nomenclature of lift and drag were discussed. Wing characteristics of aspect ratio and sweep were related to flight efficiency and high-speed flight. Performance, in terms of required thrust and power, is related to mission needs of range, endurance, glide, climb rate and turn performance. As examples, the Predator was studied to estimate engine power requirements, and the range (distance flown) and endurance (time aloft) were predicted for the Global Hawk, based on simple analytic tools, its aerodynamics, and its powerplant.

A design example was presented to estimate the gross weight, fuel required, wing span, and wing area of a long-dwell air vehicle for a given mission with cruise, loiter, and payload requirements. As part of this estimation process, empty and gross weights of similar-class air vehicles were used (see figure below). The fuel-fraction method of mission analysis was also used to determine the fuel burned for each leg of the mission, arriving at a total fuel requirement. By adopting these tools from manned aircraft design, UAVs can similarly be sized to estimate the air-vehicle needs for certain missions. Likewise, mission requirements can be estimated for a given air vehicle – for example, estimating the range of a platform operating from a country with flight restrictions.
Human factors issues from an operational context were discussed by Mr. Goldfinger. He reviewed the current state-of-the-art regarding UAV ground control stations and their man-machine interface followed by a brief discussion of crew manning issues that are unique to UAV operations. For example, if a UAV is capable of 24+ hour continuous operations, how often should a crew change occur? Should the crew be swapped out as a team to enhance crew coordination or as individuals to enhance mission continuity.

Professor Nita Miller, Department of Operations Research, gave a very thoughtful presentation on human fatigue and its impact on military operations. She reviewed formal studies done on both military and civilian workers regarding circadian rhythms and the drastic consequences that can occur when these rhythms are disrupted. The most eye-opening conclusion equated lack of sleep to alcohol intoxication regarding their effect on performance in demanding environments.

Unmanned Aerial Vehicles (UAVs) are flexible tools that can carry a variety of payloads, but a UAV can also be made useless by overloading it or making it too expensive. Determining the best UAV design usually requires testing the UAV in its operating environment with a variety of payloads, either by simulation or exercise, and selecting the design that works best when considering the effect of the UAV on the combat system as a whole. The UAV design problem is in general no less complicated than is the optimization of any other characteristic of a combat system. There are some circumstances, however, where simple calculations based on cost-effectiveness can be used to make decisions about payloads.

The employment of unmanned aerial vehicles (UAVs) requires a system of systems; e.g actual airborne platforms (the UAVs), sensors, ground control station or stations, communication links, etc. The operational effectiveness of UAVs in military operations is importantly affected by reliability, maintainability, and vulnerability of all subsystems and components. Faculty and students at the Naval Postgraduate School have been developing analytical tools to assess the UAV system operational effectiveness as a function of overall system reliability, maintainability, and vulnerability. One operational measure of performance for such a UAV system is the fraction of time an assigned system of UAVs can maintain presence over a Named Area of Interest (NAI). The ability of the UAV system to maintain presence is clearly affected by the number of UAVs available and the number that can be flown simultaneously, the ingress and egress times to the NAI, the endurance of the air platforms, the times to mission-affecting failure, repair concept of operations (CONOPS), for instance prioritization and extensiveness scheduled in the light of the current demand, repair times, turn time, etc. The pattern of the times between mission-affecting failures is an important factor in the ability to maintain operationally useful presence: failures that occur at takeoff postpone launch and will affect the ability of a UAV to relieve another UAV on station. Occasional long repair times affect not only the affected air platform but also other air platforms that could need repair.

It is important to record and analyze data from operations on the times between failure and the repair times. In learning from such data it can be essential to use more than the simplest summary, their means or averages, to assess likely current and future effects on UAV operational performance. Analytic/mathematical and simulation modeling tools developed by NPS faculty and students are currently aiding, and will continue to be employed in the quantification of operational effectiveness as a function of reliability, sustainability, and vulnerability. Such information will be useful for acquisition and to guide the military sustainability and operation of future generations of UAV systems.
Mr. Goldfinger concluded the module with a brief discussion of existing standards for manned aviation and the need for similar standards for unmanned aviation.


ANTENNAS, PROPAGATION AND SIGNATURES FOR UNMANNED AERIAL VEHICLES

Associate Professor David Jenn
Department of Electrical and Computer Engineering

The wireless electronic systems on Unmanned Aerial Vehicles (UAVs) require antennas to transmit and receive signals. No matter what the mission, command and control information must be transferred between the master station and vehicle. Data and images from radar, video, infrared, chemical and biological sensors must be transmitted by data links. Furthermore, the sensors themselves may require a dedicated antenna; for example, radar and electronic warfare receivers. The placement of the antenna is crucial to the performance of the system. Without proper antenna location, a system’s field of view or operational range may be limited, and interference between systems can occur. Consequently, there are many systems competing for the limited amount of surface area available for antennas.

New technologies have been developed to address the unique requirements for UAV antennas. Broad bandwidth antennas operate over unusually wide frequency ranges, thus allowing them to be shared by several systems simultaneously. Conformal designs are integrated into the skin of the aircraft, and fabricated using integrated and printed circuit techniques. They can be made light-weight and have built-in signal processing functions. Circuits incorporated in the antenna are capable of monitoring the signals passing through it, and adjusting for phase and amplitude errors that might be caused by temperature, physical distortion, or even the failure of internal components.

The antenna problem is particularly challenging for a micro-air vehicle (MAV) because of its extremely small size.

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UNMANNED AERIAL VEHICLES: LESSONS LEARNED FROM THE PAST AND PLANNING FOR THE FUTURE
CW2 Chris Manuel, United States Army

Introduction
“What enables the wise sovereign and the good general to strike and conquer, and achieve things beyond the reach of ordinary men, is foreknowledge (Sun Tzu, The Art of War).”

Since September 11th, 2001, military leaders have been forced to plan for a different kind of war. Additional planes, tanks and ships are not the answer for defeating this new enemy. Our new adversaries are conducting a worldwide insurgency campaign with the battlegrounds in the country of their choosing, including America. We lack the foreknowledge or information on who and where they are. We must alter the way we find our opponents in order to effectively eliminate them. In order to accomplish the mission of finding and fixing the enemy, we need to incorporate our technological advantage into tactical operations in order to maintain information superiority and rapidly eliminate perishable targets as they emerge.

Background
In the 1960s, the U.S. Air Force deployed Buffalo Hunter Unmanned Aerial Vehicles (UAVs) to North Vietnam to collect tactical and strategic intelligence. They were launched from DC-130s flying over friendly controlled airspace and then flown into enemy territory to collect intelligence. Upon completion of their reconnaissance mission, the Buffalo Hunters were flown back to friendly territory, landed remotely and were reused after their film was recovered. The Air Force attempted to use them to collect intelligence and provide situational awareness prior to the Son Tay Raid, but “two were shot down and four malfunctioned prior to the raid,” (Vandenbroucke 1993, p.56). Unmanned Aerial Vehicles have thus offered intelligence for targeting and battle damage assessments for over 40 years. It was unfortunate the Special Operations Command did not see the use for UAVs during Desert Storm or explore UAV technology to provide a greater stand-off capability for the units under its command. Perhaps the percentage of compromised Operational Detachment Alphas (ODAs) would have decreased. This situation has continued; compromise of SOF operations and the reconnaissance equipment for the individual soldier have seen few changes in technology in the last fifty years.

In January 2002, the concept of providing Special Forces soldiers the capability to receive Predator UAV video on the ground was briefed to the Predator Program Director at Wright Patterson AFB, William Grimes. A prototype was developed and was called the Remote Observation Video Encoded Receiver (Rover II). In February 2002, C Company, 3rd Battalion 3rd Special Forces Group deployed to Operation Enduring Freedom, Afghanistan, with the ROVER II prototype. Operations with this integration of ground surveillance equipment and UAVs are the model for future tactical Net-Centric warfare (Operation Flintstone).

The Naval Postgraduate School UAV Working Group
Based on the experience gained from the C Company in Afghanistan and the UAV field experiments conducted at NPS by LT Josh Butner, USN (December 2002), Distinguished Professor David Netzer, Dean of Research and Director, Center for Defense Technology and Education for the Military Services, put together an interdisciplinary team to produce the next generation of Rovers and to explore potential improvements in SOF combat effectiveness through the use of multiple, netted UAVs. A series of three field experiments, supported by modeling and simulation, are

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LESSONS LEARNED FROM THE PAST AND PLANNING FOR THE FUTURE, continued from page 14

being used to determine the best way to promote the successes of missions like Operation Flintstone. NPS will utilize one of its unique assets in this endeavor, the tactical knowledge of our students combined with the technical expertise of our faculty.

Operations Analysis of Unmanned Aerial Vehicles and Special Operations

First steps in analyzing UAV contributions to Joint Special Forces (SF) team missions include designing experimentation, modeling and simulating the problem, analyzing results and then iteratively improving the models. This particular project affords an excellent opportunity for operations analysts to work directly with SF operators, systems technicians and engineers. Due to the cutting-edge nature of the communications, aeronautical and information technology, much of the experimental planning focused on managing and integrating those elements. However, several important operational questions emerged:

- How much will these new systems change combat effectiveness?
- How can decision makers measure improvements in situational awareness or mission success?
- To what extent does the technology enhance operators’ ability to execute these missions and what are the bounds on these enhancements? And, finally,
- What limited objective experiment can capture the salient measures under varying conditions and operational configurations and provide insight?

Operators broadly defined two types of missions, one a point reconnaissance of a specified site, the other an area reconnaissance comprised of several named areas of interest (NAIs). Special ground teams are employed because strategic assets, either satellite or high-profile UAVs, could not resolve locating or identification issues with targets of interest (TOIs). These personnel act as sensors capable of processing quickly emerging events on the ground, making decisions and potential targeting sites or controlling interdiction aircraft to do so. Whether the tactical environment is semi-permissive or hostile impacts team mobility, effectiveness, and may impact mission success. Although in a point reconnaissance mission this may be minor, the inability of SF teams to move and search an area in a hostile scenario will decrease combat effectiveness.

Complex processes that require investigation include the implications of counterdetection, search planning and optimum UAV control duties. This last issue touches upon Human Systems Integration and assigning task responsibilities. Students in the Systems Engineering and Architecture course (SI 4001) will conduct feasibility studies and develop courses of action for employment of the human, sensor and information systems involved. In addition to the wide-ranging measures of performance, there are also a large number of influential factors that will affect mission performance. Besides the mission type and opposition force activity mentioned above, weather and terrain will affect the operation. Time of day and target movement (or lack thereof) will drive asset employment. Communications network issues, such as propagation, the number of sensors, personnel and UAVs in the network and its geometry will influence the flow of data and affect the ability of operators to react to information and the ability of decision makers to act on it.

All of this places a heavy burden on the limited amount of time and money available to conduct a thorough, focused and relevant experiment. Designing the series of events to capture these elements requires the teamwork of researchers, technicians, analysts, operators and engineers. The goal is to achieve valid results that enable real insight into the employment of these systems in complex and dynamic operational environments.

Field Experiments

The series of three field experiments will be conducted during July-September 2003 and are made possible by the active participation of several companies, government laboratories and the NPS CIRPAS. The first experiment will be used to measure the performance of the Advanced Ceramics Research Silver Fox UAV flying over various terrain and under various flight conditions; sweep rate, sweep width, rate of false-target ID, etc. The second experiment will be used to characterize the performance of the new communications package being put together by the team of companies; e.g., two-way voice, data and streaming video capabilities as a function of altitude, distance, aircraft speed, terrain, environmental conditions, etc. The third experiment will utilize the CIRPAS surrogate Predator flying high, three Silver Fox flying low, Special Forces Teams and ground sensors on the ground, and a red team, all involved in a missile launcher search and ID mission. The first two experiments will be used to validate technologies, measure characteristics, and to provide data for the development of appropriate models. The models will be utilized to help plan the third experiment and to obtain quantitative measures of performance.
NPS ORGANIZES AN AUTONOMOUS MARITIME SURFACE VESSEL RESEARCH GROUP

Capitalizing on experience from mature Unmanned Aerial Vehicle (UAV) and Unmanned Uninhabited (UUV) research efforts, NPS researchers have recently formed a group to address maritime missions for Unmanned Surface Vehicles (USV). The USV Research group includes professors from diverse disciplines, including Mechanical and Electrical Engineering, Physics, Information Science, Operations Research, Computer Science, Oceanography and Meteorology. Their initial efforts are focused on exploring the concept of operations for a USV launched from a Littoral Combatant Ship (LCS) or Nuclear Guided Missile Submarine (SSGN) to conduct covert advanced force littoral environmental sensing and characterization. The USV’s data would be linked back to the host platform to help its commander determine counter-detection ranges and optimal placement for long-term sensors. A phased approach to realizing this concept of operations is proposed by first constructing a local environmental sensor suite and processor with appropriate data links and testing on an existing USV.

Professor Ken Davidson of the Department of Meteorology has demonstrated a prototype end-to-end sensor/model system that relates variations of near-shore coastal environment situations to influence on Rf and IR propagation on the basis of real-time data. The model and its sensor suite are called the Small Combatant Integrated METOC System (SCIMS). Combined with threat radar and infra-red information, the model allows a probability versus range of counter-detection to be computed. SCIMS has been developed and demonstrated in coastal waters with combatant craft.

Associate Professor Alex Bordetsky of the Department of Information Science has developed several tactical and command and control links to support UAV and peer to peer experimentation. The first phase of this proposal intends to combine these links, SCIMS, and an USV to demonstrate the potential for over-the-horizon advanced force operations by USVs.

A longer term and larger vision of the research group is to expand their work to the design and employment of a USV with a multiple environmental, acoustic, and bottom survey sensor packages with appropriate links.

In coordination with all of the above, development of models and simulation to aid in CONOPS development and creation of automated TACAEs (Tactical Decision Aids) for USV and Sensor employment will be developed.

Figure 1. Mobile Satellite Environmental Data Collection Network.
Chemical and biological (ChemBio) weapon attacks have posed a response concern for some time and have gained a renewed focus. The toxic cloud has to be measured and its dispersion predicted to successfully respond to attacks by such weapons. NPS researchers formulated an atmospheric model, Unmanned Aerial Vehicle (UAV) configuration/instrumentation and field measurement effort to demonstrate and validate a method for the synthesis of measurements and predictions to aid in the response to an attack by chemical and biological weapons. The eventual goal of the demonstration/evaluation of integration of technology was to enable operational units to have a near-real time decision aid, integrated into a command and control net, to assist them in responding in a focused way to a ChemBio attack. This decision aid was based on atmospheric model predictions of the agent transport and dispersion so that effective dispersion could be mapped upstream to the source or downstream to the region to be affected.

The multi-factor problem led to a demonstration attempt to sort out real issues and to calibrate expectations. The demonstration effort, addressing issues in ChemBio attack response, was of the transition of emerging as well as operational capabilities into seamless products. The approach and procedures were selected to culminate with the Intensive Operation Period (IOP) demonstration designed to simulate a “toxic” plume by releasing a smoker on the grounds of Camp Roberts, fly a UAV for mapping the dispersing plume, and having supporting atmospheric observations for evaluating assumptions and for ingesting into the atmospheric modeling parameter. Overall the demonstration proved the feasibility of linking a coarse grid mesoscale model to a fine scale diagnostic wind model for producing fine resolution forward and backward trajectories. Several challenges were noted which provide future research opportunities to improve on the meso-scale model-diagnostic wind model methodology as a tool for defending against ChemBio weapon attacks.
UNMANNED VEHICLES: RELATED THESES

DESIGN AND TESTING OF A COMBUSTOR FOR A TURBO-RAMJET FOR UNMANNED AERIAL VEHICLE AND MISSILE APPLICATIONS
 Lieutenant Ross H. Piper, United States Navy, March 2003

EXPERIMENTAL ANALYSIS OF INTEGRATION OF TACTICAL UNMANNED AERIAL VEHICLES AND NAVAL SPECIAL WARFARE OPERATIONS FORCES
 Lieutenant Joseph C. Butner IV, United States Navy, December 2002

TRACKING CONTROL OF AUTONOMOUS UNDERWATER VEHICLES
 Lieutenant Joseph J. Keller, United States Navy, December 2002

OBSTACLE AVOIDANCE CONTROL FOR THE REMUS AUTONOMOUS UNDERWATER VEHICLE
 Lieutenant Lynn Renee Fodrea, United States Navy, December 2002

ELECTROMAGNETIC AIRCRAFT LAUNCH SYSTEM TECHNOLOGY SCALING FOR UNMANNED AERIAL VEHICLE LAUNCH TARGETED TOWARD THE ADVANCED LOGISTIC DELIVERY SYSTEM
 Major S.W. McKee, United States Marine Corps, September 2002

MODELING ROBOT SWARMS USING AGENT-BASED SIMULATION
 Captain A. Dickie, Australian Army, June 2002

TRAJECTORY PLANNING FOR THE ARIES AUTONOMOUS UNDERWATER VEHICLE
 Lieutenant Commander John J. Keegan, United States Navy, June 2002

LOITERING BEHAVIORS OF AUTONOMOUS UNDERWATER VEHICLES
 Lieutenant Douglas L. Williams, United States Navy, June 2002

MICRO AIR VEHICLES FOR SPECIAL OPERATIONS: OPTIONS FOR IMMEDIATE EMPLOYMENT
 Major T.K. Woodrick, United States Air Force, June 2002

THE EFFECT OF UNMANNED AERIAL VEHICLE SYSTEMS ON PRECISION ENGAGEMENT
 Major C.J. Werenskjold, United States Air Force, June 2002

