

Naval Postgraduate School
Monterey, California 93943-5138
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Compilation of
THESIS ABSTRACTS
September 2010



Office of the Vice President and Dean of Research
Naval Postgraduate School

PREFACE

This publication contains abstracts of unrestricted or unclassified theses submitted for the degrees doctor of philosophy, master of business administration, master of science, and master of arts for the September 2010 graduation.

This compilation of abstracts of theses is published in order that those interested in the fields represented may have an opportunity to become acquainted with the nature and substance of the student research that has been undertaken. Copies of theses are available for those wishing more detailed information. The procedure for obtaining copies is outlined on the last page of this volume.

For additional information on programs, or for a catalog, from the Naval Postgraduate School, contact the director of admissions.

Director of Admissions

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The World Wide Web edition of the school's catalog is at:

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Vice President and Dean of Research

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The *Compilation of Theses Abstracts* (unrestricted) can be found online at <http://www.nps.edu/Research/MoreThesesAbst.html>.

Summary of Research, an annual compilation of research projects and publications, is also available online, at <http://www.nps.edu/Research/SummaryRes.html>.

INTRODUCTION

Mission

The Naval Postgraduate School (NPS) was established to serve the advanced educational needs of the Navy. The broad responsibility of the school is reflected in its stated mission:

Increase the combat effectiveness of U.S. and allied armed forces and enhance the security of the United States of America through advanced education and research programs focused on the technical, analytical, and managerial tools needed to confront defense–related challenges of the future.

To fulfill its mission, the Naval Postgraduate School strives to sustain excellence in the quality of its instructional programs, to be responsive to technological change and innovation in the Navy, and to prepare officers to introduce and utilize future technologies.

The research program at NPS exists to support the primary mission of graduate education. Research at NPS:

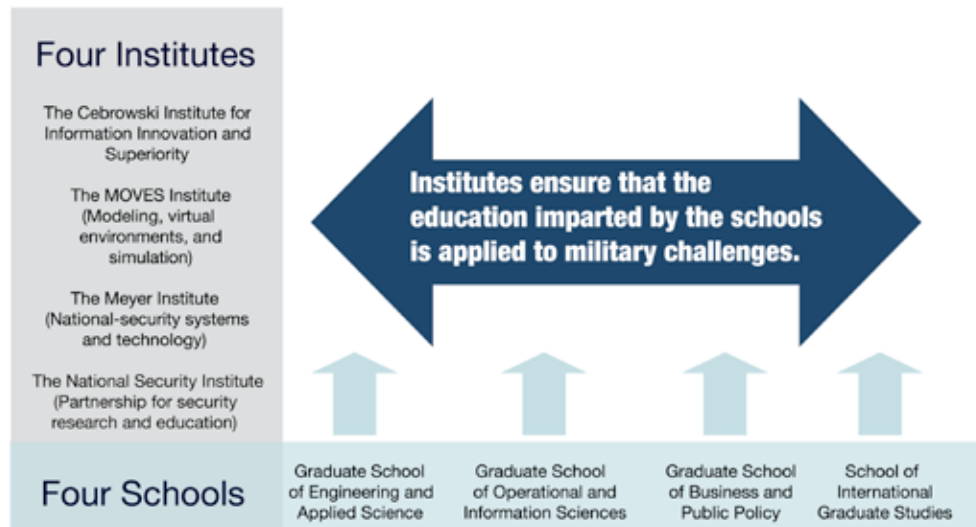
- maintains upper–division course content and programs at cutting edge;
- challenges students with creative problem solving experiences on DoD–relevant issues;
- advances DoN/DoD technology;
- solves warfare problems; and
- attracts and retains quality faculty.

Academic Programs

To meet its educational requirements, the Navy has developed a unique academic institution at the Naval Postgraduate School through the use of specially tailored academic programs, and a distinctive organization tying academic disciplines to naval and joint warfighting applications.

The Naval Postgraduate School has aligned its education and supporting research programs to achieve three major goals: 1) academic programs that are nationally recognized and support the current and future operations of the Navy and Marine Corps, our sister services, and our allies; 2) institutes that focus on the integration of teaching and research in direct support of the four pillars of Joint Visions 2010 and 2020 and their enabling technologies; and, 3) executive and continuing education programs that support continuous intellectual innovation and growth throughout an officer’s career.

Integrated • Systems Oriented • Flexible • Partnered for Strength



INTRODUCTION

Programs of graduate studies at NPS are grouped as follows:

Graduate School of Operational and Information Sciences

- Computer Science
- Computer Technology
- Electronic Warfare Systems
- Human Systems Integration
- Information Sciences
- Information Systems and Operations
- Information Systems and Technology
- Information Warfare
- Joint C4I Systems
- Joint Information Operations
- Modeling, Virtual Environments, and Simulation
- Operations Analysis
- Operational Logistics, Joint
- Software Engineering
- Special Operations and Irregular Warfare
- Systems Analysis

Graduate School of Engineering and Applied Sciences

- Applied Mathematics
- Combat Systems Science and Technology
- Electronic Systems Engineering
- Meteorology
- Meteorology and Oceanography
- Naval/Mechanical Engineering
- Oceanography
- Operational Oceanography
- Reactors–Mechanical/Electrical Engineering
- Space Systems Engineering
- Space Systems Operations
- Systems Engineering
- Systems Engineering Management
- Undersea Warfare
- Underwater Acoustic Systems

Graduate School of Business and Public Policy

- Acquisition and Contract Management
- Contract Management
- Defense Business Management
- Defense Systems Analysis
- Defense Systems Management, International
- Executive Management
- Executive Master of Business Administration
- Financial Management
- Information Systems Management
- Material Logistics Support
- Manpower Systems Analysis
- Program Management
- Resource Planning and Management for International Defense
- Supply Chain Management
- Systems Acquisition Management
- Transportation Management