DEVELOPING A CONCEPTUAL UNMANNED AERIAL VEHICLE COMMUNICATIONS MOBILE AD HOC NETWORK SIMULATION MODEL
 Captain H.L. Blackshear, United States Marine Corps, June 2002

THRUST MEASUREMENTS AND FLOW VISUALIZATION FOR FOUR CONFIGURATIONS MODEL DESIGN FOR A BATTLEGROUP INTRANET USING AN UNMANNED AERIAL VEHICLE
 Lieutenant M.A. Spivey, United States Naval Reserve, March 2002

DESIGN AND RAPID PROTOTYPING OF FLIGHT CONTROL AND NAVIGATION SYSTEM FOR AN UNMANNED AERIAL VEHICLE
 Major B-A Lim, Republic of Singapore Air Force, March 2002

MODEL DESIGN FOR A BATTLEGROUP INTRANET USING AN UNMANNED AERIAL VEHICLE
 Captain S.M. Sadlier, United States Marine Corps, and Lieutenant F.R. Hubbard, United States Navy, March 2002

INVESTIGATION OF WAVE MOTION EFFECTS ON THE NUSC 21UUV THROUGH SIMULATION
 Lieutenant Commander James E. Ivey, United States Navy, December 2001

HIGH ALTITUDE LONG ENDURANCE (HALE) PLATFORMS FOR TACTICAL WIRELESS COMMUNICATIONS AND SENSOR USE IN MILITARY OPERATIONS
 Major C.R. Ferguson, United States Marine Corps, September 2001

AUTONOMOUS UNDERWATER VEHICLE STEERING PARAMETER IDENTIFICATION FOR IMPROVED CONTROL DESIGN
 Lieutenant Jay H. Johnson, United States Navy, June 2001

UNMANNED AERIAL VEHICLES AND SPECIAL OPERATIONS: FUTURE DIRECTIONS
 Major G.K. James, United States Army, December 2000

VISION-BASED NAVIGATION FOR AUTONOMOUS LANDING OF UNMANNED AERIAL VEHICLES
 Lieutenant Commander P.A. Ghyzel, United States Navy, September 2000

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UNMANNED VEHICLES: RELATED THESES, continued from page 19

VISION-BASED NAVIGATION ALGORITHM FOR AUTONOMOUS FLIGHT TRAJECTORY PLANNING EA-6B FOLLOW-ON STUDY: UAVS AND UCAVS
Ensign L. Nance, United States Navy, June 2000

THE EXPERIMENTAL EVALUATION OF A DGPS BASED NAVIGATIONAL SUITE IN THE ARIES AUTONOMOUS UNDERWATER VEHICLE
Ensign Benjamin M. Stinespring, United States Navy, June 2000

FORMATION CONTROL FOR MULTI-VEHICLE ROBOTIC MINESWEEPING
Lieutenant Peter M. Ludwig, United States Navy, June 2000

OPTIMAL FAULT DETECTION AND RESOLUTION DURING MANEUVERING FOR AUTONOMOUS UNDERWATER VEHICLES
Lieutenant Andrew S. Gibbons, United States Navy, March 2000

DISSEMINATION AND STORAGE OF TACTICAL UNMANNED AERIAL VEHICLE DIGITAL VIDEO IMAGERY AT THE ARMY BRIGADE LEVEL
Major A.K. Apostolopoulos, Hellenic Army, December 1999
Captain R.O. Tisdale, United States Army, September 1999

DEVELOPMENT OF A HIGH POWER MICROWAVE UNINHABITED COMBAT AIR VEHICLE (U)
Lieutenant T.B. Sanders, United States Navy, September 1999

HIGH POWER MICROWAVE SOURCE INTEGRATION WITH AN UNMANNED COMBAT AIR VEHICLE
Lieutenant A.R.L. Smitha, United States Navy, September 1999

AN EXPERIMENTAL INVESTIGATION OF FLAPPING WING PROPULSION FOR MICRO AIR VEHICLES
Captain S.J. Duggan, Canadian Armed Forces

EFFECTIVENESS ANALYSIS OF EA-6B SUPPORT JAMMING WITH A DISTRIBUTED NETWORK OF ELECTRONIC WARFARE-CAPABLE UNMANNED AIR VEHICLES (U)
Lieutenant T.C. Barkdoll, United States Navy, September 1999

TELEMETRY AND GPS ANTENNA FOR A MICRO AIR VEHICLE
E. Guven, Turkish Navy, September 1999

STOCHASTIC MODELING OF NAVAL UNMANNED AERIAL VEHICLE MISHAPS: ASSESSMENT OF POTENTIAL INTERVENTION STRATEGIES
Major M.G. Ferguson, United States Marine Corps, September 1999

SIMULATIONS TO PREDICT THE COUNTERMEASURE EFFECTIVENESS OF USING PYROPHORIC TYPE PACKETS DEPLOYED FROM TALD AIRCRAFT
Lieutenant M. Demestihas, Hellenic Navy

SIMULATION ANALYSIS OF UNMANNED AERIAL VEHICLES
Captain D. Heath, United States Army, June 1999

DESIGN AND PROTOTYPE DEVELOPMENT OF A WIRELESS POWER TRANSMISSION SYSTEM FOR A MICRO AIR VEHICLE
R.L. Vitale, DoD Civilian, June 1999

SIMULATION AND MODELING OF A SOFT GROUNDING SYSTEM FOR AN AUTONOMOUS UNDERWATER VEHICLE
Lieutenant Junior Grade Bahadir Beyazay, Turkish Navy, June 1999

SEAWAY LEARNING AND MOTION COMPENSATION IN SHALLOW WATERS FOR SMALL AUTONOMOUS UNDERWATER VEHICLES
Lieutenant Commander Jeffery Scott Reidel, United States Navy, June 1999

UNMANNED AERIAL VEHICLE/REMOTELY PILOTED AIRCRAFT DESIGN OPTIMIZATION BASED ON SERVICE-STATED METEOROLOGICAL/OCEANOGRAPHIC REQUIREMENTS
Lieutenant Commander R.J. Stanton, United States Navy, March 1999

NAVAL COMMAND AND CONTROL FOR FUTURE UNMANNED AERIAL VEHICLES
Lieutenant S.E. Majewski, United States Navy, March 1999

LOW COST AUTONOMOUS UNDERWATER VEHICLE HEADING REFERENCE USING A TCM2 ELECTRONIC COMPASS MODULE
Lieutenant Shawn E. White, United States Navy, March 1999
SMART EXPERIMENTAL DESIGNS PROVIDE MILITARY DECISION-MAKERS WITH NEW INSIGHTS FROM AGENT-BASED SIMULATIONS

Associate Professor Thomas W. Lucas, Department of Operations Research
Professor Susan M. Sanchez, Department of Operations Research and the Graduate School of Business and Public Policy

The 6th International Project Albert Workshop, described elsewhere in this newsletter, is part of an ongoing effort that seeks to exploit the advances in computing power and new technologies in order to “provide quantitative answers…to important questions facing military decision-makers” (Brandstein, 1999). In particular, in his former position as Chief Scientist of the U.S. Marine Corps, Dr. Brandstein was frustrated with legacy models because he felt they were unable to support analysis needs in the rapidly evolving global environment. Areas of particular concern were, and continue to be, our inabilities to adequately deal with the chaos inherent in military engagements, the human dimensions of warfare (e.g., leadership, courage, trust, unit cohesiveness), and adversaries who adapt their behavior based on perceptions of

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About the INVESTIGATORS

Thomas W. Lucas is an Associate Professor in the Department of Operations Research (OR). Dr. Lucas received a B.S. in Industrial Engineering and Operations Research from Cornell University, an M.S. in Statistics from Michigan State University, and a Ph.D. in Statistics from the University of California at Riverside. He joined the NPS faculty in 1998, and has been teaching courses in statistics and combat modeling. He was recognized by the OR Department for his Outstanding Instructional Performance in 1999.

Dr. Lucas is a member of the American Statistical Association, the Military Applications Society of the Institute for Operations Research and the Management Sciences (INFORMS), and the Military Operations Research Society (MORS). His primary research interests are combat analysis, design of simulation experiments, and robust Bayesian statistics. Previously, he worked as a statistician at RAND and as a systems engineer at Hughes Aircraft Company.

Susan M. Sanchez is a Professor and Associate Chair of Instruction in the Department of Operations Research. She also holds a joint appointment in the Graduate School of Business and Public Policy. Dr. Sanchez received a B.S. in Industrial and Operations Engineering from the University of Michigan, and her M.S. and Ph.D. in Operations Research from Cornell University. Dr. Sanchez came to NPS as a Senior Postdoctoral Associate under a National Research Council fellowship in 1999, and joined the NPS faculty in 2000. She teaches courses in statistics, operations research, and simulation analysis.

Dr. Sanchez is a member of the Institute for Operations Research and the Management Sciences (INFORMS), the American Statistical Association, and the American Society for Quality. She is currently President of the INFORMS College on Simulation, and is also President of the INFORMS Forum on Women in Operations Research and Management Science. She serves as Simulation Area Editor for the INFORMS Journal on Computing and as an Associate Editor for Naval Research Logistics. Her research interests include the design and analysis of simulation experiments, selection procedures, and active learning.

“Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world.”

Albert Einstein
our strategies and tactics.

Project Albert focuses on *Operational Synthesis*—that is, the process of combining the information gleaned from a family of diverse analytical tools to provide the most compelling analyses. The majority of Project Albert’s efforts have involved the building of relatively simple models, along with data farming and visualization environments in which they can be explored. These models by design are fast-running, flexible, and easy to use. They contain only the essence of a given question or scenario and utilize only that detail absolutely necessary to capture the relevant aspects.

To date, several modeling platforms have been developed by a diverse set of researchers under the Project Albert umbrella. Most of these are agent-based simulations. While the definition varies, we use this term to mean a simulation composed of agents, objects, or entities that make decisions (where to go, whom to shoot at, etc.) autonomously. These agents are aware of, and interact with, their local environment through relatively simple internal decision rules. The rules determine an agent’s “personality” traits, such as their drive to move toward or away from a destination, and alive or injured friendly (or enemy) agents. Additionally, group characteristics can be defined which affect group behavior—such as the difference in forces required for an agent in a unit to want to advance toward an enemy. An agent’s physical characteristics include their ability to sense, communicate, and engage with other agents.

Motivation

While Project Albert’s distillations are quite simple by traditional Department of Defense (DoD) simulation standards, they nonetheless contain many variables that an analyst might desire to explore. Thus, a key thrust of the project is to utilize supercomputing to “farm” or run the models many times—millions of computation experiments are necessary.

In order to fully evaluate all of the combinations of a model containing only 100 factors, each with only two settings, $2^{100}$ (about $10^{30}$) runs of the model are necessary. Is this feasible? Former Air Force Major General Jasper Welch succinctly summarized the analyst’s dilemma by the phrase “$10^{30}$ is forever.” Using a computer that can evaluate a model run in a nanosecond, an analyst who started making runs at the dawn of the universe would just be finishing his runs -- hence it would have taken him or her “forever” to explore the model.

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SUPPLYING DEMOCRACY? U.S. SECURITY ASSISTANCE TO JORDAN, 1989-2002
Captain Nathan G. Forbes, United States Air Force
Master of Arts in National Security Affairs – March 2003
Advisor: Associate Professor Glenn E. Robinson, Department of National Security Affairs
Second Reader: Assistant Professor Harold Trinkunas, Department of National Security Affairs

Democracy promotion has been a principal foreign policy goal of the United States in the post-Cold War world. Democratic expansion is seen as an essential element of enhanced security and stability throughout the world. Jordan, having begun its own democratization program in 1989, has been a major recipient of U.S. security assistance since the end of the 1991 Gulf War. This thesis explores the question of whether U.S. security assistance has helped or hindered democratization in Jordan. It accomplishes this through an examination of the military aid received and the specific nature of civil-military relations in Jordan, particularly during the democratization program and its subsequent rollback. This thesis concludes that, counter to declared U.S. policy, U.S. security assistance to Jordan has effectively helped to limit democratization in Jordan through the empowerment of anti-democratic elements in Jordan. The findings present challenges to further democratization in Jordan that will be difficult to surmount. A conditional foreign aid program would encourage further political reform in Jordan that could serve as a model for other authoritarian regimes in the Middle East.

REDEFINING ATTACK: TAKING THE OFFENSIVE AGAINST NETWORKS
Lieutenant Zachary H. Staples, United States Navy
Master of Arts in National Security Affairs – March 2003
Lieutenant Robert J. Michael II, United States Navy
Master of Science in Modeling, Virtual Environments, and Simulation and Master of Science in Computer Science – March 2003
Advisors: Associate Professor Daniel Moran, Department of National Security Affairs
Associate Professor Rudolph Darken, Department of Computer Science
Research Professor John Hiles, Department of Computer Science

The Information Age empowers individuals, and affords small groups an opportunity to attack states’ interests with an increasing variety of tactics and great anonymity. Current strategies to prevail against these emerging threats are inherently defensive, relying on potential adversaries to commit mistakes and engage in detectable behavior. While defensive strategies are a critical component of a complete solution set they cede initiative to the adversary. Moreover, reactive measures are not suited to quickly suppress adversary networks through force. To address this shortfall in strategic planning, the science of networks is rapidly making clear that natural systems built over time with preferential attachment form scale-free networks. These networks are naturally resilient to failure and random attack, but carry inherent vulnerabilities in their highly connected hubs. Taking the offensive against networks is therefore an exercise in discovering and attacking such hubs. To find these hub vulnerabilities in network adversaries, this thesis proposes a strategy called Stimulus Based Discovery, which leads to rapid network mapping and then systematically improves the accuracy and validity of this map while simultaneously degrading an adversary’s network cohesion. Additionally, this thesis provides a model for experimenting with Stimulus Based Discovery in a Multi-Agent System.
THE MOBILE AIRCRAFT MAINTENANCE OFFICE CONCEPT FROM A WIDE AREA PERSPECTIVE
Lieutenant Commander Sil A. Perrella, United States Navy
Master of Science in Information Technology Management – March 2003
Advisor: Professor Norman F. Schneidewind, Department of Information Science
Second Reader: Douglas E. Brinkley, Graduate School of Business and Public Policy

As mobile computing becomes more ubiquitous, through the use of very capable mobile computing devices and broadband wide area wireless data networks, naval aviation maintenance has an opportunity to extend the reach of the Naval Aviation Logistics Command Management Information System (NALCOMIS) to fielded aircrew, maintenance technicians, and maintenance supervisors supporting out of local area operations. The combination of the new mobile technologies and the wireless Internet makes modern Mobile Business (m-business) initiatives possible but ushers in a host of new problems and issues that are radically different from those experienced with traditional fixed electronic business (e-business) projects. This thesis examines the concept and components that comprise m-business, details wide area data over cellular technologies, and identifies problems and issues unique to m-business initiatives. Scenario-based Use Cases will be employed within the Unified Process (UP) framework to develop the three major artifacts of the UP’s inception phase—the project’s vision, a Use Case model, and a supplemental specification containing functional and non-functional requirements for an aircrew mobile aircraft maintenance application. The results of this study can serve as the foundation for the development of a complete mobile aircraft maintenance office.

DESIGN AND TEST OF THE CROSS-FORMAT SCHEMA PROTOCOL (XFSP), continued from page 22

As mobile computing becomes more ubiquitous, through the use of very capable mobile computing devices and broadband wide area wireless data networks, naval aviation maintenance has an opportunity to extend the reach of the Naval Aviation Logistics Command Management Information System (NALCOMIS) to fielded aircrew, maintenance technicians, and maintenance supervisors supporting out of local area operations. The combination of the new mobile technologies and the wireless Internet makes modern Mobile Business (m-business) initiatives possible but ushers in a host of new problems and issues that are radically different from those experienced with traditional fixed electronic business (e-business) projects. This thesis examines the concept and components that comprise m-business, details wide area data over cellular technologies, and identifies problems and issues unique to m-business initiatives. Scenario-based Use Cases will be employed within the Unified Process (UP) framework to develop the three major artifacts of the UP’s inception phase—the project’s vision, a Use Case model, and a supplemental specification containing functional and non-functional requirements for an aircrew mobile aircraft maintenance application. The results of this study can serve as the foundation for the development of a complete mobile aircraft maintenance office.

NUMERICAL AND EXPERIMENTAL STUDY OF THE PERFORMANCE OF A DROP-SHAPED PIN FIN HEAT EXCHANGER
Lieutenant Junior Grade Jihed Boulares, Tunisian Navy
Mechanical Engineer and Master of Science in Mechanical Engineering – June 2003
Advisor: Associate Professor Ashok Gopinath, Department of Mechanical Engineering

This research presents the results of a combined numerical and experimental study of heat transfer and pressure drop behavior in a compact heat exchanger (CHE) designed with drop-shaped pin fins. A numerical study using ANSYS was first conducted to select the optimum pin shape and configuration for the CHE. This was followed by an experimental study to validate the numerical model.