School of International Graduate Studies

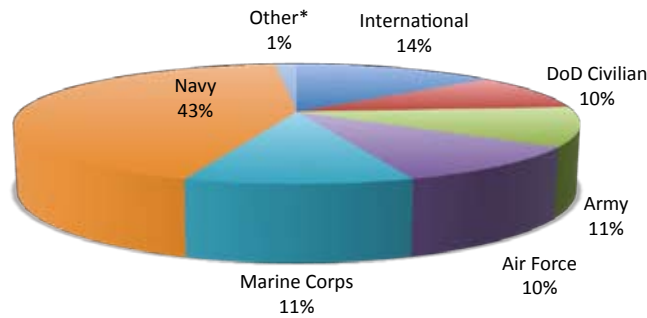
- Civil–Military Relations
- Combating Terrorism: Policy, Strategy
- Defense Decision Making and Planning
- Homeland Defense and Security
- Homeland Security and Defense
- Security Studies
- Stabilization and Reconstruction
- National Security and Intelligence:
 - Middle East, South Asia, Sub–Saharan Africa
 - Far East, Southeast Asia, Pacific
 - Europe and Eurasia
 - Western Hemisphere

Students

The student body consists of U.S. officers from all branches of the uniformed services, civilian employees of the

INTRODUCTION

federal government, and military officers and government civilian employees of other countries. The resident degree/subspecialty student population for September 2010 is shown in Figure 1 on the following page.



**Army Reserve, Army Reserve National Guard, Coast Guard, National Oceanographic and Aeronautics Administration*

Figure 1: Resident Degrees/Subspecialty Student Population for September 2010

Academic Degrees

Curricula meet defense requirements within the traditional degree framework. All curricula lead to a master's; additional study may yield an engineer's or doctoral degree. Below is a listing of the degrees offered at NPS:

Master of Arts

Security Studies

Master of Business Administration

Master of Science

- Applied Mathematics
- Applied Physics
- Applied Science
- Astronautical Engineering
- Combat Systems Technology
- Computer Science
- Computing Technology
- Contract Management
- Defense Analysis
- Electrical Engineering
- Electronic Warfare Systems Engineering
- Engineering Acoustics
- Engineering Science
- Human Systems Integration
- Information Operations
- Information Systems and Operations
- Information Technology Management

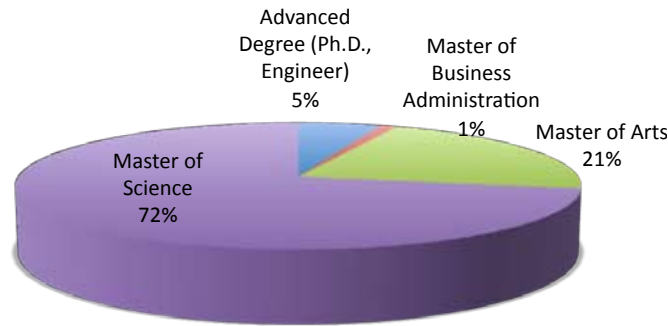
- Information Warfare Systems Engineering
- Management
- Materials Science and Engineering
- Mechanical Engineering
- Meteorology
- Meteorology and Physical Oceanography
- Modeling, Virtual Environments, and Simulation
- Operations Research
- Physical Oceanography
- Physics
- Product Development
- Program Management
- Software Engineering
- Space Systems Operations
- Systems Analysis
- Systems Engineering
- Systems Engineering Analysis
- Systems Engineering Management
- Systems Technology

Engineer

- Astronautical Engineer
- Electrical Engineer
- Mechanical Engineer
- **Doctor of Philosophy**
- Applied Mathematics
- Applied Physics
- Astronautical Engineering
- Computer Science
- Electrical Engineering
- Engineering Acoustics
- Information Sciences
- Mechanical Engineering
- Meteorology
- Modeling, Virtual Environments, and Simulation
- Operations Research
- Physical Oceanography
- Physics
- Security Studies
- Software Engineering

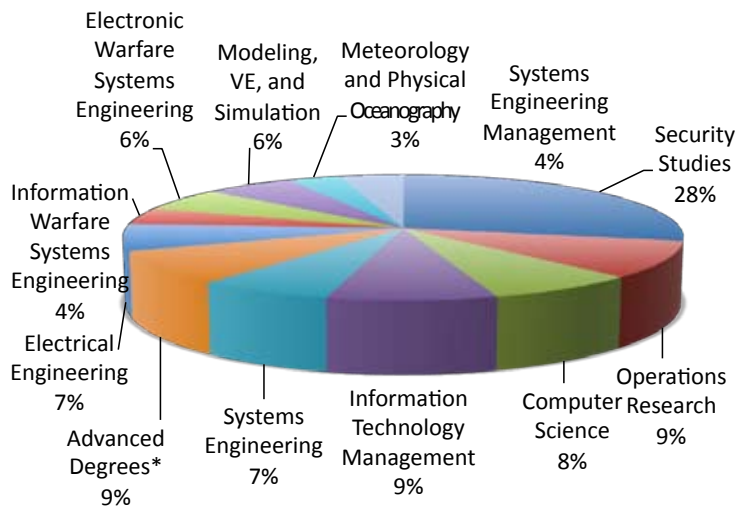
In September 2010, 182 degrees were conferred. Figure 2 indicates distribution by type, Figure 3 by degree area.

INTRODUCTION



**Figure 2. Degrees Conferred in September 2010
(182 Degrees Conferred)**

**Advanced degrees—Doctorates: Meteorology (2); electrical and computer engineering; aeronautical engineering; information sciences;*



physics; modeling, virtual environments, and simulation (2). Engineer: Mechanical engineer (2)

***Other master's degrees: Aerospace engineering (1), applied physics (2), applied science (1), business administration (2), contract management (4), engineering acoustics (2), information systems and operations (3), mechanical engineering (5), meteorology (3), physical oceanography, program management (2), remote-sensing technology (1), software engineering (2), space systems operations (3)*

**Figure 3. Degrees Conferred in September 2010
(182 Degrees Conferred)**

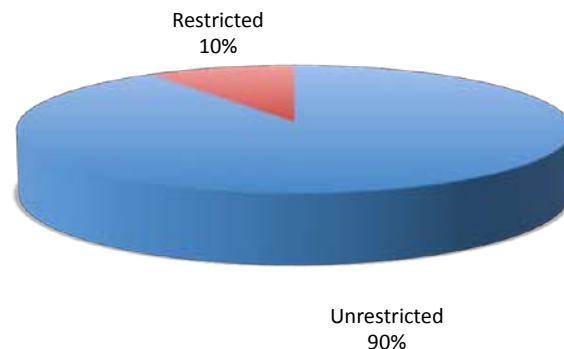
INTRODUCTION

Theses

The thesis is the capstone of the student's academic endeavor at NPS. Thesis topics address issues ranging from the current needs of the fleet and joint forces to the science and technology that is required to sustain long-term superiority of the Navy/DoD.