The results indicate that the drop shaped pin fins yield a considerable improvement in heat transfer compared to circular pin fins for the same pressure drop characteristics. This improvement is mainly due to the increased wetted surface area of the drop pins, and the delay in the flow separation as it passes the more streamlined drop shaped pin fins. The data and conclusions of this study can be used in heat exchanger design for large heat flux cooling applications as in gas turbine blades, and high-power electronics.
STUDENT RESEARCH

CLOSED LOOP SHIPBOARD SENSOR CALIBRATION SYSTEM
Lieutenant Steven Perchalski, United States Navy
Master of Science in Electrical Engineering – June 2003
Advisor: Associate Professor Xiaoping Yun, Department of Electrical and Computer Engineering

This thesis presents an application of wireless technology in a shipboard environment. The application is on developing a closed-loop shipboard sensor calibration system with two main objectives. The first objective is to reduce the personnel required to conduct a sensor calibration. The second objective is to reduce the time required to complete the calibration process. This is accomplished using wireless protocols and using technology that can be easily installed or used on United States Navy ships.

Using DataSocket protocol, this thesis proves that pressure data that is wirelessly transmitted via IEEE 802.11b from a Network Capable Application Processor (NCAP) or Wireless LAN Input Output Node (W-LION) to an access point or gateway can be displayed on a wireless tablet computer. At the same time, the calibration standard being applied to the system is transmitted via Bluetooth to the wireless tablet computer. Both pressures are displayed simultaneously on the screen while the computer computes the difference and compares the sensor data versus an operator-inputted tolerance. A green light indicates that the difference is within tolerance and a red light indicates that the difference is not within tolerance. The operator can then adjust the calibration constants on the tablet computer screen and watch the sensor data come within tolerance. Once the sensor data is within tolerance, the operator can write the constants wirelessly to the NCAP. This process reduces the number of personnel required to calibrate a sensor from two to one, and the time required by a factor of ten. It also helps the Navy facilitate condition based maintenance assisting the United States Navy to move forward with initiatives that reduce manning and streamline processes.

(Above) Working demonstration kit used at Ship’s Control Systems Symposium (SCSS) 2003 in Orlando, FL.

(Right) Flow of information used in thesis.

LT Perchalski demonstrating thesis results to representatives from Naval Surface Warfare Center-Philadelphia at the SCSS 2003 in Orlando, FL.
EVALUATING CONFIGURATION MANAGEMENT TOOLS FOR HIGH ASSURANCE SOFTWARE DEVELOPMENT PROJECTS

Lynzi Ziegenhagen, Department of Defense Civilian
Master of Science in Computer Science – June 2003
Advisor: Associate Professor George Dinolt, Department of Computer Science
Second Reader: Michael Thompson, Aesec Corporation

This thesis establishes a framework for evaluating automated configuration management tools for use in high assurance software development projects and uses the framework to evaluate eight tools. The evaluation framework identifies a dozen feature areas that affect a high assurance project team’s ability to achieve its configuration management goals and evaluates the different methods that existing tools use to implement each feature area. Each implementation method is assigned a risk rating that approximates the relative risk that the method adds to the overall configuration management process. The tools with the lowest total ratings minimize risk to high assurance projects.

The results of the evaluation show that although certain tools are less risky to use than other tools for high assurance projects, no tool minimizes risk in all feature areas. Furthermore, none of the existing tools are designed to leverage high assurance environments—i.e. none run on operating systems that have themselves been evaluated as meeting high assurance requirements. Thus, high assurance development projects that want to leverage the benefits of configuration management tools and achieve a sufficiently strong configuration management solution must employ existing tools in a protected environment that specifically addresses the risks created by the tools’ implementation methods.

SPACE AND NAVAL WARFARE SYSTEMS CENTER-SAN DIEGO STUDENT RESEARCH FELLOWSHIPS AWARDED

The Space and Naval Warfare Systems Center-San Diego (SSC-SD) announced the awards of the latest round of SSC-SD Fellowships. SSC-SD sponsors a Student Research Fellowship Program at NPS. The program was instituted to promote NPS’s 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. NPS students submit proposals that are reviewed by the technical staff of SSC-SD and approved by the SSC-SD Commander, CAPT T.V. Flynn. Seventy-seven students have been awarded fellowships to date. The fellowship includes a $10,000 award to support the student’s research. The latest recipients (along with the title of their successful proposal) are:

Lieutenant Commander Dean A. Barsaleau, United States Navy
Performance Analysis of the Differentiated Services Architecture in Providing Quality of Service for the Automated Digital Network System

Captain William Eger, United States Army
Computer Network Attack Metrics or Battle Damage Assessment Methodology for Computer Network Attack

Space and Naval Warfare Systems Center-San Diego Student Research Fellowships Awarded

Lieutenant John J. Fay, United States Navy
Transforming Network Operations through Collaborative Decision Support and Augmented Reality Technologies

Captain Claude O. Hutton, Jr., United States Marine Corps
Web-based 3D Visualization of Operation Planning Data Using XML, X3D, SVG and JAVA-based Technologies

Captain James Neushul, United States Marine Corps
Developing XML Ontologies for Use by Navy and Marine Corps Command and Control Software

Lieutenant Steven G. Plonka, United States Navy
Modeling Temperature Dependence of Single Event Upsets

Lieutenant Douglas K. Shamlin, United States Navy
Integrating Hardware and Software Technologies to Automate the Information Condition (INFOCON) Implementation Process

Lieutenant Colonel Eric Treworgy, United States Marine Corps
Wireless Networks for Damage Control Command and Control

Captain Juan Carlos Vega, United States Army
Cyber-Warfare: Identify, Attack, Defend, and Assess
June 2003 marks the graduation of the first Masters of Business Administration (MBA) class at the Naval Postgraduate School. The Graduate School of Business and Public Policy is responsible for the master's level academic programs leading to the MBA Degree. This graduation represents a milestone in the efforts of faculty and students to provide high-quality relevant management education to a new generation of officers. NPS’s Defense-focused MBA is a unique program, unlike any in the country in its integration of defense applications into familiar business disciplines. Concentrations in financial management, acquisition and contracting, logistics management, manpower resource management and management of information technology prepare NPS students to take their places managing complex organizations, large budgets and major programs.

Another unique aspect of the MBA program is that it is interactive. Formal student feedback was an integral design element of the program. Many informal feedback loops also developed over the course of the first eighteen months. This active student participation has affected the design, delivery and operations of the MBA program for this class and for succeeding classes. This type of student input has enabled the Graduate School of Business and Public Policy itself to be a learning organization. The inputs from the students and other data have been used to engage in a process of continuous adjustment and improvement.

Forty-four officers graduated with the June graduation class, including members from all military services and nine countries. One requirement of the MBA degree program is the completion of an MBA Application Project. The Application Project is a culminating activity in the degree program and is designed to allow graduates to apply the knowledge and skills learned in the program to current issues or problems within the Navy and Defense community. Project teams may be interdisciplinary, involving students from different MBA curricula, to bring a variety of skills together to address project topics. The results of Application Project efforts are documented in an MBA Professional Report. A few MBA Projects, with abstract descriptions, are highlighted in this article.

TRANSFORMATION OF DOD CONTRACT CLOSEOUT
Lieutenant Commander Ricardo Byrdsong, Supply Corps, United States Navy
Captain Luis Crespo, United States Army
Major George Holland, United States Army
Lieutenant Commander Christopher Parker, Supply Corps, United States Navy
First Lieutenant Emine Gulsen Torunoglu, Turkish Air Force
Masters of Business Administration – May 2003
Lead Advisor: Associate Professor David V. Lamm, Graduate School of Business and Public Policy
Support Advisor: CDR Phil R. Candreva, USN, Graduate School of Business and Public Policy

The Department of Defense (DoD) has tens of thousands of contracts physically completed but not formally closed-out. At issue are potentially millions of dollars that are obligated on those contracts which could be deobligated, thus making them available for use by DoD. At the request of the Deputy Assistant Secretary of the Navy for Research, Development and Acquisition (Acquisition Management), our team was formed to chart the current contract closeout process and to recommend ways to improve and transform the process while reducing the current backlog of physically completed contracts.

This report identifies the steps necessary to affect contract closeout once a contract becomes physically complete. Utilizing data from available DoD and non-DoD sources and interviews from personnel managing and working within the contract closeout process at several Governmental activities involved in affecting closeout, our team (1) identifies the major causes preventing contracts from closing in a timely manner, (2) provides recommended actions to reduce the size of the overaged inventory of physically completed contracts, and (3) recommends modification to the existing closeout process to include pre-award and administration period actions in order to reduce the number of contracts that become overaged.
**A NAVY ESCROW ACCOUNT: INCREASING FINANCIAL FLEXIBILITY**  
Commander Marcus A. Pritchard, United States Navy  
Master of Business Administration – June 2003  
Advisor: Senior Lecturer John E. Mutty, Graduate School of Business and Public Policy  
Second Reader: Professor Jerry L. McCaffery, Graduate School of Business and Public Policy

Effective execution of the Department of the Navy’s (DoN) budget is critical for national defense. However, political instability and the evolving demands placed upon the Navy and Marine Corps team present challenges in the execution and future planning of DoN budgets. In the current budgetary system, shortfalls are typically funded through targeted cuts while the methodologies for recapitalizing cost savings are non-existent.

The proposed Navy escrow account provides a buffer for rapidly shifting requirements and budgetary shortfalls. It creates an incentive for generating cost savings and the means to redistribute those savings toward emergent financial demands or unfunded requirements.

This study outlines critical factors in creating and maintaining a Navy escrow account. Specifically, it addresses: 1) the proposed operation and functioning of the Navy escrow account; 2) barriers to implementation including legal restrictions and potential congressional and Department of Defense (DoD) resistance; and 3) proposed implementation strategies including the required cultural modifications and techniques for effectively managing the change process associated with the creation of an escrow account mechanism.

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**PACFLT REGIONAL INVENTORY STOCKING MODEL**  
Lieutenant Commander Gregory Pekari, United States Navy  
Lieutenant Commander Kurt Miles Chivers, United States Navy  
Lieutenant Brian Erickson, United States Navy  
Lieutenant Robert Belcher, United States Navy  
Major Vitalii Kartashov, Ukrainian Air Force  
Master of Business Administration – June 2003  
Lead Advisor: Senior Lecturer Raymond Franck, Graduate School of Business and Public Policy  
Support Advisors: Associate Professor Keebom Kang, Graduate School of Business and Public Policy, and Professor Dan Dolk, Department of Information Science, Graduate School of Operational and Information Sciences

This project describes and assesses the current inventory stocking tool used by Commander U.S. Submarine Force Pacific Fleet (CSP), Mission Essential Spare Support (MESS), to manage its Standard Stock Number (SSN) stocking levels during a deployment work-up period. A proposed demand based inventory management tool, Pacific Regional Inventory Stocking Model (PRISM), is introduced and compared with the tools currently being used within CSP.

The effectiveness of each system is evaluated as a management tool using data from CSP’s SSN-688 Fast-Attack Submarines. The decision criteria estimated are operational readiness and associated inventory costs. Statistical simulation modeling will be employed to compare these evaluated criteria as determined by MESS and PRISM. The analysis provides evidence that with the inclusion of repair part demand data, cost savings will be realized for a specified inventory service level. Recommendations are provided, based on the results of the comparison, as to the feasibility of implementing PRISM, maintaining MESS, or developing a new submarine stocking system to replace the status quo.

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**ENGINEERING FIELD DIVISION/ACTIVITY STAFFING**  
Lieutenant Lawrence Hilton, United States Navy Reserves  
Lieutenant Earl Marks, United States Navy  
Lieutenant Nathalie Zielinski, United States Navy  
Captain Hana Visnovska, Czech Republic Army  
Master of Business Administration – June 2003  
Lead Advisor: CDR W. D. Hatch II, USN, Graduate School of Business and Public Policy  
Support Advisors: Senior Lecturer Raymond Franck and Senior Lecturer John Mutty, Graduate School of Business and Public Policy

The Naval Facilities Engineering Command (NAVFAC) is responsible for all U.S. Navy and Marine Corps facilities. The mission of NAVFAC is to plan and deliver innovative, best-value, technology-leveraged solutions and alternatives that
NPS METEOROLOGY DISCOVERY LEADS TO MAJOR SCIENCE NEWS STORIES

Professor C.-P. Chang’s research (Department of Meteorology) on the formation of Typhoon Vamei in December 2001 near Singapore, sponsored by the Office of Naval Research and the National Science Foundation, was the subject of several recent science news stories worldwide.

Historically, the equatorial zone has been considered by sailors to be free from tropical storms. When Battle Group USS Carl Vinson unexpectedly ran into Vamei, one of the general accepted meteorological rules that hurricanes cannot develop near the equator was cast in doubt. The formation of Typhoon Vamei not only caused damage to two Navy ships and property and life losses in the southern Malay Peninsula; it baffles scientists because at 1.5°N not enough Coriolis effect is available to spin up rotation at the cyclone scale. Professor Chang and his research team analyzed weather model and satellite remote sensing data for the event, and found that the typhoon formed as a result of two interacting weather systems: a weak vortex disturbance near Borneo that drifted into the southern tip of the South China Sea, and a strong and persistent monsoon wind surge that created the large background cyclonic vorticity at the equator. Both systems are common features of the Asian winter monsoon, but a rare combination of the particular space and time characteristics was necessary for the Borneo vortex to spin up without the help of earth’s rotation.

The paper on the equatorial hurricane formation mechanism was published in Geophysical Research Letters. The Associated Press picked it up from American Geophysical Union’s March 2003 Journal Highlights and released a news story in early April that appeared in numerous newspapers in the U.S and abroad. USA TODAY adapted the story and put it in its permanent science education website, and revised the contents of its hurricane reference page (http://www.usatoday.com/weather/news/2003-04-05-typhoon-vamei_x.htm). Meanwhile, SCIENCE Magazine published an article based on an interview with Professor Chang in its online SCIENCE Now (http://sciencenow.sciencemag.org/cgi/content/full/2003/408/4).

Because the work used NASA’s QuikSCAT satellite ocean surface wind data, Jet Propulsion Laboratory issued a press release on the research as a News Spotlight feature article for Earth Science (http://www.jpl.nasa.gov/earth/features/typhoonvamei.cfm). JPL also used the work as the front cover of the Compendium of Science Papers of the QuikSCAT satellite project. In May 2003, the National Science Foundation selected the research as one of the 2003 Science News Highlights that resulted from NSF-funded research grants. (http://www.nsf.gov/od/lpa/highlights/highlights200305.htm). Several other articles featuring this NPS research are underway in U.S. and international media.
METEOROLOGY FACULTY AND STAFF PARTICIPATE IN RADAR DETECTION PREDICTION PROJECTS

During May and June, faculty and staff (Professor Ken Davidson, Paul Frederickson, Keith Jones, and Richard Lind) and theses students in the Department of Meteorology have three separate projects related to operational estimation of radar detection. These result from developments and findings in previous sponsored research on model developments and from recent field tests with the Naval Surface Warfare Center-Carderock Division Ship Signature Directorate. Two of the current efforts are associated with SPECWARCOM combatant craft operations. The first combatant craft effort is METOC data collection/analysis of refractive effects in a radar signature tests conducted at San Clemente Island beginning 30 May and continuing through June. The second combatant craft effort is a response to SPECWARCOM Group 3 requests for real-time measurement and calculation capabilities to estimate detection by radar. This response is being coordinated by SPAWAR (PMW-155) with NPS providing advice and direction on operational METOC measurement and modeling, and SPAWAR Systems Center (SSC), San Diego providing decision aids guided by onboard detection calculation. NPS will use the SCI field tests to evaluate the several aspects of the solution before it goes operational. The third effort is to adapt METOC instrumentation and models for use on Unmanned Surface Vehicles (USV) to determine counter-detection probabilities and sensor predictions as part of larger force operations in the littorals. This is being performed in direct collaboration with Associate Professor Alex Bordetsky of the Department of Information Science in order to have necessary real-time data links for the UAV-based operation. This is part of the work described in this newsletter lead article on Unmanned Vehicle programs at NPS.

NATIONAL CHALLENGE INITIATIVE TO RECRUIT AND EDUCATE FUTURE NAVAL SHIP DESIGNERS

The National Naval Engineering and Research Consortium (NERC) recently announced the launch of a four-year, $6.9 million program funded by the Office of Naval Research. Through NERC, academic institutions, shipbuilders and government participants are working together to tackle the challenges of building a sustainable culture of innovation for a future Navy requiring more capability from fewer ships and smaller budgets. The expected outcome of the NERC collaboration is a portfolio of innovative research and education activities that attract more students to the field of marine engineering and inspire them to make it their career choice.

Professor Charles Calvano, Department of Mechanical Engineering, will address “Advanced Total Ship Systems Engineering and Optimization,” as one of the recipients of a NERC award.

ENGINEERING FIELD DIVISION/ACTIVITY MANPOWER STAFFING, continued from page 27

enable the clients and various commands to accomplish their missions. NAVFAC is the major claimant for the eleven Engineering Field Divisions/Activities (EFD/A). The Officer in Charge of Contracts (OICC) is primarily responsible for the post-award phase of construction contracts that NAVFAC administers. The OICCs work at the various field offices throughout the NAVFAC organization.

The resource sponsor for NAVFAC is N4, Fleet Readiness and Logistics, who is responsible for identifying the mission, funding and authorizing requirements for NAVFAC. As the major claimant, NAVFAC is responsible for determining the requirements for the EFD/As, which are funded by N4. Due to funding constraints, the Navy is required to be as efficient as possible. This research analyzes the current manpower algorithm used to determine requirements for the various EFD/As. The data shows that the current algorithm does not reflect a number of factors impacting work-hours. An analysis was conducted to derive a more accurate algorithm to include the number of contracts and a method to include other missing factors such as distance, complexity, other military construction providers and commanding officer interest, etc. The conclusion of this research is that a more accurate algorithm that includes these missing factors is essential to the safe, efficient and thorough completion of workload accomplished by the EFD/A in support of NAVFAC’s mission and ultimate responsibilities of N4.
AMERICA’S ARMY: OPERATIONS GAME
Professor Michael Zyda, Director, The Modeling and Simulation Institute (The Modeling, Virtual Environments, and Simulation Institute (MOVES))

Introduction
If you go strictly by the number of young adults playing it at all hours, it’s a success. But how does America’s Army, the U.S. Army’s free PC game strategic communications tool, fare in the real world of costs and benefits? The answer is gratifying and the quality is award winning.

The Game
America’s Army’s roots go back to 1997, when the National Research Council (NRC) issued a report specifying a joint research agenda for defense and entertainment modeling and simulation [Zyda/Sheehan]. The MOVES Institute responded by realigning its research directions with the NRC’s agenda.

The idea for America’s Army originated in a discussion between MOVES (Modeling, Virtual Environments and Simulation Institute) directors and the U.S. Army’s Office of Economic and Manpower Assessment (OEMA). The Army

Marksmanship Training: Fort Benning, Georgia Rifle Range.
was concerned with falling recruitment and the need to attract digitally-sophisticated teens to today’s cutting-edge army. Recruiters had noted that the dwindling availability of veterans with whom kids could talk about Army life meant that a possible military career entered into few calculations. OEMA and MOVES posited that PC games might effectively attract computer-savvy teens and also convey to the uninitiated what an Army career entails. Piggybacking the armed-services message onto popular entertainment was pioneered years ago in movie newsreels, radio, and TV ads. Might today’s gaming technology provide an effective vehicle for the army’s strategic communication? The only way to know was to try.

The MOVES Institute's proposed project, “America’s Army: Operations,” was designed as a fully 3D, accurate, gaming environment well beyond any product on the market, with technological efforts vastly more complex than previous attempts. Funding was received in May 2000, and the game was built secretly for two years, until results had been

**HOW BIG IS IT?**

Figures change daily, but as of January 13, 2003 (six months post-release), the following apply:
- Registered users: 1.3M+
- Players completing basic training: 800K+
- Missions played since 4 July 02: 62M+
- Missions played weekdays: 500K
- Average missions played weekends: 600K
- Hours of play since 4 July 02: 5.8M+

--continued on page 60
Scott St. John helped Los Alamos National Laboratory in New Mexico analyze a suite of sensors and surveillance strategies to detect weapons of mass destruction, with focus on cargo containers used in commercial transportation systems. Matt Ahlert’s role on a team at the Naval Research Laboratory in Washington, DC, was to resolve errors in sonar propagation simulations for Joint Semi-Automated Forces, a program to simulate the movement and battle of forces that can incorporate “live” military maneuvers. At the Naval Air Station at Patuxent River, Maryland, Kristen Deffenbaugh ran thermal analyses and other testing of aluminum alloys being considered for use in replacement parts in aging aircraft. These sophisticated studies were conducted not by published scientists or engineers, nor by graduate students, but by Midshipmen from the United States Naval Academy.

Summers at the U.S. Naval Academy are divided into three four-week periods called “blocks.” Rising seniors (students between junior and senior years) must spend one block in operational settings, such as cruises on destroyers or submarines, or with a Marine Corps unit; one block in credited summer training, which can include internships on-site at host institutions; and one block is allowed for leave. Naval Academy underclassmen are required also to do “cruise blocks” in the summer, but internships are allowed only during leave blocks. For the summer of 2003, plans are well underway to enable Midshipmen once again to be at the cutting edge of scientific, technological, and policy developments that will enable the operational superiority of future naval forces.

In the summer of 2002, more than 250 Midshipmen engaged in hands-on internships at 50 host institutions across the world. Of the 250, sixty percent received credit for summer training; the rest did internships on leave. Hosts included Navy and Marine Corps warfare centers and laboratories, government Centers such as NASA’s Space Flight Centers at Goddard and Johnson, laboratories of the Department of Energy including Los Alamos and Lawrence Livermore, and industries like Boeing and Northrop-Grumman. Midshipmen also joined policy teams in such places as the Office of the Chief of Naval Operations, the Center for Strategic and International Studies, and the Department of State. Not all internships were on U.S. soil; dozens of Midshipmen were in nine foreign countries, participating in cross-cultural exchanges at places like NATO in Brussels or the German Naval Academy in Flensburg.

Conventional wisdom accepts internships as important augmentations to academic training. But experience shows that the impact is much broader. While on internships, Midshipmen are challenged to hone leadership skills as they often head small teams of researchers or learn to work with civilians, “…a task very different from leading military personnel” noted one Midshipman. The students also get first-hand insight into near- and far-term military challenges, not only technologically but also from a policy viewpoint. A Midshipman who interned at the State Department in the Office of Counterterrorism remarked that it was a revelation to see “…how a lot of policies are developed that we, as the military, end up carrying out in military operations.” A Midshipmen who spent time in Prague with 120 students from former Soviet-block countries (as part of the American Institute on Political and Economic Systems) observed: “As Americans, we must always hold to certain ideals upon which our nation was founded, and we must never be ashamed of providing bold leadership…in pursuance of those ideals, but we must also learn to appreciate and be considerate of the beliefs of other nations.” As Professor Elsa Gilmore, Chair of the Language Studies Department, notes: “Midshipmen learn that we operate in a global theater.”

The Midshipmen are often surprised, and even a little intimidated, by how readily they are accepted and expected to contribute like other adults on the team. The delight was best expressed perhaps by a Midshipman who worked with the U.S. mission to NATO: “…it was my expectation that I would be occupied with making new coffee and shredding documents. (In fact) the Colonels and Captains solicited my opinions on cables and other documents. I was shocked when I was asked to draft a memo to SECDEF.” Many Midshipmen describe the internship as a first experience in total independence, from being given the barest of instructions and told to produce a new computer code to having to do their own laundry.

Professor Reza Malek-Madani, the Naval Academy’s Director of Research and Scholarship, believes that the internship experiences go both ways: “The Midshipmen have an opportunity to calibrate their academic experience at the Naval Academy, and to see how what we’re teaching them is relevant. The faculty members, on the other hand, are motivated to see how much of what the students learn can be brought back into the curriculum.”

In an institution that strives for academic and military excellence, the impact of internships is everything we could hope for.
MEMORANDUM OF UNDERSTANDING BETWEEN THE NAVAL POSTGRADUATE SCHOOL AND THE COMMANDER, FLEET FORCES COMMAND ESTABLISHES SPONSORSHIP OF NPS RESEARCH AND EDUCATION INSTITUTES IN SUPPORT OF SEA POWER 21 SEA TRIAL INITIATIVES

To meet the demand for officers with knowledge and skills in highly interdisciplinary systems, the Naval Postgraduate School recently aligned itself into a matrix organization consisting of four graduate schools and three research institutes. The graduate schools in Applied Sciences and Engineering; Operations and Informational Sciences; International Studies; and Business and Public Policy, provide the academic rigor and focused research for the Institutes to use in interdisciplinary education and research in current and emerging military challenges. Each Institute can provide a unique contribution to fleet relevant initiatives related to SEA POWER 21 and SEA TRIAL.

The Cebrowski Institute for Information Innovation and Superiority (CI) is the center of innovative research and education in enabling information technologies, operations and strategies, with focus on their development and application for national security. Using partnerships with industry and academe as appropriate, it also provides Information Professional education and innovative fleet technologies by utilizing technologies in the areas of network infrastructure, fixed and mobile technologies, computer and network security, software systems and interfaces, strategic operations and applications, educational technologies, and policies and management.

The Institute for Modeling and Simulation’s mission is focused on research, application and education in modeling, virtual environments, and simulation. Specially, its research focuses on 3D visual simulation, networked virtual environments, computer-generated autonomy, human performance engineering, immersive technologies, defense/entertainment collaboration, and operational modeling.

The Wayne E. Meyer Institute of Systems Engineering (MI) provides unique graduate education and research to increase the knowledge and skills of military officers and supporting civilian force in systems engineering, systems analysis, and large-scale experimentation. In addition to applied research in these areas, this Institute sponsors a campus-wide interdisciplinary systems engineering project that addresses force-level issues. In the past these studies have included the value of Unmanned Aerial Vehicle (UAV) aircraft carriers, small inshore combatants, and a systems of systems review of Expeditionary Warfare.

Commander Fleet Forces Command (CFFC) is given the Navy’s lead to integrate operational testing of emerging concepts under the Chief of Naval Operations’ SEA POWER 21 vision. SEA TRIAL will involve almost all CFFC’s subordinate commands and will be the catalyst to shape our Nation’s future fleet. It is this agreement’s purpose to ensure NPS gives appropriate support to CFFC in the SEA TRIAL process while continuing its support to CFFC’s subordinate and supporting commands.

Under NPS’s Dean of Research, the three NPS Institutes provide CFFC and subordinate commands a resource for SEA POWER 21 conceptual development and specific research in all areas of SEA SHIELD, SEA STRIKE, SEA BASING and FORCEnet. As previously stated, it is this agreement’s purpose to provide an established conduit for NPS to support these initiatives. CFFC’s sponsorship will help insure that the Institutes’ research and projects support fleet relevant SEA TRIAL initiatives. In addition, the Institutes will update the fleet on the past year’s studies and research through an annual briefing to CFFC and the SEA TRIAL Steering Group. The SEA TRIAL Steering Group will assume the oversight role for involvement of all three Institutes in SEA TRIAL activities with a member of that group, Chief of Naval Research, acting as the primary advocate.


This Memorandum of Understanding continues a prior agreement between the Naval Postgraduate School (NPS) Transportation Security Administration’s (formerly the Federal Aviation Administration’s) Transportation Security Laboratory (TSL) for the continuance of the Transportation (formerly Aviation) Security Chair at NPS.

The NPS and the TSL share common interests in conducting --continued on page 34
MEMORANDUM OF UNDERSTANDING WITH U.S. JOINT FORCES COMMAND OUTLINES OBJECTIVES, RESPONSIBILITIES, AND LIABILITIES ASSOCIATED WITH MANAGEMENT AND OPERATION OF THE U.S. JOINT FORCES COMMAND JOINT OPERATIONAL TEST BED SYSTEM (JOTBS)

This Memorandum of Understanding (MOU) establishes the relationships between and responsibilities of U.S. Joint Forces Command (USJFCOM) and the Naval Postgraduate School (NPS) for employing unmanned aerial vehicle (UAV) flight services with Naval Air Systems Command (NAVAIRSYSCOM) assets in support of the USJFCOM Joint Operational Test Bed System (JOTBS).

The NPS Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS) operates a Government Flight Activity (GFA) to provide UAV flight services in support of military and other customers. A separate MOU between USJFCOM and the Program Executive Officer for Strike Weapons and Unmanned Aviation (PEO(W)) establishes the relationships and responsibilities for NAVAIRSYSCOM support to the JOTBS.

USJFCOM vision and goals in pursuit of UAV interoperability objectives are achieved through the JOTBS to identify doctrine, organization, training, materiel, leadership and education, personnel, and facilities [DOTMLPF] improvements for joint warfighting. This MOU complements the JOTBS Strategic Plan.

USJFCOM will lead Department of Defense (DoD) UAV interoperability experimentation efforts by integrating PEO(W) owned assets with CIRPAS UAV flight services capabilities under USJFCOM management to establish an inherently joint UAV experimentation capability - JOTBS. JOTBS will be used to experiment with UAV and Tactical Control System (TCS) operating concepts and operational flexibility, and command, control, communications, computers, and intelligence, surveillance, and reconnaissance (C4ISR) dissemination interoperability as well as to research and develop future UAV and TCS interoperability requirements.

PEO(W)/PMA-263, acting for the Commander Naval Air Systems Command (COMNAVAIRSYSCOM), is the controlling and reporting custodian for Predator UAV and TCS ground control station (GCS) assets previously procured by Congressional action to support operational experimentation and TCS testing. USJFCOM controls the priority for use of these assets. USJFCOM has physical custody of the TCS GCS and associated ground data terminal. Under USJFCOM direction, CIRPAS will employ its assets, in conjunction with organic capabilities in order to meet JOTBS requirements.

JOTBS operations will support a wide range of UAV interoperability activities and initiatives. USJFCOM will schedule JOTBS employment in accordance with the following research and transferring technologies that relate to both military and commercial aviation and maritime transportation. The TSL desires to broaden the scope of its efforts to counter threats to include chemical/biological/HAZMAT, explosives, nuclear/radiological, and weapons. The TSL accordingly researches diverse technologies to identify those with transfer potential for threat detection and resolution. This search is conducted with an emphasis on academia, medical technology, military projects, NASA programs, the national and federal laboratories, and the industrial sector.

To be responsible to homeland security needs and realize efficiency with respect to continuing research and development activities, coordinated planning and shared usage of unique facilities and assets is in the interest of each party. Both organizations have roles and missions that are supportive and complementary, with a strong potential for providing significant benefits from teaming, collaboration, and integration of some of their research activities.

The scope of the relevant technology is highly interdisciplinary, involving equipment and human factors in aviation and maritime transportation, aircraft design and avionics as well as chemical, biological, HAZMAT, nuclear, and radiological detectors/sensors and threat assessment for terrorist attack. At NPS, this breadth of knowledge is contained across several departments/groups: Homeland Security, Physics, National Security Affairs, Special Operations/Low-Intensity Conflict, and the School of Aviation Safety.

The current Chair incumbent is Dr. James Fobes.
MEMORANDUM OF UNDERSTANDING BETWEEN NAVAL AIR SYSTEMS COMMAND AND NAVAL POSTGRADUATE SCHOOL CONTINUES CHAIR OF LOGISTICS

The Naval Postgraduate and the Naval Air Systems Command renewed their commitment to the Logistics Chair at NPS through a follow-on agreement that culminated with a ceremony to rename the Chair Professorship in honor of Admiral Stanley Arthur, USN (Ret.). The Chair Professorship resides within the Graduate School of Business and Public Policy at NPS.

The objective of the Admiral Stanley Arthur Logistics Chair is to provide a direct relationship between NAVAIR and the Naval Postgraduate School to 1) manage relevant research supportive of NAVAIR requirements and 2) provide opportunities for professional development of both faculty and students in Logistics and related Curricula at NPS. The specific research objective is to ensure research in topics of interest to the Naval Air Systems Command is carried out and to stimulate and coordinate continuing relevant research by NPS faculty and students. The specific educational objective is to enhance the capabilities of graduates to assume management and policy-making positions within the Department of Defense acquisition workforce.

It is the joint responsibility of NAVAIR and the Superintendent, Naval Postgraduate School, to administer this program so that the highest professional standards are maintained in a spirit of cooperation and benefit. The current Admiral Stanley Arthur Logistics Chair is Senior Lecturer Don Eaton.

MEMORANDUM OF AGREEMENT WITH U.S. ARMY SPECIAL OPERATIONS COMMAND PROVIDES FUNCTIONAL AREA (FA) 39 MASTER’S PROGRAM AND INTERMEDIATE LEVEL EDUCATION

This Memorandum of Agreement (MOA) describes the responsibilities and relationships between NPS and the U.S. Army Special Operations Command (USASOC) regarding the FA 39 Master’s Degree in Defense Analysis and the management of the FA 39 Intermediate Level Education for the U.S. Army John F. Kennedy Special Warfare Center and School (USAJFKSWCS), a major subordinate command of USASOC.

The Master of Science in Defense Analysis was established in 1992 at the NPS at the request of the U.S. Special Operations Command (USSOCOM) regarding the FA 39 Master’s Degree in Defense Analysis and the management of the FA 39 Intermediate Level Education for the U.S. Army John F. Kennedy Special Warfare Center and School (USAJFKSWCS), a major subordinate command of USASOC.

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Support for the Peter C. Conrad Chair of Financial Management was renewed through the signing of a Memorandum of Understanding between the Naval Postgraduate School and the Office of the Assistant Secretary of the Navy (Financial Management and Comptroller) (OASN (FM&C)). The Chair Professorship resides within the Graduate School of Business and Public Policy.

The objective of the agreement is to not only provide for the Chair professor, but to also provide a direct relationship between OASN (FM&C) and NPS to allow for opportunities for professional development of both faculty and students in financial management at NPS and, secondarily, to guide selected MBA (FM) curriculum students to areas of resource management of particular interest to the OASN (FM&C). The specific teaching objective is to enhance the academic and practical capabilities of graduates to assume responsible FM positions throughout the Department of the Navy, but mainly in the financial and acquisition areas. The specific research objective is to enable students in their selection of applied research topics.

The current Chair Professor is VADM Thomas Hughes, USN (Ret.).

INTERINSTITUTIONAL AGREEMENT PROVIDES FOR TRAINING FOR AEROSPACE MEDICINE RESIDENTS

The Bureau of Medicine and Surgery and Naval Operational Medicine Institute (NOMI) have established an approved professional training program for Aerospace Medicine Residents. The Naval Postgraduate School’s School of Aviation Safety (NPS-SAS) engages in certain activities in which Aerospace Medicine Residents engaged in the NOMI program may participate to obtain a part of their required learning experiences. An Interinstitutional Agreement between NOMI and NPS renewed this mutually beneficial relationship.

MEMORANDUM OF UNDERSTANDING WITH U.S. JOINT FORCES COMMAND, continued from page 34

priorities: 1) Experiments with joint UAV interoperability objectives; 2) Joint exercises and training events with UAV interoperability concepts, tactics, techniques, and procedures (TTP); 3) Developmental and operational tests in support of TCS program requirements; 4) Support to other users/customers pursuing joint objectives (provided on an “at cost” basis); and 5) Support to other users/customers pursuing Service objectives (provided on an “at cost” basis).