Aided by their faculty advisors, NPS students represent a vital resource within the DoD for addressing warfighting problems, one especially important at present, when technology in general, and information operations in particular, is changing rapidly. Our officers think innovatively and possess the knowledge and skill to apply nascent technologies in the commercial and military sectors. Their first-hand grasp of operations, when combined with a challenging thesis project that requires them to apply their focused graduate education, is one of the most effective elements in solving fleet/joint-force problems. NPS graduate education encourages a lifelong capacity for applying basic principles to the creative solution of complex problems.

NPS is unique in its ability to conduct classified research. Restricted theses are available on the NPS SIPRNET.



**Figure 4. Classification of Theses
(159 Degrees Conferred)**

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ADVANCED DEGREES

Doctor of Philosophy

Engineer

DOCTOR OF PHILOSOPHY

A FULLY AUTOMATED METHOD OF LOCATING BUILDING SHADOWS FOR AEROSOL OPTICAL DEPTH CALCULATIONS IN HIGH RESOLUTION SATELLITE IMAGERY

Brian L. Belson-Major, United States Air Force

B.S., Tulane, 1997

M.S., Air Force Institute of Technology, March 2004

Doctor of Philosophy in Meteorology, September 2010

Advisor: Phillip Durkee, Department of Meteorology

Vincent (2006) developed a technique for remotely measuring aerosol optical depth (AOD) using commercial, high-resolution, satellite imagery. This technique measured the radiance difference between a building shadow and an adjacent sunlit region with the same surface reflectance to calculate total optical depth (TOD). AOD is then determined by subtracting Rayleigh scattering from TOD. The procedure for making this calculation was time consuming, particularly locating suitable shadows within the region of interest. This paper outlines a fully automated method of performing the AOD calculation and examining shadow properties. The automated method relies on high-resolution digital surface model (DSM) data collected using a light detection and ranging (LIDAR) sensor coupled with sun and satellite geometry to identify shadow regions. Configuration settings allowed for specific regions in the shadow and sunlit area to be selected before determining their respective radiances. Finally, a technique for aligning the satellite and DSM pixels was developed to correct for small differences between the datasets. Results from the automated method were compared with AERONET data for validation. The automated method using WorldView-1 and QuickBird imagery worked best at Solar Village, Saudi Arabia and an area northeast of Washington, D.C, which included the Goddard Space Flight Center. Testing of IKONOS multispectral imagery suggested the resolution is inadequate in urban settings. Testing in areas that included downtown regions in Houston, TX and Baltimore, MD identified weaknesses in the alignment algorithm.

KEYWORDS: aerosol, optical depth, aerosol optical depth, automated shadow detection, high resolution commercial satellite imagery, digital surface model, WorldView-1, QuickBird, IKONOS, BuckEye, LIDAR.

A PERSONAL NAVIGATION SYSTEM BASED ON INERTIAL AND MAGNETIC FIELD MEASUREMENTS

James Calusdian–Civilian, United States Navy

B.S., California State University–Fresno, 1988

M.S., Naval Postgraduate School, December 1998

Doctor of Philosophy in Electrical Engineering–September 2010

Advisor: Xiaoping Yun, Department of Electrical and Computer Engineering

This work describes the development and testing of a personal navigation system (PNS) for use during normal walking on level ground surfaces. A shoe-worn miniature inertial/magnetic measurement unit (IMMU), which is comprised of accelerometers, magnetometers, and angular rate sensors, provides the measurement data for the PNS algorithm. The well-known strapdown navigation algorithm is adapted for use in the PNS, which further incorporates the error correction technique commonly referred to as zero-velocity updates. A gait-phase detection algorithm estimates instances of foot stance and swing, and establishes the appropriate times to apply the velocity error correction technique within the PNS algorithm.

A main contribution of the work described herein pertains to the design and analysis of a quaternion-based complementary filter for estimation of three-dimensional attitude of the IMMU. This complementary filter algorithm builds on an earlier three-dimensional attitude estimator known as the factored quaternion algorithm (FQA). The complementary filter is further tailored for the PNS application through the use of an adaptive gain switching strategy based on knowledge of the gait phase.

DOCTOR OF PHILOSOPHY

A novel and incidental effort described here pertains to the design and implementation of a locomotion interface for a virtual environment using the shoe-worn IMMU. In this application, one IMMU is worn on each foot. A set of foot gestures was conceived and a custom software program was developed to decode the user's foot motions. This unique interface gives the user freedom to navigate through a virtual environment in any direction he/she chooses for those applications utilizing large-screen displays.

KEYWORDS: personal navigation, accelerometer, magnetometer, angular rate sensor, quaternion, complementary filter, zero-velocity update, gait-phase detection algorithm

MARITIME ADAPTIVE OPTICS BEAM CONTROL

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M.S., Stanford University, June 2004

M.B.A., University of New Mexico, August 2007

Doctor of Philosophy in Astronautical Engineering, September 2010

Advisor: Brij N. Agrawal, Department of Mechanical and Aerospace Engineering

The Navy is interested in developing systems for horizontal, near ocean surface, high-energy laser propagation through the atmosphere. Laser propagation in the maritime environment requires adaptive optics control of aberrations caused by atmospheric distortion. In this research, a multichannel transverse adaptive filter is formulated in Matlab's Simulink environment and compared to a complex lattice filter that has previously been implemented in large system simulations. The adaptive filters are used to augment a classical adaptive optics controller and are also compared to a Kalman filter augmenting a classical controller.

Additionally, the Naval Postgraduate School's first laboratory testbed to use adaptive optics for the compensation of atmospheric turbulence is designed and built. The control algorithms are evaluated both in simulation and in the presence of a laboratory-generated disturbance. Finally, effects of horizontal propagation through deep turbulence are created in the lab. Beam control algorithms are tested in this environment to draw initial conclusions about performance in deep turbulence. For the system implemented in this research, the simple transverse filter in combination with a classical proportional-integral controller performs comparably to the complex lattice filter and the Kalman filter in a standard turbulence scenario and demonstrates more robust performance in the deep turbulence scenario. The adaptive optics testbed itself can be transitioned easily between traditional and deep turbulence scenarios and can support a wide range of atmospheric realizations for further beam-control research.