OFFICE OF THE ASSISTANT SECRETARY OF THE NAVY (FINANCIAL MANAGEMENT AND COMPTROLLER) AND NAVAL POSTGRADUATE SCHOOL RENEW RELATIONSHIP TO SUPPORT THE REAR ADMIRAL PETER C. CONRAD CHAIR OF FINANCIAL MANAGEMENT

A recently executed Memorandum of Understanding between the Naval Postgraduate School and the Office of the Assistant Secretary of the Navy (Research, Development and Acquisition), Deputy Assistant Secretary of the Navy (Acquisition Management) (ASN (RD&A) DASN (ACQ)) establishes a sponsoring relationship for the Chair of Acquisition Management within the Graduate School of Business and Public Policy. The primary objective of the relationship is to 1) conduct and manage relevant studies and analyses supportive of ASN (RD&A) DASN (ACQ) requirements, and 2) provide opportunities for professional development of both faculty and students in Acquisition Management and related curricula at NPS. The specific objective is to accomplish current studies and analyses in topics of immediate concern to the ASN (RD&A) and the DASN (ACQ) as well as to stimulate and supervise studies and analyses conducted by NPS faculty and students. The specific educational objective is to enhance the capabilities of graduates to assume management and policymaking positions within the Department of Defense acquisition workforce.

The current Chair of Acquisition Management is RADM James Green, USN (Ret.).

RELATIONSHIPS, continued on page 37
MEMORANDUM OF AGREEMENT AMONG THE USAF SPACE AND MISSILE SYSTEMS CENTER DETACHMENT 12 SPACE TEST PROGRAM, NAVAL POSTGRADUATE SCHOOL AND THE U.S. NAVAL ACADEMY ESTABLISHES RELATIONSHIP FOR LAUNCH OF MidSTAR-1

The Memorandum of Agreement (MOA) defines the relationship among the USAF Space and Missile Systems Center, Detachment 12, Space Test Program (SMC Det 12/ST, or “STP”), the United States Naval Academy (USNA), and the Naval Postgraduate School (NPS) on the terms and conditions for spacecraft design and build, payload integration, space vehicle testing, launch and operations of the MidSTAR1 (P03-3) mission. The Department of Aerospace Engineering at USNA is sponsoring the MidSTAR-1 program and USNA is responsible for the design, build, payload integration, test and operations, which will be executed by Midshipmen. The mission of MidSTAR-1 is to provide a space vehicle for two Space Experiment Review Board (SERB) experiments. The USNA 0201 Internet Communications Satellite (ICSat) will be provided by the U.S. Naval Academy. The Configurable Fault Tolerant Processor (CFTP) will be provided by the Naval Postgraduate School (NPS). Additionally, MidSTAR-1 will provide training to students in the Aerospace Engineering curriculum at USNA and Space and Electrical Engineering curricula at NPS.

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CHAIR PROFESSORSHIPS

ADimiral Stanley Arthur Chair of Logistics at the Naval Postgraduate School

Senior Lecturer Donald Eaton of the Graduate School of Business and Public Policy is continuing as the Admiral Stanley Arthur Chair of Logistics. The Chair Professorship was recently renewed through a Memorandum of Understanding with the Naval Air Systems Command. Senior Lecturer Eaton has served as the "Logistics Chair" since 1994.

Eaton retired as a Rear Admiral on 1 January 1994 after serving for more than 36 years in the Navy. He entered the Navy in 1957 as a Naval Aviation Cadet in Pensacola, Florida. In 1959, upon graduation from flight school at NAS Corpus Christi, Texas, as the first NAVCAD Naval Flight Officer, he flew as a Heavy Attack Bombardier/Navigator in A3D-2 aircraft in VAH-3, VAH-7, and VAH-13. In June 1963, he transitioned to the A-6 airplane as a Bombardier/Navigator and deployed to Vietnam in May 1965. During this tour he flew 66 combat missions and on 14 July 1965, he and his pilot were shot down near Sam Neua, Laos. They were rescued after successfully evading enemy troops for a night and a day. In February 1966, he was assigned to VA-42 as an A-6 flight instructor until his assignment to the Naval Postgraduate School where he earned a Bachelor of Science in Engineering Science in 1969. In February 1970, after assignment at the Naval Air Rework Facility in Norfolk, Va., flying production test, he returned to A-6 instructor duties in VA-42. Later he transferred to VA-85 as the maintenance officer for the first deployment of the A-6E. In August 1973, he joined USS America (CVA-66) as an Aerospace Maintenance Duty Officer and served as the Assistant AIMD Officer and later as the AIMD department head. While aboard America, he completed a cruise to the Mediterranean and participated in Northern Merger, a NATO exercise. From October 1975 until June 1978, he served as the AIMD Officer at NAS Norfolk.

After a tour at the Naval Military Personnel Command as the Aerospace Maintenance Duty Assignment Officer, he was enrolled as a student at the Industrial College of the Armed Forces. While there, he studied at George Washington University and earned a Master of Science in Administration.

From August 1980 to June 1983, he was assigned to the Naval Air Systems Command as the Director for Support Systems, Director for Logistics and Maintenance Policy and Executive Director. In July 1983, he took command of the Naval Plant Representative Office at General Electric in Lynn, Massachusetts, and helped introduce the T-700 and F-404 engines. In June 1985, he commanded the Naval Air Engineering Center in Lakehurst, New Jersey and brought the low-pressure steam catapult to maturity for use on the Navy's newest aircraft carriers. From March 1987 until June 1989, he was the Executive Assistant and Naval Aide to the Assistant Secretary of the Navy for Research, Engineering and Systems. From June 1989 until March 1990 he served in his first Flag assignment as the Program Director for Space and Sensor Systems in the Space and Warfare Systems Command. From March 1990 until December 1993, he served as the Deputy Assistant Commander for Aviation Depots and Assistant Commander for Logistics and Fleet Support in the Naval Air Systems Command.

In March 1994, he joined NPS as the Logistics Chair. In 1994 he led the establishment of Acquisition Logistics 304 for the Defense Acquisition University. In 1995 he created the course "Strategic Planning and Policy for Logistics Managers" which is open to all students in the Graduate School of Business and Public Policy. In 1995, he became the Academic Associate for Transportation Management, Inventory Management and Logistics Material Management, which are now consolidated in the logistics MBA program. In 1999, he participated in a DoD, FAA aging aircraft conference and presented a paper on aging wiring systems. Later that year, Senior Lecturer Eaton became a member of the Space Shuttle --continued on page 39
The Peter C. Conrad Chair of Financial Management was recently renewed through a Memorandum of Understanding with the Office of the Assistant Secretary of the Navy (Financial Management and Comptroller). VADM Thomas J. Hughes, USN (Ret.), a Visiting Distinguished Professor at NPS, is the current chair incumbent. During his tenure, RADM Hughes would like to: 1) identify the best candidates in the MBA (Financial Management) curriculum who show potential for senior positions in the Navy as financial managers; 2) infect some knowledge, based on his experience in the Navy, of real life challenges to financial managers in the Navy to complement the education received at NPS; and 3) participate in any activities that would meet any NPS requirement for which he can make a contribution.

VADM Hughes received his B.S. degree from Harvard University and was commissioned in the U.S. Navy via the NROTC program. VADM Hughes served as a Junior Officer on Destroyers, Amphibious and Service Force Ships. He attended the Armed Forces Staff College in Norfolk, VA, and earned a Master of Science in Operations Analysis at NPS. In 1962 VADM Hughes was assigned to the organization of the Joint Chiefs of Staffs, followed by command of a guided missile destroyer, USS John King. He commanded the amphibious cargo ship, USS Thuban, and assumed command of the oiler USS Chikaskia. In September 1971, VADM Hughes became Commander Destroyer Squadron Thirty-Six and served as the Gunline Commander off South Vietnam. He assumed duty as Assistant Chief of Naval Personnel for Financial Management in 1974. In 1976, he assumed command of Service Group Two. He later became the Deputy Director and then Director of Budget and Reports in the Office of the Navy Comptroller. In June 1981, he became Assistant Deputy Chief of Naval Operations (Manpower, Personnel and Training). From June 1983 through July 1987, he served as the Deputy Chief of Naval Operations (Logistics).

VADM Hughes retired in 1987 after 43 years of active Naval Service. He then became President and CEO of the Navy Federal Credit Union, the largest credit union in the United States. He has also served as a board member of the National Association of Federal Credit Unions, the Credit Union National Association Reserves Study Commission, the Baltimore Branch of the Federal Reserve Bank of Virginia, the Thrift Institutions Council, VISA U.S.A. Board of Directors, and on an advisory group to the Board of Governors of the Federal Reserve System.

CHAIR OF UNDERSEA WARFARE

A Memorandum of Understanding between the Naval Undersea Warfare Center and the Naval Postgraduate School has established the Chair of Undersea Warfare (USW). The Chair will also serve as the Director of the Undersea Warfare Center located in the Wayne E. Meyer Institute of System Engineering. The resurgence of interest and concern about USW as a component of littoral and expeditionary warfare resulted in initiatives at NPS to enhance the academic and research content in several curricula with USW related material. The result of those initiatives, along with the establishment of the Undersea Warfare Center and the Undersea Warfare Chair Professorship, places NPS as a major center of excellence for instruction, research, and analysis in the field of undersea warfare.

The USW Chair Professor will be involved in the

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COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS FACILITATE COLLABORATIVE EFFORTS WITH INDUSTRY

The Naval Postgraduate School has an active Technology Transfer Program. Technology is transferred to the public sector primarily through the publications of the faculty and students. NPS also interacts with industry on collaborative research efforts through Cooperative Research and Development Agreements (CRADA). Recent endeavors are highlighted here.

LOCKEHD MARTIN NAVAL ELECTRONICS AND SURVEILLANCE SYSTEMS

NPS Program Manager: Professor Dan Boger, Department of Information Science

The Naval Postgraduate School has entered into a Cooperative Research and Development Agreement with Lockheed Martin Naval Electronics and Surveillance Systems (LM NESS) in Moorestown, NJ. The objective of this collaborative effort is to integrate LM NESS COMBATSS capability into a collaborative secure/classified lab environment at NPS.

COMBATSS represents how future command, control, communications, computer and intelligence (C4I) spaces aboard warships will be configured. It will introduce NPS students to the latest information systems technology used in the Fleet.

COMBATSS’ main feature is its scaleable C4I system, operating at the SIRPNET/Secret level, affording NPS the capability to “plug n’ play” and collaborate with fleet battle experimentation, operations, tactics and knowledge superiority in a secure lab environment. This capability will allow NPS to evolve with the Fleet and directly participate in how we will fight as a transformed Navy across the four major pillars of Seapower 21: Sea Shield, Sea Strike, Sea Basing and FORCENet, where fleet units are virtually linked in a networked, global information grid irrespective of geographic location. With COMBATSS, NPS will fully function as a participatory node in the Navy's FORCENet grid.

RIVERMIND, INC.

NPS Program Manager: Associate Professor Cynthia Irvine, Department of Computer Science

RIVERMIND and NPS entered into a Cooperative Research and Development Agreement to allow for the participation of the future development of an educational computer game that simulates computer and network security attack scenarios and countermeasures. This game has --continued on page 41

NORTHROP GRUMMAN SHIP SYSTEMS

NPS Program Manager: Professor Chuck Calvano, Department of Mechanical Engineering

The Naval Postgraduate School (NPS) and Northrop Grumman Ship Systems (NGSS) of Pascagoula, MS, a sector of the Northrop Grumman Corporation, finalized a Cooperative Research and Development Agreement (CRADA) between the two organizations. The CRADA will promote cooperative efforts and exchange of innovative ideas between NGSS and the Total Ship Systems Engineering (TSSE) program at NPS in Monterey, CA.

NGSS is a major Defense contractor, with primary operations in Pascagoula, MS, New Orleans, LA, Gulfport, MS, and Tallulah, LA, as well as in fleet support offices in the U.S. and Japan. It is one of the nation's leading full service systems companies for the design, engineering, construction, and life cycle support of major surface ships for the U.S. Navy, U.S. Coast Guard and international navies, and for commercial vessels of all types.

The TSSE Program at the Naval Postgraduate School was instituted in 1991 to provide education in Systems Engineering methods and the Navy ship design process to officer-students in the Mechanical Engineering, Electrical Engineering and Combat Systems Engineering curricula. The students, working as a team, produce an annual ship design intended to explore innovative concepts and solutions to emerging defense challenges.

The Cooperative Agreement will foster the exchange of innovative ideas and potential design solutions between the parties. They will work together to coordinate design topics, research areas and mutual site visits. The TSSE faculty will be available to provide input on the technical aspects of NGSS design work and NGSS will participate in reviews of NPS student designs.

The CRADA represents “an unprecedented opportunity to introduce real-world industrial viewpoints into the students’ academic design projects, making those projects of even greater value to the students and of increased relevance for the Navy”, said Professor Charles Calvano, NAVSEA Chair of Total Ship Systems Engineering.
PROSENSING, INC.
NPS Program Manager: Professor Jeffrey Knorr,
Department of Electrical and Computer Engineering

NPS and ProSensing Inc. will work together to modify an existing AN/MPQ-64 tactical radar to operate as a rapid-scanning weather radar system. The combined electronically and mechanically scanned antenna of the MPQ-64 will provide an exceptional tool for studying rapidly developing convective storms, including thunderstorms and tornadoes. ProSensing will provide: 1) Tactical Weather Processor; 2) processor and software installation and functional testing; 3) postprocessing software for data display and interpretation and 4) documentation as required for NPS to operate the radar with the weather processor and to use the postprocessing software.

SCIENTIFIC SYSTEMS COMPANY, INC.
NPS Program Manager: Research Assistant Professor Ramesh Kolar, Department of Aeronautics and Astronautics

Scientific Systems Company, Inc. is the recipient of a Small Business Technology Transfer contract from the National Aeronautics and Space Administration under NASA Contract No. NAS4-02022, Small Business Technology Transfer (STTR) Phase II Research Study entitled, “Integrated Software Toolbox for Aeronautics and Dynamic Stability Analysis of Air Vehicles.” NPS is a collaborator with Scientific Systems on this STTR award.

ORINCON DEFENSE
NPS Program Manager: Professor Dan Boger, Department of Information Science

NPS and ORINCON will work together to demonstrate the capabilities and advantages of the Intelligence and Visualization and Activity Database Software. ORINCON will provide: 1) TIBCO BusinessFactor™ software application package for NPS evaluation and use; 2) evaluation of visualization and activity monitoring recommended by the Navy and/or joint personnel; and 3) concept definition and prototyping of a tailored, PC-based Visualization and Activity Monitor tool for naval and joint intelligence centers. The partners will co-develop a Pacific-tailored demonstrator that can be used for Fleet operator evaluation.

RIVERMIND, INC., continued from page 40

the working title of SimSecurity. NPS will provide RIVERMIND with considerable game content and security scenario descriptions that will be incorporated into the future version of the game. The CRADA provides the framework for NPS to continue to provide evolving technical content to developers of the SimSecurity game, and for NPS to provide RIVERMIND with student resources for conducting testing and preparation of scenarios.

CHAIR OF UNDERSEA WARFARE, continued from page 39

review of USW curriculum to assure appropriate content relative to undersea and antisubmarine warfare principles and technology applications. The Chair will liaison with Navy laboratories, acquisition programs managers, program sponsors, and operation commands to identify prioritized needs for research topics in the USW area. The Chair will also be involved in wargaming support for the Office of Naval Research and other naval activities, particularly in the antisubmarine warfare area of wargaming. Concurrently assigned as the Director of the Undersea Warfare Center, the Chair will be involved in the research planning and program execution of the Center.

The inaugural incumbent of the Chair, VADM Roger F. Bacon, USN (Ret.) will report to NPS in July. VADM Bacon graduated with a Bachelor of Science degree from the United States Naval Academy in 1959, and holds a master’s degree in Computer Science from NPS. He also attended the National Defense University Flag and General Officer CAPSTONE course and the Harvard University National and International Security course.

VADM Bacon served thirty-four years of active U. S. Navy duty that culminated in the assignment as Assistant Chief of Naval Operations for Undersea Warfare, the head of our nation’s submarine force. He was responsible for 64,000 Navy personnel, a $14 billion annual budget, and U. S. submarine force strategy.

VADM Roger F. Bacon, USN (Ret.)

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VADM Bacon's career included progressive commands. He commanded two nuclear powered submarines in the Pacific, a submarine tender in Guam, a submarine squadron in Pearl Harbor, HI, a U.S. and NATO group of submarines in the Mediterranean, and a carrier battle group. He served as Commander Submarine Force, U.S. Atlantic Fleet and Commander Submarines Allied Command Atlantic, a force of 106 ships with 82 submarines, from 1988 to 1990. After retiring from active duty in 1993, he served as Vice President of the Pacific Northwest office for Sonalysts, Inc. In 1995, he became Vice President and manager of Tank Waste Remediation Systems in Richland, Washington. He was responsible for ensuring the safe storage and remediation of radioactive and chemical wastes, and resolving safety issues. He was the President and Manager of Safe Sites of Colorado from 1996 to 1999. His company was responsible for nuclear operations, material stabilization, cleanup and closure of the Department of Energy’s Rocky Flats Environmental Technology Site in Colorado.

In 1992, VADM Bacon was decorated with the French Legion of Honor. He was also the recipient of the nation’s highest peacetime decoration, the Distinguished Service Award, in 1988, 1990 and 1993.
CONFERENCES

NAVY HOSTS EIGHTH NATIONAL HIGH CYCLE FATIGUE CONFERENCE

The 8th National Turbine Engine High Cycle Fatigue (HCF) Conference was hosted by the Navy in Monterey on 14-16 April. The “kick-off” 1st and 2nd Conferences were hosted at NPS, and the 4th Conference was held in 1998 in Monterey also. It was during the 2nd Conference that the Air Force and Navy managers agreed to establish the ‘Navy Rotor-Spin Research Facility’ at the Turbopropulsion Laboratory (TPL) at NPS to work with and support the Navy Rotor Spin Facility at Patuxent River. This working alliance has been extremely successful and has resulted in loss of the total engine and aircraft.

High Cycle Fatigue (HCF) results from vibratory stress cycles at frequencies that can reach thousands of cycles per second and can be induced from various aeromechanical sources. It is a widespread phenomenon in aircraft gas turbine engines that historically has led to the premature failure of major engine components (fans, compressors, turbines) and in some instances has resulted in loss of the total engine and aircraft.

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Figure 1. The Navy Rotor Spin Research Facility at the Turbo Propulsion Laboratory (TPL) can accommodate full-scale engine fan, compressor and turbine rotors. The vacuum spin pit is below the ground, and the test rotor is contained within a wall of steel some ten inches thick. The test article is hung from and driven by an air-turbine. Speeds to 12,000 RPM in large rotors and 30,000 RPM in small rotors are typical. Strain gauge measurements are brought out through a 50-channel high-speed slip-ring unit to a 16-channel real-time data system. Laser-light and capacitive probes measure resonant blade oscillations induced by either a succession of air-jets (AJE), oil-jets (OJE), or magnet-pairs (ECE).
CLASSIFIED ADVANCED TECHNOLOGY UPDATE SHORT COURSE

The Naval Postgraduate School will once again offer its Classified Advanced Technology Update (CATU) Short Course this year during the week of 21 July 2003. This five-day short course has evolved into a very successful and highly anticipated annual event at NPS. The CATU, now in its fifth year offering, is facilitated by Professor Herschel H. Loomis, Department of Electrical and Computer Engineering, and Ms. Rita Painter, SPAWAR Systems Center-San Diego. This short course is offered by the Electrical and Computer Engineering Department's Cryptologic Research Center, a member center of the Cebrowski Institute.

The CATU is specifically tailored to meet the educational requirements of U.S. military, civilian and contractor technical personnel with appropriate security clearances who need to stay current on advanced technologies that support their missions for the Department of Defense. Speakers, from industry and government, in addition to NPS academia, are selected to present topics for which they are recognized subject matter experts. Course topics include Cryptology, Information Operations, Overhead Reconnaissance, Digital Signal Processing, Navigation, Communications, High Power Microwave and Geolocation.

The course fee is waived for NPS faculty and students who have the appropriate clearance level. Registration information and program details can be obtained at www.nps.navy.mil/CATU or by calling Ms. Painter at (831)656-2148.

ELEVENTH INTERNATIONAL CONFERENCE ON TELECOMMUNICATION SYSTEMS-MODELING AND ANALYSIS WILL BE HOSTED BY NPS

The 11th International Conference on Telecommunication Systems - Modeling and Analysis will be held at the Naval Postgraduate School, Monterey, CA on October 2-5, 2003. The conference will build on the tradition of the earlier conferences. The general idea is to encourage informal interaction and exchanges of ideas by limiting the number of participants, concentrating on a few topics, and by presenting new problems and problem areas. The objective is to advance the state of the modeling and analysis in telecommunications by stimulating research activity on new and important problems.

The Conference General Chair is Professor Bezalel Gavish, Cox School of Business, Southern Methodist University. The Technical Program Chair is Associate Professor Alex Bordetsky, Department of Information Science.

MILITARY OPERATIONS RESEARCH SOCIETY MEETING, continued from page 42

nor have I previously had the opportunity to work with people with such integrity and discipline and to hear stories about what life in the navy and the army is really like. For all the experiences I gained from attending the colloquium, I would like to thank you for putting this event together and for being the pioneer in opening the door for many students to participate in military OR competitions. This event certainly opened my eyes to the many OR opportunities that exist inside the military.”

NAVY HOSTS EIGHTH NATIONAL HIGH CYCLE FATIGUE CONFERENCE, continued from page 43

productive. Following an initial paper given at the 4th Conference on the reactivation of the engine-scale vacuum spin pit at TPL, a paper has been contributed in each subsequent conference on the development of HCF blade excitation and measurement techniques for spin testing.

This year’s paper was given by Professor Ray Shreeve and co-authored by Professor Garth Hobson, TPL engineer Doug Seivwright, all of the Department of Aeronautics and Astronautics, and graduate student LT Scott Russell, USN. The paper was entitled “Vacuum Spin Test Experience with Eddy-Current Excitation of a Large Titanium Fan Blisk.” Since the paper was given, an oil-jet excitation system has been installed (see Fig. 1), and a new test article is being prepared (Fig. 2). The purpose of the upcoming program is to evaluate the effectiveness and durability of visco-elastic dampers (VEDs) in engine fan blades while attempting to monitor individual blade response using non-contact tip-timing techniques. The TPL team is working with GE/AADC engineers responsible for the VEDs development, Air Force and Navy program managers (Frank Lieghley and Ray Pickering respectively). A review of the upcoming program was held at TPL immediately following the Conference.

The National HCF S&T Program officially began in December 1994. The purpose of this national effort was to help eliminate HCF as a major cause of engine failures. The Program is directed by an Air Force led Steering
NPS HOSTS THE MARINE CORPS WARFIGHTING LABORATORY’S SIXTH PROJECT ALBERT INTERNATIONAL WORKSHOP

Analysts and warfighters from around the world came to NPS this past March to participate in the Marine Corps Warfighting Laboratory’s (MCWL) 6th Project Albert International Workshop (PAIW6). Seventy participants represented five countries: Australia, Canada, Germany, Singapore, and the United States. Local participants included faculty affiliated with the Operations Research (OR) Department, Graduate School of Business and Public Policy, the Modeling, Virtual Environments and Simulation (MOVES) Institute and the Meyer Institute of Systems Engineering, as well as NPS OR students. NPS alumni from both home and abroad were also well represented. This unclassified international effort is investigating how new techniques (such as agent-based models, visualization tools, and data farming), supported by the technical infrastructure (e.g., supercomputers and web-based access) can allow analysts to better address strategic and tactical questions posed by military decision-makers.

Project Albert Director Dr. Gary Horne kicked off the workshop with a look back at Project Albert’s beginnings and a look ahead toward using these new approaches to have a tangible benefit on military decision-making. This introductory session was followed by in-briefs from the workgroup team leaders. Some workgroups were refining and extending results from the previous workshop. These teams (and team leaders) dealt with peace support operations (LTC Klaus Titze, German Army), entry from the air and sea (Colonel Grant Sanderson, Australian Army), shallow water obstacles (Captain Ryan Patterson, USMC), communication in sensor networks (Major Szu-Ching Wan, Singapore Army), and military operations in urban terrain (LTC Thomas Cioppa, TRAC-Monterey). Several new problem areas were identified, including the global war on terrorism (Dr. Al Brandstein, Northrop-Grumman), C2 and future conflicts (LtCol John Kuntz, USMC), and force protection (COL William Carlton, U.S. Military Academy, West Point). Some teams explored how these modeling platforms—initially developed for investigating small-scale combat operations—could be adapted for other purposes, such as expeditionary logistics (OR student Captain Eric Wolf, USMC) and enhanced blast

U.S.-RUSSIAN STRATEGIC CONFIDENCE BUILDING MEASURES WORKSHOP

Associate Professor Mikhail Tsypkin of the Department of National Security Affairs hosted this U.S.-Russian Workshop in Garmisch, Germany on 2-5 June. The workshop is a follow-on effort to the August 2000 Monterey Workshop funded by the Defense Threat Reduction Agency and explored the utility of strategic modeling as a tool for bilateral confidence building. Topics discussed include: 1) Current U.S. and Russia strategic doctrines and transformation initiatives; 2) Factors influencing strategic stability, to include non-military issues; 3) Strategic modeling techniques and concepts; and 4) Options and limitations for conducting bilateral modeling exercises.

Project Albert participants from military and civilian organizations in five countries gather in the School of International Graduate Studies courtyard outside Hermann Hall. NPS was well represented at the conference by five faculty, two current students, and twelve alumni.
The Naval Postgraduate School recognized outstanding researchers at the Research Recognition Evening held in April. This year's event recognized recipients from 2001 and 2002. The evening was hosted by the Faculty Chair, Professor Terry McNelley, with opening remarks from RADM David Ellison, USN, Superintendent of NPS. The Evening's commentator was Distinguished Professor David Netzer, Associate Provost and Dean of Research. Recognized researchers and their achievements are highlighted.

School of International Graduate Studies
The Department of National Security Affairs recognized Professor David Yost for his research achievements in 2001. Professor Yost undertook five major research projects: 1) Europe and Information Warfare, 2) European Security and NATO Nuclear Policy, 3) NATO's New Roles in International Security, 4) National Missile Defense and European Security, and 5) Nuclear Arms Control and European Security. Professor Yost's work was published in the journals *International Affairs*, *Survival*, and *Comparative Strategy*.

Associate Professor Dan Moran was recognized for outstanding research in 2002 in the Department of National Security Affairs. His edited volume *The People in Arms: Military Myth and National Mobilization since the French Revolution* was recently published by Cambridge University Press. Professor Moran also contributed the essay on strategic theory and the history of war to the volume *Strategy in Contemporary World* published by Oxford University Press. He also was a leading contributor to the Center for Contemporary Conflict, providing five Strategic Insights for the Center's web site. Professor Moran played a pivotal role in the recent study on the Navy and the Global War on Terrorism that was conducted for N51 and was recently briefed to N3/5.

Assistant Professor Robert McNab's output of peer-reviewed articles shows remarkable consistency and an expanding depth of knowledge in a broad spectrum of subject areas and has resulted in his being recognized for outstanding research achievement in 2001 and 2002 in the Defense Resource Management Institute. In 2002, he had articles in press at *Monetary Studies, Business and Economic Review, World Development, Public Budgeting and Finance*, and *Public Finance and Management*. These five papers are in addition to his previous contributions to the literature. His research topics are timely and of special interest to the U.S. Government and the Naval Postgraduate School: the prospects for performance budgeting in the federal government, how fiscal decentralization affects economic growth, and the relationship between international aid and governance and economic growth. His written contributions to the literature on aid, corruption and governance have been incorporated into his

PROJECT ALBERT INTERNATIONAL WORKSHOP, continued from page 45

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PROJECT ALBERT INTERNATIONAL WORKSHOP, continued from page 45

weapons (Mr. Ken Curio, MCWL).

Following the opening morning sessions, the teams had nearly four days to refine their agent-based scenarios, specify sets of simulation runs to explore the models’ behaviors, and analyze the results. Concurrent plenary sessions provided opportunities for workshop participants and others across campus to learn more about Project Albert’s goals, suite of agent-based modeling platforms, and data-farming and visualization tools. Dr. Hugh Montgomery, Technical Director of the Warfighting Lab, also provided an overview of the lab’s current initiatives and highlighted the ever-increasing need for qualified new scientists, engineers, and analysts as the current civilian workforce ages. Literally billions of simulation runs were submitted to the Maui High-Performance Computer Center for processing, and out-briefs were given at the end of the week. The results from PAIW6 will be published later this year in *Maneuver Warfare Science 2003*.

The teams will reconvene at the next Project Albert workshop, to be held at the Marine Corps Warfighting Laboratory in September 2003.

Further information about Project Albert, including past workshops, research documents and contact information, can be viewed at <http://www.mcwl.quantico.usmc.mil/divisions/albert/index.asp>. This edition’s featured project, “Smart Experimental Designs Provide Military Decision-Makers With New Insights From Agent-Based Simulations,” describes how Associate Professor Thomas Lucas, Professor Susan Sanchez, and their students have contributed to the Project Albert effort.

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lectures at DRMI. Professor McNab’s work is highly relevant to public finance and budgeting in transitional economies and well aligned with the Institute’s interests in resources management and international involvement. The health of developing and transitional economies is directly relevant to the management of their defense resources.

Graduate School of Operational and Information Sciences
Associate Professor Geoffrey Xie was recognized for outstanding research achievement in 2001 in the Department of Computer Science. Professor Xie does research on improving the speed and efficiency of computer networks, a topic of great importance to the Navy and Department of Defense with their increasing attention to network-centric and information-centric warfare. His work includes modeling of networks and development and enforcement of rules controlling them. He has made major contributions to improving the throughput and timeliness of data in networks. DARPA and NSF have supported his work.

Associate Professor J. Bret Michael was recognized for outstanding research achievement in 2002 in the Department of Computer Science. Dr. Michael made recent contributions to information security, software testing, and distributed operating systems. All of these are topics of high importance to the military. Military software must be proved to be secure and correct, and must work across wide ranges of networks. Professor Michael’s recent work has included analysis of the security of telephone networks; development of metrics for measuring software efficiency; development of automatic methods for enforcement of policy for computers and networks; and design of deception methods for defense on computer systems under attack during cyber-warfare, analogous to defense of military units during battle.

In 2001, the Department of Information Science recognized Associate Professor William Kemple. Professor Kemple was the Principal Investigator for the recently completed NPS program in support of Joint Experimentation sponsored by U.S. Joint Forces Command J9. He led a team of over twenty NPS researchers from Command and Control, Information Systems, Operations Research, Human Factors, Information Warfare, National Security Affairs, Business and Public Policy along with faculty from the Meyer Institute and the MOVES Institute. This team, along with NPS students, and in collaboration with researchers at J9 and elsewhere, conducted analyses to examine future joint warfighting concepts; conducted and facilitated workshops in support of future joint warfighting concept development; provided analysis of future joint warfighting concepts as played in the Navy’s Global Wargame; and conceptualized, designed, and led training and analysis for the Effects Tasking Order-to-Actions Limited Objective Experiment conducted at J9 in December 2001. One highlight of this project was the Peer-to-Peer, Wireless, Limited Objective Experiment designed by Professor Kemple’s interdisciplinary team and conducted at NPS between 12-14 March 2002. Over thirty students from six curricula and fifteen NPS researchers from five departments participated in this experiment, which featured several technology advances developed by faculty and students at NPS. Six class projects and twelve theses resulted from the J9 project, and eighteen papers were presented at the 2001 Recipients (from left to right, first row): Professor Kenneth Davidson, Associate Professor Kemple, Research Associate Professor Chris Brophy, Associate Professor Geoffrey Xie, Associate Professor Gamani Karunasiri; (second row) Associate Professor Don Brutzman, Research Associate Peter Fredrickson, Professor Tom Herbers, Professor Larry Jones, and Professor Charles Therrien.

2001 Recipients (from left to right, first row): Professor Kenneth Davidson, Associate Professor Kemple, Research Associate Professor Chris Brophy, Associate Professor Geoffrey Xie, Associate Professor Gamani Karunasiri; (second row) Associate Professor Don Brutzman, Research Associate Peter Fredrickson, Professor Tom Herbers, Professor Larry Jones, and Professor Charles Therrien.

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FACULTY RECOGNIZED AT RESEARCH RECOGNITION EVENING, continued from page 47

Command and Control Research and Technology Symposium, the Military Operations Research Society Symposium and other conferences. Twenty-six reports and papers were completed for this project.

In 2002, Associate Professor Alexander Bordetsky was recognized for outstanding research achievement in the Department of Information Science. Professor Bordetsky has provided significant contributions to NPS research in the areas of collaborative technology, shared situational awareness, Habitats for Command and Control. This wide range of research projects has been sponsored by Joint Forces Command, SPAWAR Systems Command, NAVAIR Systems Command, and the Department of Justice Homeland Security Program, as well as the private sector firms Aprisma Corporation, Foundry Networks, and SBC Research Labs. In addition to his own prolific publication, papers by his students have won symposium best paper awards and have been briefed to and received special recognition from Fleet Commanders.

Associate Professor Robert F. Dell was recognized for outstanding research achievement in 2002 in the Department of Operations Research. The award recognizes his optimization research with military applications and the continuing publication of this research in the open literature. The U.S. Army has funded this research for over a decade, most recently resulting in the decision-support systems OSAF (Optimal Stationing of Army Forces) and BAEC (Budget Allocation for Environmental Cleanup). Both involve detailed, large-scale integer programs. The Army has used OSAF for numerous stationing studies and has adopted OSAF to help plan its 2005 base realignment and closures. The Army used BAEC to help guide over $350 million in environmental cleanup at over 400 sites on 41 current and former installations. Professor Dell has also been working with other Operations Research faculty to support N81, the Navy's Assessment Division. This research has culminated in a desktop, optimization-based decision support-tool to integrate, rationalize, and schedule the Navy's capital spending programs over the next 25 years. By the way, these plans total over one trillion dollars.

Dell has reported on this and other research in numerous briefings to high-level Army and Navy personnel, in technical reports, in conference presentations and in scholarly journals. In fact, in the last few years, he has published five papers in...
Interfaces, the premier journal covering applications of operations research technology.

**Graduate School of Engineering And Applied Sciences**

In 2001, the Department of Aeronautics and Astronautics recognized Research Assistant Professor Christopher Brophy for his research on pulse detonation engines and rocket plume phenomena which has generated national and international attention. Specifically, he has contributed to the determination of the minimum and optimum parameters for successful pulse detonation engine operation. He has also contributed to the detection of non-axisymmetric features in rocket exhaust plumes.