KEYWORDS: Adaptive Optics, Deep Turbulence, Adaptive Filter, Maritime, Lattice, LMS, RLS, Testbed

KNOWLEDGE AS A CONTINGENCY FACTOR: ACHIEVING COORDINATION IN INTERORGANIZATIONAL SYSTEMS

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B.B.A., University of Notre Dame, 1985

M.S., Naval Postgraduate School, March 1992

M.M.S., Marine Corps University, June 1997

Doctor of Philosophy in Information Sciences, September 2010

Advisor: Mark E. Nissen, Department of Information Sciences

Organizational research shows how mismatches between organizational design characteristics and contingency factors lead to lower performance. In addition to classic contingency factors, *knowledge* is a powerful resource that influences performance. This research explores *knowledge* as a structural contingency factor for interorganizational systems. It explores the performance effects of different *types of knowledge* (i.e., tacit and explicit) interacting with organizational *coordination mechanisms* (e.g., direct supervision and mutual adjustment)

in the highly complex environment of crisis events (e.g., natural disasters) where multiple organizations often rapidly develop reciprocal interdependencies. In those events, teams of boundary spanners often work to coordinate the interorganizational response; hence, understanding how performance is affected by the interaction of knowledge types available and various coordination mechanisms is useful to managers. Using a mixed methodology design, this research extends structural contingency theory to the interorganizational level. First, immersive qualitative field research is conducted to observe widely dispersed organizations during a developing crisis. Those observations help formulate a baseline agent-based computational organizational model. Using that baseline, theoretically driven changes are made to create unique models that populate each quadrant of a two factorial experiment design. A Monte Carlo simulation of each model generates performance effects (e.g., speed and project risk) of different types of coordination mechanisms interacting with different types of knowledge. This research shows that a mutual adjustment coordination mechanism is most fit when teams are made up of people with a high level of tacit knowledge. During a crisis or disaster response situation, however, managers may not have much control over the type of knowledge available within the boundary spanning teams. This research also shows some interesting interaction effects across the different performance variables; hence, managers faced with reciprocal interdependencies should apprise themselves of the knowledge types associated with interacting boundary spanning teams.

KEYWORDS: Organization Design, Knowledge Dynamics, Contingency Theory, Computational Organization Modeling, Interorganizational Theory, Disaster Research, Military Command and Control, Military Planning, Interorganizational Coordination.

**A MULTI-SCALE ANALYSIS OF TROPICAL CYCLOGENESIS WITHIN
THE CRITICAL LAYER OF TROPICAL EASTERLY WAVES IN THE
ATLANTIC AND WESTERN NORTH PACIFIC SECTORS**

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B.S., Lyndon State College, December 1995

M.S., Air Force Institute of Technology, March 2004

Doctor of Philosophy in Meteorology—September 2010

Advisor: Michael T. Montgomery, Department of Meteorology

Committee: Patrick A. Harr, Department of Meteorology

Committee member: Richard W. Moore, Department of Meteorology

Committee member: Francis X. Giraldo, Department of Mathematics

Committee member: Zhuo Wang, Department of Meteorology, University of Illinois

A newly proposed tropical cyclogenesis sequence that describes the transition of a tropical wave's critical layer to a tropical cyclone is used to examine two formation cases in the western North Pacific basin. Typhoon Nuri (2008), formed from a precursor easterly wave during the Tropical Cyclone Structure 2008 field experiment, and Typhoon Man-yi (2007), formed within an equatorial Rossby wave as it interacted with a monsoon trough. In each case, i) the critical layer of the parent wave protects a proto-vortex from an external hostile environment and allows it to strengthen until it becomes a self-sustained entity and ii) the intersection between the wave trough and critical latitude, within the Kelvin cat's eye, is the preferred location for tropical cyclogenesis. Numerical simulations suggest that the so-called "bottom-up" pathway to tropical cyclogenesis is favored within Typhoon Man-yi's critical layer.

Additionally, Tropical Rainfall Measurement Mission (TRMM) composite analyses of 55 developing easterly waves indicate that as genesis approaches, i) convection is favored in the Kelvin cat's eye circulation, ii) the convective contribution to total rain rate becomes dominant, iii) the radius of maximum convection decreases, and iv) a convective-type heating profile is present. These findings support the "bottom-up" development model within easterly wave critical layers.

KEYWORDS: Tropical Cyclone, Tropical Cyclogenesis, Tropical Cyclone Formation, TRMM

DOCTOR OF PHILOSOPHY

DESIGN AND ANALYSIS OF AN ELECTRON GUN/BOOSTER AND FREE ELECTRON LASER OPTICAL THEORY

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B.NE., Georgia Institute of Technology, September 1997
M.S., Naval Postgraduate School, June 2005
Doctor of Philosophy in Physics—September 2010
Advisor: William B. Colson, Department of Physics**

As interest in high power free electron lasers (FELs) has increased, the FEL and accelerator communities have been faced with the need to develop high bunch charge, high repetition rate, low emittance electron sources for use as the driving accelerators for FELs. A novel superconducting, radio-frequency (SRF) gun/booster has been designed by and built for the Naval Postgraduate School (NPS) FEL Beam Physics Lab in collaboration with Niowave, Inc., for studying this electron source regime. The NPS SRF gun/booster operates at 500 MHz and is based upon a quarter-wave structure. It incorporates many features that make it desirable for studying the cathodes and transport regimes necessary to explore high bunch charge beams, including adjustable field focusing, short transport out of the gun, and the ability to change cathode types and materials. After attaining “first beam” in June 2010, the NPS gun has been established as the first SRF electron gun in the United States. Initial results show excellent agreement with simulation with bunch charges of 110 pC and transverse emittance estimates of ~ 4 mm-mrad. Additionally, a modal analysis tool for the NPS FEL simulation software is developed based upon the Hermite-Gaussian basis set. Using a minimization of mode coefficients approach, we decompose output optical fields for amplifier FEL designs and experiments for FEL optimization and comparison of laser output fields.

KEYWORDS: Free Electron Laser, Electron Gun, Quarter Wave, Electron Accelerator, Hermite-Gaussian, Optical Decomposition.

ASSESSING NEUROPHYSIOLOGIC MARKERS FOR TRAINING AND SIMULATION TO DEVELOP EXPERTISE IN COMPLEX COGNITIVE TASKS

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B.S., Catholic University of America, 1986
M.S., Naval Postgraduate School, 1998
Doctor of Philosophy in Modeling, Virtual Environments and Simulation—September 2010
Dissertation Advisor: Rudolph Darken, Department of Computer Science**

This work explores the theoretic basis and provides empirical support for using neurophysiologic markers to provide information on a trainee’s cognition. Improved insight into cognition serves as the basis for improving the design of simulation responsive to individual traits for training continuous complex cognitive tasks. Individualized instruction has been empirically proven to be vastly superior to other forms of instruction. However, current methods to design simulation that is responsive to the user have relied primarily on raw performance metrics. These metrics are often misleading and provide very little diagnostic value. For complex tasks, understanding cognitive processes is critical. Neurophysiologic markers can potentially inform instructional systems on trainees’ cognition but have yet to be validated. This research developed a sample process to identify neurophysiologic markers for informing individualized instruction. Applying the process to helicopter overland navigation, a theoretic model of eye scan behavior was developed. The process and theoretic model were validated by analyzing novices and expert navigators. Predicted eye scan metrics reliably distinguished between expert and novice behavior, providing insight not available using raw performance metrics. Also, a visualization tool was developed to explore expert scan strategies. In addition to confirming expected strategies and novice expert differences, we discovered novel, unexpected strategies of expert navigators.

KEYWORDS: Training, Simulation, Human Factors, Aviation, Navigation, Neurophysiology, Expertise

DOCTOR OF PHILOSOPHY

A DISCOURSE IN HUMAN SYSTEMS INTEGRATION

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M.D., Uniformed University of the Health Sciences, 1997

M.P.H. and M.T.M., Tulane University, 2002

Doctor of Philosophy in Modeling, Virtual Environments, and Simulation—September 2010

Advisor: Nita L. Shattuck, Department of Operations Research

Committee Member: Michael M. McCauley, MOVES Institute

Committee Member: Eugene P. Paulo, Systems Engineering

Committee Member: Lawrence G. Shattuck, Department of Operations Research

Committee Member: Clifford A. Whitcomb, Department of Systems Engineering

This dissertation tackles, head on, two fundamental questions: What is human–systems integration (HSI) and how should one think about HSI problems? The objective was to develop a coherent systems method to improve the integration of HSI domains to create sustainable systems while preserving system stakeholder preferences.

This dissertation addresses these questions by accomplishing two things: 1) extracting the lessons learned from a historical analysis of the emergence of HSI both as a philosophy and as a Defense Department program, and 2) using those lessons to characterize and illustrate a technical approach to addressing HSI considerations early in an acquisition process. It is shown that the discourse on general systems that occurred over the latter half of the twentieth century, coupled with pressing organizational factors within the U.S. Army, were the principal forces that shaped and drove the emergence and formal recognition of HSI. As determined from this historical analysis, HSI involves the integration of the behavioral sciences, human factors engineering, and operations research to more broadly represent human considerations in early weapon system analyses and the products that evolve from these analyses.

Inclusion of HSI in system analyses necessitates a holistic perspective of the performance and economic trade space formed by the synthesis of the HSI domains. As a result, individual domain interventions are considered in terms of tradeoff decisions. Ideally, the HSI trade space can be systematically explored by integrating Simon’s research strategy, Kennedy and Jones’ isoperformance approach, and coupling isoperformance with utility analysis through means such as physical programming. Although domain tradeoffs are a central element of HSI, very few studies illustrate the integration of the behavioral sciences and human factors engineering with the tools and methodologies of operations research. Accordingly, three case studies are presented: a preexisting opportunistic dataset of potential Air Force unmanned aircraft pilots, a prospective dataset of Army Soldiers in Basic Combat Training, and data derived from simulation of staffing and shift scheduling solutions using a biomathematical model. Lastly, guidelines for a New HSI method and future challenges are discussed.

KEYWORDS: Acquisition, Fatigue(Physiology), Human Factors Engineering, Human Systems Integration, Humanities, Isoperformance, Manpower, Operations Research, Performance(Human), Safety, Selection, Social Sciences, Systems Engineering, Training

ENGINEER

ANALYSIS OF MICROSTRUCTURE REFINEMENT DURING SINGLE-PASS AND MULTI-PASS FRICTION-STIR PROCESSING OF NIAL PROPELLER BRONZE

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B.S., University of Texas at Austin, 2004

Mechanical Engineer–September 2010

Master of Science in Mechanical Engineering–September 2010

Advisor: Terry McNelley, Department of Mechanical and Aerospace Engineering

Second Reader: Sarath Menon, Department of Mechanical and Aerospace Engineering

High strength, corrosion resistance, ductility, and toughness are material properties required for United States Navy (USN) Propellers. Propellers for both surface ships and submarines in the USN are currently made from cast nickel aluminum bronze (NAB) Wrought NAB exhibits strength, corrosion resistance, high dampening capacity, low friction coefficients, and good fracture toughness for a wide range of temperatures [1].

Casting NAB into large structures lowers some of the qualities seen in wrought material and sought after for the propellers. After casting, some of the structure exhibits high porosity and an undesirable grain structure. Friction-stir processing (FSP) can be used to refine grain structures and remove pores created during casting. This would reduce or eliminate the need for heat treatment and fusion welding currently being used to prepare Navy propellers.

Orientation imaging microscopy was used to aid understanding of friction stir process's effects on grain structure evolution and processes of recrystallization in nickel aluminum bronze. Observations were made about the grain orientation, size, and texture within the stir zone, thermal-mechanically affected zone, and the heat-affected zone for both a single-pass and a multi pass processed pieces of bronze.