In 2002, Research Assistant Professor Jose Sinibaldi was recognized by the Department of Aeronautics and Astronautics for his research on pulse detonation engines, especially for the experimental investigation of the initiation and propagation of detonations and for the development of optical diagnostics to detect non-axisymmetric features in rocket exhaust plumes. His published contributions have been noted nationally and internationally.

In 2001 and 2002, the Department of Electrical and Computer Engineering recognized Professor Charles W. Therrien for his research in and contributions to statistical signal processing and multi-rate signal processing. He has developed algorithms for optimal filtering, detection and classification, tested least squares optimal filtering on data from experiments, and formulated two equivalent realizations for the optimal filtering. This work is part of the integrated sensing and processing program under DARPA DSO/AMCP. He has published several articles in the area of statistical signal processing. He is the author of two textbooks, *Discrete Random Signals and Statistical Signal Processing and Decision, Estimation, and Classification*. As a Distinguished Lecturer of the IEEE Signal Processing Society, he has lectured on the statistical signal processing topics in Australia, Europe, and the United States. He has served as the chairman of the Steering Committee of the Asilomar Conference on Signals, Systems, and Computers for over 12 years. Of particular note is his research into the history of the statistical theory of communication and the work of Lee and Wiener. This work is summarized in a recent paper published in IEEE Signal Processing Magazine and was well received in the signal processing community.

**NEW DEAN OF RESEARCH JOINS NPS**

Leonard Ferrari has joined NPS as the Associate Provost and Dean of Research. Dr. Ferrari received his Ph.D. in Electrical Engineering from the University of California, Irvine. Prior to joining NPS Dr. Ferrari held positions at Virginia Polytechnic Institute and State University as the Vice Provost for Special Initiatives and Executive Director of the Institute for Information Technology. He was also the American Electric Power Professor of Electrical and Computer Engineering.

Dr. Ferrari's research is in the areas of signal and image processing, medical imaging systems, computer graphics and multimedia systems. His most recent research is in the area of spline computations for computer graphics and data compression, where he has produced extremely efficient computational procedures. He recently created the 2-5-2 spline, a mathematical basis function suitable for all spline applications that has superior properties and computational advantages over the conventional B-splines. Dr. Ferrari and his colleagues are using the new spline algorithms and concepts in the development of low power circuits for high quality computer graphics and data compression in multimedia systems. Dr. Ferrari has more than 100 research articles in these areas and has spent twenty-one years in academic faculty positions in addition to more than ten years in industrial research and development positions. Dr. Ferrari is the recipient of the IEEE Fellow Award for contributions to research and education in signal and image processing.
the spring quarter. In addition to her research for AFRL, she has continued work, sponsored by Charles Stark Draper Laboratory in Boston, to develop a real time nonlinear guidance algorithm for reusable launch vehicles based on pseudo spectral methods. This latter work was done jointly with Associate Professor I. Michael Ross and has lead to proceedings and publications in the field that are highly regarded.

Distinguished Professor Turgut Sarpkaya was recognized in 2001 for outstanding research achievement in the Department of Mechanical Engineering. This is in recognition of Professor Sarpkaya’s outstanding research contribution in the subject areas of hydrodynamics, vortex, wake and free surface flow. He conducted five different projects in those areas, which were sponsored by the Office of Naval Research, NASA, the National Science Foundation, Space and Naval Warfare Systems Center and US Nuclear Regulatory Commission. Through his research, he has contributed to the fundamental science of the subject areas and also to the Naval applications.

In 2002, the Department of Mechanical Engineering recognized Professor Terry McNelley for the development of a significant research program in the area of Friction Stir Process. He made significant contributions to the subject area and supervised a Postdoctoral fellow, a PhD students, and multiple Master students. He has applied the technique to the Naval Application in order to improve material properties of critical structural components with minimal cost.

For 2001 and 2002, the Department of Meteorology recognized Professor Kenneth Davidson and Research Associate Paul Frederickson for their outstanding research during the past two years. Professor Davidson and Mr. Frederickson are lead investigators on a number of efforts focused on determining atmospheric impacts on the propagation of electro-optical and electro-magnetic radiation in the lowest layers of the marine atmosphere. Their work involves making precise in situ measurements in coastal regions and performing careful data analysis and interpretation to evaluate propagation models and sensors used by the military. This past year they have been involved in basic science investigations sponsored by the Office of Naval Research and applied studies for the Naval Surface Warfare Centers at Carderock and Dahlgren regarding METOC effects on the detectability of small boats used by the Special Warfare community and on the performance of the AEGIS SPY-1 radar. Five NPS METOC thesis students have worked on these projects under their supervision. Their model of the evaporation duct is used by many Department of Defense researchers and is included within the Navy’s Advanced Refractive Effects Prediction System (AREPS) used globally by the Fleet. This past year their work has appeared in four journal articles and 12 conference presentations and is highly valued by their research sponsors, the Office of Naval Research, SPAWAR, Naval Surface Warfare Center and the Naval Research Laboratory.

The 2001 award for outstanding research achievement in the Department of Oceanography recognized Professor Tom Herbers’ vigorous, Navy-relevant and internationally recognized research in nearshore oceanography, as well as his outstanding classroom instruction. His research in shallow water wave dynamics is highly productive and excellent, and represents a balance between observational and theoretical work. His thesis advising and dedication to his students are exemplary and meet the highest standards. Not only is his work characterized by strong naval relevance, but also his work has actively involved his students in research, from fieldwork to scholarly publications.

In 2002, Research Associate Professor Robin Tokmakian was recognized for outstanding contributions to the Oceanography Department, the Navy, and the scientific community through superior research. Her research in the areas of numerical ocean modeling and cross-comparisons with satellite and in-situ datasets has made invaluable contributions to operational Navy forecasting as well as to projecting longer-term environmental changes. Her leadership in conducting extended high-resolution global ocean simulations on remote supercomputers makes possible a greater understanding of our global fluid envelope. Her service in providing model analyses and data to numerous external researchers as well as to NPS students is particularly exemplary and largely unique in the research community.

Associate Professor Gamani Karunasiri of the Department of Physics was recognized for his 2001 research accomplishments. Professor Karunasiri has established a productive laboratory to continue his research activities in the development and application of novel infrared radiation detectors. In particular, he is recognized for his development of a multi-layer semiconductor optical sensor which is intended to operate similarly to biological vision systems, and for which a patent has been filed. Professor Karunasiri is also recognized for the design of a detector structure for application to
laser-guided weapons systems. Professor Karunasiri continues important research in these areas, and has also initiated important and highly relevant research to use infrared images for automatic face-recognition, as part of the NPS Homeland Security research program. In addition to the patent filing, in the year 2001 Professor Karunasiri’s research resulted in the publication of two refereed journal articles, four refereed conference proceedings articles, a conference presentation, and a masters thesis.

In 2002, the Department of Physics recognized two outstanding researchers. Associate Professor Richard Christopher Olsen was recognized for his leadership and scientific accomplishments in remote sensing programs of interest to the National Reconnaissance Office and the DoD in 2002. His leadership has been critical in the NPS space program, and his contacts have provided research funds for several faculty in the Department of Physics. His areas of research have included spectral temporal imaging, terrain classification, and passive detection of gases in the atmosphere involving both ground and space-based observations. His research resulted in seven student theses, one published paper, and one conference paper.

Assistant Professor Ryan Umstattd was recognized for his year 2002 research accomplishments in the highly-DoD-relevant area of high-power microwave (HPM) weapons research. In particular, Professor Umstattd is recognized for the establishment of the Threshold Cathode Test Facility, an experimental laboratory dedicated to the study of cathode sources for HPM devices. Professor Umstattd is also recognized for his accomplishments in the theoretical modeling and computer simulation of HPM cathode sources, and for his research to assess the vulnerability of domestic infrastructure to attack by a high-power microwave weapon. In the year 2002 Professor Umstattd’s research resulted in the publication of three refereed journal articles, three refereed conference proceedings articles, a conference presentation, and a masters thesis.

In 2001, the Space Systems Academic Group recognized Dr. Alan Ross. Dr. Ross has developed the design for a configurable fault-tolerant processor that has significant applications to satellites. This processor has been selected by the Space Test Program for inclusion on the NPSAT1 and MidSTAR missions that are scheduled for launch in 2006. The project has produced seven Masters’ theses in Space Engineering, Electrical and Computer Engineering, and Computer Science, two conference papers, and has one PhD dissertation in progress. He has significant engineering design experience in the development of space-borne computers, and he is responsible for the design of a computer that is currently flying on several U.S. Government satellites. He also serves as a consultant supporting several currently operating classified space systems.

In 2002, the Space Systems Academic Group recognized Professor Don Walters. Professor Walters has been developing and deploying acoustic profilers, performing atmospheric measurements and developing models to assess and optimize critical DoD electro-optical systems. The atmosphere limits the performance of many airborne and space assets. Understanding the source of these phenomena and predicting their occurrence are part of the mitigation process. With the assistance of co-investigator Douglas Miller of the Department of Meteorology, Professor Walters has developed and implemented a procedure to forecast optical propagation parameters using high-resolution meteorological models. This has been used during the last 18 months to supplement major development efforts that have been highly successful.

The Department of Systems Engineering recognized Senior Lecturer Robert C. Harney for outstanding research achievement in 2002. Professor Harney has engaged in research that combines a high degree of excellence with particularly strong applications to current national security issues. Of particular note are his projects in the areas of unconventional weapons of mass destruction, and national strategy for the war against terrorism. In 2001, Professor Harney completed an unfunded research effort into alternatives for terrorists using weapons of mass destruction, featuring approaches generally unnoticed in national security and scientific communities. He first published his results in a NPS Report, Unconventional Weapons of Mass Destruction and Terrorism. Subsequently, this work attracted an audience in Washington, DC, and, as a result, was quickly classified, even though based entirely on unclassified materials. However, this effort did attract attention, and funding, in FY2002 from OSD. The resulting Unconventional Weapons of Mass Destruction project has hosted conferences dealing with subjects such as binary poisons, multiple-incident terrorist attacks. It has also resulted in briefings to the Defense Threat Reduction Agency and the Director of Net Assessment. A full project report is in preparation for delivery in 2003. In the latter part of 2002, Professor Harney was a key member of the interdisciplinary NPS team tasked with devising

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GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY


Prof. D.A. Brook gave a lecture on Defense and Security Management as part of the University of California-Berkeley Lecture Series, in April 2003. Prof. Brook addressed current trends in management training for America’s senior military officers. The lecture series is one of the corner stone of Berkeley’s popular interdisciplinary technology management program.


Research and Education Institutes

In 2001 and 2002, The MOVES Institute recognized Associate Professor Don Brutzman for outstanding research achievement. Professor Brutzman has worked very hard this last year to create the XMSF (extensible modeling and simulation framework) and its supporting consortium. That framework has the potential to effect all future networked, web-based modeling, virtual environment and simulation systems with its full deployment. The XMSF Consortium, under Professor Brutzman's leadership, is attempting to define the web services required to support modeling, virtual environments and simulation across the web. This work is fundamental to much of DoD’s Modeling and Simulation.

Faculty recognized at research recognition evening

In 2001, Professor Larry Jones was recognized for his dedicated work in the area of government and public sector reforms worldwide. He served as President of an international organization, International Public Management Network, as editor of book series for two publishers, and as the editor of two international public management journals. His research, accomplishments and extensive writings in this area greatly enhanced the visibility of NPS in the public sector management community.

In 2002, Professor Nancy Roberts’ innovative approach to strategic planning greatly expanded the horizon of her research. Her creative thinking has led her into areas such as peace keeping, security building and other emerging international issues. Her expertise in these areas resulted in a grant from Defense Systems Cooperation Agency to develop the Security Building in Post-Conflict Environment program in the School of International Graduate Studies. Professor Nancy Roberts also continues to maintain a prolific writing pace. This past year she was editor of the book *The Transformative Power of Dialogue*, an original collection of interdisciplinary research articles that explore the determinants, processes and outcomes of dialogue. Her other publications include articles on research methods and public sector accountability. Two Academy of Management symposia, one of which she chaired, were vehicles for her research on networks, in particular the use of information networks to facilitate the communication, coordination, and collaboration among military, non-governmental, and UN organizations.
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J. Suchan, “The Effect of Interpretive Schemes on Video-Teleeducation’s Conception, Implementation, and Use,” the paper was the winner of the 2002 NCTE Award for Best Article on Methods of Teaching in Scientific and Technical Communication, Annual Meeting of the Association of Teachers of Technical Writing, NY, NY, March 2003.

GRADUATE SCHOOL OF ENGINEERING AND APPLIED SCIENCES

AERONAUTICS AND ASTRONAUTICS


Prof. M. Chandrasekhar’s collaborative work with the U.S. Army and NASA recently appeared in Flight International. The article, “Blade Study Gives Droop the Edge,” describes the successful test of a helicopter rotor blade with a variable-droop leading edge (VDLE) that could dramatically expand the operational envelope of helicopters.

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AERONAUTICS AND ASTRONAUTICS PROFESSOR RECEIVES NAVY SUPERIOR CIVILIAN SERVICE AWARD

Professor Oscar Biblarz of the Department of Aeronautics and Astronautics has received the Navy Superior Civilian Service Award for his exemplary performance, outstanding achievements and significant contributions to the mission of the Naval Postgraduate School. As a Professor of Aeronautics and Astronautics, Professor Biblarz has continuously demonstrated the highest integrity of what it means to be an “academic.” His students echo praise for his knowledge and ability in the classroom. Professor Biblarz is an exemplary teacher and mentor. Professor Biblarz’ dedication to “learning” at NPS is further indicated in his assignments as the Academic Associate for the Space Systems Engineering, Aeronautical Engineering, Aeronautical Engineering-Avionics, and NPS/Test Pilot School Cooperative Program Curricula. This is quite an undertaking. His research interests in aerospace propulsion and power, aerodynamics, and lasers has benefited numerous sponsors to include Naval Air Systems Command, USAF Phillips Labs, and the Naval Air Warfare Centers-Aircraft and Weapons Divisions. His expertise and experience are conveyed in the seventh edition of Rocket Propulsion Elements published in 2001. Professor Biblarz has given tirelessly to every aspect of academic life — teaching, research, and service. His accomplishments reflect great credit on himself and the Naval Postgraduate School and are in keeping with the highest traditions of service to the Department of the Navy.
FACULTY NEWS

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ELECTRICAL AND COMPUTER ENGINEERING


MECHANICAL ENGINEERING

Prof. C.N. Calvano has been elected a Fellow of the Society of Naval Architects and Marine Engineers.


METEOROLOGY


Prof. D.K. Miller was elected to serve on the Coastal Environment Committee of the American Meteorological Society, April 2003.


OCEANOGRAPHY

Eulerian and Lagrangian Data, Decomposition,” Part II, Application to Noisy Ocean Current Data Using Flow
Korzhova, T.M. Margolina, and O.M. P.C. Chu

Eulerian and Lagrangian Data, Decomposition,” Part I, Theory, Noisy Ocean Current Data Using Flow

American Geophysical Union Meeting, Nice, France, April 2003.

“Regional Sea Model Predictability,” Joint European Geophysical Society and American Geophysical Union Meeting, Nice, France, April 2003.


“Strong Thermohaline Source/Sinks Generated by Diagnostics Initializa-


Prof. B. Semtner became a member of a special committee on “The Future of Supercomputing,” convened by the National Academy of Sciences.

M. Heinemann, A. Larraza, and K.B. Smith, “Experimental Studies of Applications of Time-Reversal Acoustics to Non-Coherent Communications,” Journal of the Acoustics Society of America (accepted for May/June publication) 2003.


GRADUATE SCHOOL OF OPERATIONAL AND INFORMATION SCIENCES

COMPUTER SCIENCE

C. Arthro, D. Drusinsky, A. Goldberg, K. Havelund, M. Lowry, C. Pasareanu, G. Rosu, and W. Visser, “Experi-

Prof. P.J. Denning, Chairman of the Computer Science Department, was honored by the Commonwealth of Virginia for being one of the State’s Ten Best Teachers for 2003. Prof. Denning was at George Mason University before coming to the Naval Postgraduate School in December 2002. He was selected from among 76 nominations statewide, each the result of a competitive internal selection process at a state university. The award was presented by Virginia Governor Mark Warner, in ceremonies at the state capitol in Richmond, VA, January 16, 2003.


D. Drusinsky and M. Shing, “Verification of Timing Properties in Rapid System Prototyping,” Proceed-
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ings, 14th IEEE International Workshop, June 2003.


INFORMATION SCIENCE

Prof. N. Schneidewind was interviewed by the New York Times about the Shuttle software. The article, “Loss of the Shuttle: Technology: Computers Driving Shuttle are to be Included in Inquiry.” Prof. Schneidewind has worked with NASA on software design and considered an expert on software reliability.

Prof. N. Schneidewind has been invited by the Reliability, Maintainability, and Safety Conference, Irvine, CA, 2003.

CEBROWSKI INSTITUTE DIRECTOR APPOINTED

Professor Peter J. Denning of the Department of Computer Science has been appointed Director of the Cebrowski Institute for Information Innovation and Superiority. Professor Denning is also Chairman of the Computer Science Department. He came to NPS in 2002 from George Mason University, where he served as vice provost for continuing professional education, associate dean for computing, and chair of the Computer Science Department in the School of Information Technology and Engineering. He founded the Center for the New Engineer in 1993. He was the founding director of the Research Institute for Advanced Computer Science at the NASA Ames Research Center, was co-founder of CSNET, and was head of the computer science department at Purdue.