KEYWORDS: Friction Stir Processing, Nickel Aluminum Bronze, Propellers, Microstructural Properties, Grain Refinement, Texture, Orientation Imaging Microscopy

COST-BENEFIT ANALYSIS OF THE INSTALLATION OF A WIND TURBINE ON A NAVAL SHIP

Dimitrios Tsaknias–Lieutenant Grade (LTG), Hellenic Navy

B.S., Hellenic Naval Academy, 2001

Engineer's Degree in Mechanical Engineering–September 2010

Master of Science in Mechanical Engineering–September 2010

Advisor: Fotis Papoulias, Department of Mechanical and Aerospace Engineering

Second Reader: Kostantinos Rados, Department of Meteorology

In order to reduce environmental pollution, reduce dependability from foreign energy sources, and avoid the uncertainty associated with an unpredictable rise in the price of oil, the use of alternative forms of energy is in worldwide demand. A popular and rapidly developing alternative form of energy is wind. The use of wind energy on a naval ship is the subject of this thesis. A preliminary feasibility study has been undertaken in order to evaluate wind energy potential and drawbacks.

As expected, installation of a wind turbine on a ship must meet several conflicting requirements and is subject to environmental uncertainties. Such uncertainties are in turn coupled with the geographic area of operations of the ship, which makes the problem highly dependent on the overall operational concept and mission of the ship. A coupled ocean/atmosphere mesoscale prediction software (COAMPS) developed by the Naval Research Laboratory is used in order to obtain realistic wind profiles. During this study, the vital electrical

circuit elements of the hybrid system are analyzed along with their performance and restrictions of their use. The operational requirements of the ship are taken into account with regards to tower and turbine sizing and its position on the ship as well as all relevant naval architecture characteristics of the ship after installation. A hybrid system is designed and analyzed to cope with the uncertainty associated with wind power. Finally, an economic evaluation of the hybrid system is performed, in order to evaluate if and under what circumstances the use of the hybrid system is a profitable investment.

KEYWORDS: Wind Turbine, Hybrid System, Cost Analysis, Case Study, Naval Architecture Calculations

MASTER OF BUSINESS ADMINISTRATION

BENCHMARKS FOR ENHANCED NETWORK PERFORMANCE: HANDS-ON TESTING OF OPERATING-SYSTEM SOLUTIONS TO IDENTIFY THE OPTIMAL APPLICATION SERVER PLATFORM FOR THE GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY

Rex Burman–Lieutenant Commander, United States Navy

Anthony R. Coca–Lieutenant Commander, United States Navy

Master of Business Administration–September 2010

Lead Advisor: Douglas Brinkley, Graduate School of Business and Public Policy

Support Advisor: Albert Barreto, Department of Information Sciences

With the release of next-generation operating systems, network managers face the prospect of upgrading their systems based on the assumption that “newer is better.” The Graduate School of Business and Public Policy is upgrading their network application server, and one of the most important decisions to be made is which server operating system to use. Based on hands-on benchmark tests and analysis we aim to assist the GSBPP by providing benchmark metrics and a recommendation of which operating systems will provide the best solution.

KEYWORDS: Benchmark, Application Server, Performance Test, Microsoft Server 2008, Microsoft Server 2003, time-to-completion test, network.

REASSESSING THE AIR FORCE’S SELECTIVE RE-ENLISTMENT BONUS PROGRAM

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Master of Business Administration–September 2010

Co-Advisor: Peter J. Coughlan, Graduate School of Business and Public Policy

Co-Advisor: William R. Gates, Graduate School of Business and Public Policy

The objective of this MBA project is to reassess the Air Force’s current selective reenlistment bonus program and provide a possible alternative for the compensation calculation. To find that alternative method of calculation, the goal of this project was to create an experiment using a second priced sealed bid auction. The experiment would provide an insight to truth revealing compensation requests for future job continuation. This essential tool will allow the Air Force to begin the determination of how to retain vital active duty service members through compensation bonuses while minimizing overall personnel costs to the Department of Defense.

KEYWORDS: Military Pay, Authorized End Strength, Retention, Auctions, Auction Theory, Signaling, Signaling Theory, Selective Reenlistment Bonus Program, Selective Reenlistment Bonus, Labor Market Conditions

MASTER OF SCIENCE

Applied Science
Computer Science
Contract Management
Electrical Engineering
Electronic Warfare Systems Engineering
Engineering Acoustics
Information Systems Technology
Information Technology Management
Information Warfare Systems Engineering
Mechanical Engineering
Meteorology
Meteorology and Physical Oceanography
Modeling, Virtual Environments, and Simulation
Operations Research
Physical Oceanography
Remote Sensing Technology
Software Engineering
Space Systems Operations
Systems Engineering
Systems Engineering Management
Systems Technology

MASTER OF SCIENCE IN APPLIED SCIENCE

STRIKE PACKAGE-TARGET PAIRING: REAL-TIME OPTIMIZATION FOR AIRBORNE BATTLESPACE COMMAND AND CONTROL

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B.S., United States Naval Academy, 2000**

Master of Science in Applied Science—September 2010

Advisor: W. Matthew Carlyle, Department of Operations Research

Second Reader: Gerald Brown, Department of Operations Research

When an air strike is requested against a target, the desired result is rapid arrival of a strike package of appropriately armed aircraft to destroy the target. However, the current manual system used by airborne battle managers is outdated, resulting in a slower strike package delivery time. This primitive system requires the operator to pair strike packages to targets manually in real time. A system that improves the efficiency of the airborne battle managers in a high-workload environment would result in faster strike package-target pairing and tasking, and might result in better pairings. We develop a model, RASP, that creates strike package-target pairings that best satisfy operational requirements as outlined in various joint publications and clarified by Naval Strike and Air Warfare Center subject matter experts. RASP minimizes data entry while replicating the decision processes that military operators use to decide strike package-target pairings. The starting point for this thesis is the RAPT-OR model, developed by Zacherl in 2006, a weapon-target pairing tool we adapt for use in a real-time tactical decision aid for airborne battle managers.

KEYWORDS: Airborne Battlespace Command and Control, Strike Package-Target Pairing, Close Air Support, Time Sensitive Target, Integer Programming, Joint Fire Support, Air Tasking Order, Mathematical Programming, Air-strike, Optimization, Decision aid, Direct Air Support Center, Air Support Operations Center, Air Operations Center

MASTER OF SCIENCE IN COMPUTER SCIENCE

IMPLEMENTATION AND PERFORMANCE EXPLORATION OF A CROSS-GENRE PART OF SPEECH TAGGING METHODOLOGY TO DETERMINE DIALOG ACT TAGS IN THE CHAT DOMAIN

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B.S., Santa Clara University, June 1987

Master of Science in Computer Science—September 2010

Advisor: Craig H. Martell, Department of Computer Science

Second Reader: LtCol Joel D. Young, USAF, Department of Computer Science

Internet relay chat is a popular means of communication. Because chat data does not follow established grammatical rules, traditional machine learning algorithms perform poorly in tasks such as part-of-speech and dialog-act tagging, and yet the volume of data created makes human analysis impractical. We present a cross-genre part-of-speech tagging methodology and analyze its effectiveness in determining the dialog-act classes of chat posts. Previous methods for determining part-of-speech tags focused on accuracy, were computationally expensive and required human verification. We show that our cross-genre, maximum-likelihood estimation, part-of-speech tagging performs virtually identically to hand-tagged parts of speech and that accurate part-of-speech tags are not required for acceptable automatic dialog-act determination. Furthermore, we show that a simple, naive Bayes classifier achieves the same performance in a fraction of the time as a carefully trained neural network.

KEYWORDS: Part of Speech Tagging, Chat Dialog Act Tagging, NPS Chat Corpus, naive Bayes Classifier, Internet Relay Chat, Tactical Military Chat, Cross-Genre POS Tagging, Maximum Likelihood Estimation POS Tagging

PARTS-BASED DETECTION OF AK-47S FOR FORENSIC VIDEO ANALYSIS

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BS, Liberal Arts, Excelsior College, 2003

Master of Science in Computer Science—September 2010

Advisor: Mathias Kolsch, Department of Computer Science

Second Reader: Simson Garfinkel, Department of Computer Science

Law enforcement, military personnel, and forensic analysts are increasingly reliant on imaging systems to perform in a hostile environment and require a robust method to efficiently locate objects of interest in videos and still images. Current approaches require a full-time operator to monitor a surveillance video or to sift a hard drive for suspicious content. In this thesis, we demonstrate the effectiveness of automated analysis tools to detect AK-47s in images. By training on a large corpus of labeled data, we created Viola-Jones classifiers for detection of whole AK-47s and parts of an AK-47. Parts-based detections were then compared against learned models using support vector machines and multi-layer perceptrons. The results of this research show that parts-based classifiers combined with the above techniques leverage the high recall capability of part detectors and significantly reduce false positives in comparison to both the part and whole object classifiers. Techniques utilized in this thesis facilitate the creation of an automated capability for detecting AK-47s in support of the law enforcement and intelligence communities.

KEYWORDS: Machine Learning, Parts-Based Object Detection, Computer Forensics, VIDEX

**CLOUD COMPUTING IN SUPPORT OF SYNCHRONIZED
DISASTER RESPONSE OPERATIONS**

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B.A., California State University, 1996**

**Master of Science in Information Technology Management
Master of Science in Software Engineering–September 2010**

**Corey A. Mazyck-Major United States Marine Corps
B.A., Campbell University, 2003**

Master of Science in Computer Science–September 2010

Advisor: Man-Tak Shing, Department of Computer Science

Second Reader: Karl Pfeiffer, Department of Information Sciences

During disaster response, key resources are supplied from a variety of channels including: government agencies, volunteer organizations, commercial business, educational institutions and others. While many of the entities have efficient internal methods of communication and coordination, global collaboration has historically been hindered by political, social, and technological challenges. Following Hurricane Katrina this resulted in over-resourcing of some in-need areas with little or no resources reaching others. While there is little argument that a global approach to disaster response should be adopted, political and technical challenges surrounding the integration and ownership of such a system have prevented its emergence.

This thesis examines the current challenges to collaboration between responding entities and proposes self-synchronization using a distributed, highly scalable, web application based on cloud computing technologies to facilitate communication between a broad range of public and private entities without requiring them to compromise security or competitive advantage. The proposed design applies the unique benefits of cloud computing architectures such as automatic scaling, geographic distribution, and query performance to the disaster response domain.

KEYWORDS: Cloud Computing, Synchronization, Collaboration, Elasticity, Disaster, Common Operating

**FABRICATING SYNTHETIC DATA IN SUPPORT OF TRAINING FOR
DOMESTIC TERRORIST ACTIVITY DATA MINING RESEARCH**

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B.S., State University of New York, May 1994**

Master of Science in Computer Science–September 2010

Advisor: Simson L. Garfinkel, Department of Computer Science

Second Reader: George W. Dinolt, Department of Computer Science

Data mining is a mature technology, widespread in both government and industry. The proliferation of data storage in public and private sectors has provided more information than can be expediently processed. Data mining provides a means to extract meaningful conclusions from this store of data. In the interests of countering criminal and terrorist activity, data mining has become a focus of law enforcement and government agencies. The use of databases containing information on persons may conflict with privacy rights and laws. Gathering public awareness of government data mining programs and databases has been accompanied with concern and investigation of these programs. Following a review of data mining and privacy issues, in 2008 the National Research Council (NRC) recommended any training in development of data mining programs involving personal data be conducted using synthesized data. This thesis presents an underlying discussion of these issues, including data mining use, a simple data-synthesis model for analysis to support the validity of the NRC recommendation, and the associated difficulties encountered in the process. Included is an analysis of the inherent difficulty in creating realistic and useful data.

KEYWORDS: Data Synthesis, Data Mining, Counter Terrorism

**IMPLEMENTATION OF INTEL VIRTUAL MACHINE EXTENSION ROOT OPERATION
ON THE NPS LEAST PRIVILEGE SEPARATION KERNEL**

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B.S., Brigham Young University, 1994

M.S., Arizona State University, 2002

Master of Science in Computer Science–September 2010

Advisor: Cynthia E. Irvine, Department of Computer Science

Second Reader, David Shifflett, Department of Computer Science

A virtual machine monitor (VMM) supports execution of multiple unmodified operating systems in virtual machines (VMs) on one computer. VMM support has been added to the Intel IA 32 architecture. Enforcement of data-flow policies between VMs requires a highly trustworthy VMM. Such VMMs take advantage of hardware support. The work described here explores whether the Naval Postgraduate School Least-Privilege Separation Kernel (LPSK) can incorporate Intel hardware support for virtualization. The Intel documentation and LPSK code were reviewed to determine the changes required to transition the target processor to Virtual Machine Extension (VMX) root operation. First, paging in the LPSK had to be enabled. Requirements for the VMXON and VMXOFF instructions were determined and changes were made to the LPSK to enable the target processor to transition to VMX root operation. Testing showed that the changes to the LPSK allowed the target processor to successfully transition to and from VMX root operation.