Dr. Denning received a PhD from MIT and BEE from Manhattan College. He invented the working set model for program behavior and helped establish virtual memory as a permanent part of operating systems. He co-invented operational analysis, an approach to computer system performance prediction. He was president of the Association for Computing Machinery 1980-82. He chaired the ACM publications board 1992-98 where he led the development of the ACM digital library, and now chairs the ACM Education Board. He has published 7 books and 290 articles on computers, networks, and their operating systems, and is working on 3 more books. In 2002, he was named one of the top 5 best teachers at George Mason University and the best teacher in the School of Information Technology and Engineering. In 2003, he received one of Virginia’s 10 outstanding faculty awards. He holds three honorary degrees, three professional society fellowships, two best-paper awards, three distinguished service awards, the ACM Outstanding Contribution Award, the ACM SIGCSE Outstanding CS Educator Award, and the prestigious ACM Karl Karlstrom Outstanding Educator Award.

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SMART EXPERIMENTAL DESIGNS, continued from page 21

often made on a given scenario. While millions of runs seem like a lot, the number of runs required to comprehensively explore even the simplest distillation can be astronomically large.

Most of our models have more than 100 factors, many of which are continuous or can take on a large number of discrete values. Our analyses are often further complicated by the uncertainty corresponding to many (if not most) of the factors. Therefore, even with super computers and “simple” models, we typically cannot use brute force searches on more than about 5-10 factors at a time. Moore’s Law suggests that we will be able to extend this only by about two factors (through an increase of two orders of magnitude in processing power) each decade. Thus, if we want computational experiments that look broadly across these models, we need better designs. Our research objective is to develop search strategies that give DoD analysts flexibility in fitting models when exploring high-dimensional computer simulations in situations in which there is considerable a priori uncertainty about the shapes of the response surfaces. To this end, we are working with several NPS students to develop new search algorithms and assess their performance (analytically and empirically) over a broad set of models and scenarios.

In one sense, this need to examine many factors is an old problem. Situations we have chosen to explore via experimental designs have always been complicated. However, practical limitations (for physical experiments) and computational limitations (for simulation experiments) have forced decision-makers to focus on only a handful of factors at a time—those deemed the most important. We have found that this narrow window into a system’s behavior can give rise to misleading results. Important factors or interactions may be ignored, or the results may be highly sensitive to a model input that was set arbitrarily. If the exploration of the model’s behavior begins broadly, this reduces the likelihood of inap-

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ability and Testability Group within Boeing Commercial Airplane Company to participate in presentations/seminars on software and systems reliability. The intention of the seminars is to bring the latest research and theory before Boeing’s designers.

OPERATIONS RESEARCH


THE MODELING AND SIMULATION INSTITUTE

Prof M. Zyda has been nominated for the 2003 World Technology Award for Information Technology - Software and the MOVES Institute has also been nominated in the “corporate category.” The winners of these prestigious will be announced at the 2003 World Technology Awards and World Technology Summit in San Francisco, California on 24-25 June 2003.

PROMOTION AND AWARD OF TENURE FOR ACADEMIC YEAR 2003

Award of Tenure
Professor Leonard Ferrari
Department of Electrical and Computer Engineering
Professor Thomas Housel
Department of Information Science
Associate Professor Bret Michael
Department of Computer Science

Promotion to Professor
Professor Douglas Fouts
Department of Electrical and Computer Engineering

Professor David Jenn
Department of Electrical and Computer Engineering
Professor James Suchan
Graduate School of Business and Public Policy

Promotion to Research Associate Professor
Research Associate Professor Susan Hutchins
Department of Information Science

Research Associate Professor Haf Jonsson
Center for Interdisciplinary Remotely Piloted Aircraft Studies
Research Associate Professor Douglas Miller
Department of Meteorology
Research Associate Professor Robin Tokmakian
Department of Oceanography

CONGRATULATIONS!
propriate results and substantially improves on our ability to provide rapid responses to new questions as they arise.

Methodological Approach
An extensive body of literature on designing experiments exists—most with roots in agriculture and laboratory experiments. That is, they were developed for situations with a relatively small number of experimental units (e.g., plots of land, patients, widgets) on which experiments could be conducted. Consequently, there are not many readily available tools for high-dimensional computer explorations where we can precisely control all of the factors and potentially take millions of runs. Furthermore, most of the existing designs also assume many of the following: linear effects, sparse effects, negligible higher order interactions, homogeneous normal errors, and a single measure of performance. Experience suggests that these are risky assumptions to make with models of combat, so we need alternative methods of selecting the best set of experiments from the vast ensemble of possibilities.

Clearly, the appropriate design depends on both the type of information needed and the nature of the model’s response surfaces. In general, for exploring distillations, we want designs that can look at a large number of factors, isolate interactions, identify non-linearities (such as diminishing rates of impact, synergistic or redundant effects), and find thresholds where responses change dramatically. To accomplish this, we have developed some new experimental designs, and devising adaptive strategies that combine these with other well-known designs. In particular, we are looking at search strategies that use adaptive mixtures of full-factorial (or grid), fractional-factorial, group screening, random perturbations, Latin hypercube, and frequency-based designs. Further details are available in Sanchez et al. (2002) and Lucas et al. (2002).

Our findings to date show that the adaptive search strategies can greatly enhance an analyst’s ability to explore agent-based models efficiently and effectively. It is not surprising that the appropriateness of the design depends critically on the shape of the model’s surface and the number of samples feasible. There is no one-fits-all design, but we have developed some guidelines that depend on the total computational budget and the number of factors involved. They also reflect knowledge of the nature of the response surface, if this is available from previous experiments or subject-matter experts. As examples,

- For relatively smooth surfaces, fractional factorial designs are an efficient means of looking at a dozen or so factors.

• For high-dimensional surfaces with sparse effects, group screening designs work well.

• When large samples are feasible (hundreds of thousands or millions), regular Latin hypercube designs work very well, particularly on highly nonlinear surfaces.

• For high-dimensional searches of highly nonlinear surfaces when only a few hundred or a few thousand runs can be taken, special near-orthogonal Latin hypercube designs are more efficient.

• Frequency-based designs also work well on highly nonlinear surfaces when moderate or large samples are feasible, even in the presence of substantial error. Furthermore, they allow for a natural multi-resolution search.

Our current work focuses on combining these designs into an adaptive sequential framework. This is richer and substantially more powerful than any single one-stage design. The one-stage designs often used in practice correspond to categorizing all factors into two classes: those evaluated (typically at a common level of resolution) and those ignored.

Applications and Assessments
This section summarizes some of what we have learned by a series of empirical explorations on a variety of models and scenarios.

Brown (2000) examined how the personalities of leaders and subordinates can affect Blue agents’ ability to reach a goal in a simulated urban environment. In his scenario, he found that losses are reduced for a local commander who has a strong propensity to mass his forces while maneuvering away from the enemy, and who assigns a relative degree of importance to the mission of reaching the objective without letting this objective dominate his actions. He identified an interesting interaction between friction (modeled as inhibiting the subordinates’ ability to listen to their local commander) and the bond (modeled as their desire to stay with their local commander). Even if the subordinate agents cannot hear, comprehend, or otherwise act on the local commander’s orders, their losses are reduced if they stay with him.

Of course, we cannot tell without additional data involving real people, perhaps under real combat conditions, whether these insights extend to real combat. Nonetheless, there are some interesting insights gleaned regarding the effectiveness of potential designs. Specifically, a 2^{11} fractional factorial design was almost as informative, in terms of variance explained, as a 5^3 full factorial design, despite requiring less than one percent
as many runs. Similarly, Wan (2002) used both a full factorial design (with 174,000 runs) and a Latin hypercube design (with only 4,800 runs) to examine the effects of human factors in a small unit infantry engagement. He found that almost all of the information extracted from the full factorial design could be more efficiently obtained by the Latin hypercube.

We have found Latin hypercubes (McKay et al., 1979) particularly valuable. Ordinary Latin hypercubes have received widespread use because they are extremely flexible and easy to generate. However, if the number of runs is moderate relative to the number of factors, this inhibits the analyst’s ability to obtain precise estimates of some parameters. To rectify this, Cioppa (2002) developed an algorithm that generates “nearly orthogonal” Latin hypercubes. These designs also have excellent space-filling properties, which make them amenable to fitting non-parametric surfaces. They have been used to study peace-enforcement operations and guerrilla combat, and are currently being considered for use in important Army transformational studies.

The output of ordinary and near-orthogonal Latin hypercube designs can be analyzed by a host of analytical techniques. Some examples include:

- Vinary and Lucas (2002) used linear modeling and intensity plots to identify regions of non-monotonicity and explore the mitigating effects of making some variables stochastic elements in the infamous 18 dimensional Dewar combat model.
- Pee (2002) applied neural networks, in combination with visualization techniques, while assessing the impact of information systems and procedures on battle outcomes. He found that the Blue force can ensure a positive outcome if it can sufficiently control two of its process latencies—regardless of the values of the other nine factors examined.
- Ipekci (2002) used classification trees, multiple additive regression trees (MART), Bayes nets, and Trellis plots in a 22 dimensional exploration of a simulation of a guerrilla infiltration attack he experienced as a platoon commander. The results of his sequential analysis indicate that the outcome of an infiltration scenario was dominated by Red agent parameters. This suggests that when combating guerrillas, we might best use our resources to restrict the terrorists’ abilities to mass, move, train, and acquire materiel.
- Wu (2002) explored the use of a frequency-based approach to designing experiments for terminating simulations. He applied these to multiple performance measures for a peace-enforcement scenario. His results show once again that the set of factors classified as important depends on the construct of the performance measure, but that frequency-based designs can be a natural and efficient way of administering the experiments. Wu also applied human factors principles in creating visual and auditory displays of the results.

Future Directions

This ongoing project will continue to advance both the theory and application of high-dimensional simulation exploration in several ways. The experiments described above have used designs generated locally and then exported for batch processing at the supercomputing facilities in Maui, Hawaii or Woodbridge, Virginia. We are in the process of converting our algorithms so they are readily available to all Project Albert researchers before the next Project Albert workshop in September 2003. Second, we are enhancing the sequential performance of our designs. Our goal is to provide enough guidance that the procedure can be used as a decision-support tool for an analyst with little experience in experimental design. Finally, we continue to apply our approaches to a broad spectrum of application areas, such as Marine logistics, Army force design, and Navy littoral area analysis.

It is worth noting that our approach is not restricted to agent-based simulations. These designs can be applied to any computer model with many factors—deterministic or stochastic—where the analyst is interested in gaining insight into how the performance varies across a wide range of possibilities.

Additional Reading

McKay, M.D., R.J. Beckman, and W.J. Conover, 1979. “A
obtained, approvals secured from the Army, and the unveiling was made at the bellwether of gaming conventions, Electronics Entertainment Expo, in May 2002. Operations garnered critical praise and industry awards out the gate, and has since won an enormous following.

What’s It Like?
Operations is a first-person mission experience. But the temperament of play contrasts markedly with the hormone-frenzied nuke-’ems on the shelf. The game opens with a new recruit ready to train. He embarks on basic rifle marksman-ship and combat training at Fort Benning, Georgia, where, as in the Army, his scores determine advancement in firearms.

Weaponry is represented precisely; for example, rifles are loaded and cleared correctly, the load is finite, and breathing affects accuracy. The army worked shoulder-to-shoulder with Operations’ artists, engineers, and designers to provide guidance and detail, resulting in excellent verisimilitude. Fort Benning, Georgia, for example, is clearly to be recognized, its
obstacle course timed and sequenced as in reality. The game’s audio vastly increases the quality of immersion through minute attention to sound effects, weapons foley, and ambiances. The Operations game is the first game ever shipped with Dolby 5.1 sound.

On completion of training, the player joins other gamers for networked mission play in a variety of combat settings. In Operations, no one ever plays a villain fighting the U.S. Both teams see themselves as part of the U.S. Army and perceive the other team as the opposition. Players abide by the rules of warfare, including the uniform code of military justice, rules of engagement, and laws of land warfare. Reprisal for violation is instant, starting with a cell at Fort Leavenworth and ending (potentially) with expulsion from the game.

Privacy note: If a player requests information about an Army career, a dialog asks whether his scores may be sent to a recruiter. But no cookies are set in the game and no information gathered or shared without express permission.

Spoils of War
Besides adrenalinated reviews and features, America’s Army: Operations continues to collect trophies, including Action Vault’s Debut Game of the Year, Surprise of the Year, and honorable-mention Multiplayer Game of the Year; Frictionless Insight’s Best Business Model (developer) E3; IGN Editors’ Choice Award for first-person shooters; IGN’s Biggest Surprise of E3; Gamespy’s Best PC Action Game runner-up; Penny Arcade’s Best Misappropriation of Taxpayer Dollars Ever; Wargamers Best of Show, first-person/tactical shooters; Well-Rounded Entertainment’s Best of E3 2002, and Computer Gaming World’s Editors’ Choice.

The Real Cost
To understand the dividends of America’s Army, a look at traditional recruiting is in order. The Army spends $2B (two billion) per year to attract and enlist 120,000 recruits (80,000 army, 40,000 national guard). That’s $16,666 per soldier.

Twenty percent (or 24,000) of these recruits drop out during basic combat training with the excuse that the army was not what they expected and combat training was not for them. With them goes $400M in wasted recruiting expenditure. In addition, the army has spent $75K each for training; thus, the Army’s loss per annum from this drop-out group is $2.2 billion.

America’s Army cost $7M to build, a tag equivalent to that of 420 recruits who wash out (if we count recruiting costs alone). If the game encourages only 120 potential waverers to stick with it, it’s broken even, counting recruiting and training costs. And of course, if it attracts those who would not otherwise have considered an army career, it’s worth $92K apiece.

In promotion, production and distribution, typically sizable sums in publication of any kind, the Army has managed a free ride by authorizing gaming magazines to burn CDs for inclusion in issues, a cost avoidance to the government of $2.24M. The manufacturer of a popular graphics card has bundled the game with its product, and an independent publisher stepped up to produce a guidebook. In addition, the free availability of the game over the Web has saved the army $7M in CDs.

The Army estimates America’s Army is conserving some $700M-$4B per year. With respect to recruitment, actual results won’t be known for four or five years, when the current raft of thirteen- and fourteen-year olds will be old enough to join. The hope is that through realistic role playing and exploration of a soldier’s job, the important work of the military will be among the options that compatible young men and women will consider when planning a career.

Down the Road
Having a successful online game inside the MOVES Institute is like having your own particle accelerator. Lots of proposed applications and interesting research are coming in the door.

Many related training applications using the America’s Army code base as a starting point are being considered. We have funding from one project that’s using Operations for treaty verification pre-planning, and an Air Force group is looking at funding a training level within the game that will deal with force protection.

Infantry soldiers at Fort Benning are using Operations before setting foot on the real range. Also, the army’s Objective Force is looking at integrating prototypes of their new weapons systems into Operations to evaluate their potential utility.

One extraordinary possibility, raised by the undersecretary of defense’s office, is massively multiplayer (MMP) gaming, and the America’s Army project is being looked at both as a model of how such an effort could be carried out...—continued on page 62
NAVY HOSTS EIGHTH NATIONAL HIGH CYCLE FATIGUE CONFERENCE, continued from page 44

Committee consisting of representatives from the Air Force, the Navy, the Army, and NASA, along with an adjunct Industry Advisory Panel.

At this 8th Conference, the Navy’s welcome to Monterey was given by the NPS Dean of Research Dave Netzer, who outlined many of the advances and changes underway at the School. The keynote speaker Rear Admiral Tim Heeley, currently the Assistant Commander for Research and Engineering, referred to his earlier experience as an aeronautical engineering student at NPS, even recalling the grade he received in Netzer’s propulsion course! He gave a presentation that emphasized the Navy’s severe operating environment, and the importance of achieving reliability in its propulsion systems.

After the guest lecture by Dr. Kurt Nichol on “Test Protocols for HCF Assessment,” technical overviews were given by the Air Force program manager and technical managers from GE/AADC, Pratt & Whitney, Rolls-Royce and Honeywell. The morning session was followed by two and a half days of parallel technical sessions. A total of eighty-five papers were presented.

The final (10th) Conference in the HCF program is scheduled to be held again in Monterey in 2005.

Figure 2. Strain gauges and temperature gauges are applied to the next test article, a AE3007 bladed-disk fan rotor, by TPL engineer Doug Seivwright. Highly specialized techniques are required because of the high rotational speeds and associated stresses, An ‘arbor’ has been designed and manufactured to adapt the engine hardware to the turbine drive spindle. Following assembly and instrumentation, the rotor must be carefully balanced before being installed.

AMERICA’S ARMY: OPERATIONS GAME, continued from page 60

within government and as possible starting point for an MMP project. The work involved might include the procurement (or development) of a government-owned game engine capable of full-spectrum combat modeling and large-scale inter-operability integration, as well as a programming interface for modeling human and organizational behaviors and stories. An additional goal would be rapid prototyping interface to the MMP that would allow any mission to be put together nearly overnight.

Reference and Reading

Links concerning the America’s Army project and the MOVES Institute: www.movesinstitute.org/aapress.html


Also linked at www.movesinstitute.org/publications

The U.S. Army’s America’s Army site: www.americasarmy.com


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ADDITIONAL INFORMATION ABOUT RESEARCH AT NPS CAN BE FOUND AT HTTP://WWW.NPS.NAVY.MIL/~CODE09/.

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