Keywords: LPSK, Virtual Machine, Intel Virtual Machine Extension.

**ANALYSIS AND DESIGN OF A DISTRIBUTED SYSTEM FOR MANAGEMENT
AND DISTRIBUTION OF NATURAL-LANGUAGE ASSERTIONS**

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Master of Science in Computer Science–September 2010

Co-Advisor: Man-Tak Shing, Department of Computer Science

Co-Advisor: James B. Michael, Department of Computer Science

This research entails the design and development of an automated system that allows researchers working remotely to store, manage, and transfer assertion data to an external system run by the Intelligence Advanced Research Projects Activity. The research stems from the University of Maryland's involvement in the Social-Cultural Content in Language program which seeks to investigate methodologies, designs, and technologies that can contribute in the understanding of the social goals of persons or groups of people by demonstrating a relationship between these goals and their particular language use.

In this research we interview the stakeholders to determine the software requirements of the system. After a careful analysis of the requirements, we used Unified Modeling Language notation to provide the reader with a visual model of the software design. Finally we develop a working prototype of the proposed system consisting of two Web services and a Web-service client written in the Java programming language.

KEYWORDS: SOA, Web services, Assertions, Knowledge Base

**CORRELATING PERSONAL INFORMATION BETWEEN DOD411,
LINKEDIN, FACEBOOK, AND MYSPACE WITH UNCOMMON NAMES**

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B.S., University of Utah, May 2004**

Master of Science in Computer Science—September 2010

Advisor: Simson Garfinkel, Department of Computer Science

Second Reader: Neil Rowe, Department of Computer Science

It is generally easier to disambiguate people with uncommon names than people with common names; in the extreme case a name can be so uncommon that it is used by only a single person on the planet, and no disambiguation is necessary. This thesis explores the use of uncommon names to correlate identity records stored in DoD411 with user-profile pages stored on three popular social network sites: LinkedIn, Facebook, and MySpace. After grounding the approach in theory, a working correlation system is presented. We then statistically sample the results of the correlation to infer statistics about the use of social network sites by DoD personnel. Among the results that we present are the percentage of DoD personnel that have Facebook pages; the ready availability of information about DoD families from information that DoD personnel have voluntarily released on social network sites; and the availability of information related to specific military operations and unit deployments provided by DoD members and their associates on social network sites. We conclude with a brief analysis of the privacy and policy implications of this work.

KEYWORDS: privacy, unusual names, uncommon names, facebook, myspace, linkedin, social networking, social network site, privacy policy, identity correlation, internet footprint

**ANALYSIS, DESIGN, AND PROTOTYPING OF ACCOUNTING
SOFTWARE FOR NAVY SIGNAL INTELLIGENCE COLLECTION
SYSTEMS RETURN-ON-INVESTMENT REPORTING**

**James M. Torres, Captain, United States Army
B.S., United States Military Academy, 2004**

Master of Science in Information Warfare Systems Engineering

Master of Science in Computer Science—September 2010

**Charles C. Spivey, Lieutenant, United States Navy
B.S., United States Naval Academy, 2003**

Master of Science in Information Warfare Systems Engineering—September 2010

Thesis Advisor: Thomas Housel, Department of Information Science

Co-Advisor: Man-Tak Shing, Department of Computer Science

Previous research studies demonstrated a practical methodology for quantifying the return on investment (ROI) of Navy Cryptologic Carry-On Program (CCOP) signals intelligence (SIGINT) collection systems and a practical pathway for implementing a performance-accounting system that generates these estimates. This research is a continuation of previous work on the requirements and design of an accounting software to provide return on investment (ROI) estimates for CCOP SIGINT collection systems. We follow the unified process, an iterative, incremental software development process and apply use-case analysis to obtain requirements of the accounting software. We then develop a high-level architecture design for a software meeting the requirements, and provide a proof-of-concept prototype to demonstrate the ROI analysis functions in Microsoft Excel.

KEYWORDS: ROI, return on Investment, IT ROI, IT performance, IT Valuation, KVA, Knowledge Value Added, public sector finance, design, analysis, development

RULEMAKING IN THE NAME OF A FREE AND OPEN INTERNET

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Master of Science in Computer Science—September 2010

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Second Reader: Arijit Das, Department of Computer Science

Network neutrality is a principle dictating that traffic flowing over a network do so without discrimination. Whether government regulation is necessary to ensure the Internet as we know it is perpetuated in today's relatively neutral state is being debated more and more as use of the Internet becomes more vital to everyone on a day-to-day basis and content grows at an incredible rate.

The Federal Communications Commission (FCC) on October 22, 2009, decided to act in this regard and proceed in an attempt to identify rules that will preserve a free and open Internet. The basis of these rules are six principles that the FCC has proposed (directed at broadband providers) that outline what it believes will maintain a free and open internet. Debate has formed among three groups:

- Those favoring this sort of regulation by the government
- Those who determine it is unnecessary and
- A third group, which proposes that the FCC, has no authority granted by Congress to implement its proposed rules.

This thesis examines the debate, formulates conclusions and proposes recommendations that will ensure the Internet remains the incredibly effective innovation tool into which it has grown.

KEYWORDS: Network Neutrality, Broadband, Telecommunications, Federal Communications Commission

A MOBILE PHONE-BASED SENSOR GRID FOR DISTRIBUTED TEAM OPERATIONS

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Master of Science in Computer Science—September 2010

Advisor: Gurminder Singh , Department of Computer Science

Second Reader: Neil Rowe, Department of Computer Science

In distributed warfare, warfighters operate in remote and austere environments with limited support from outside. In such situations, each team has to take care of its own safety and security. For operations that last over several days, even the most highly trained teams are vulnerable to fatigue, leading to a loss of focus during long periods of boring activities such as night watch. This can lead to mission failure and loss of life.

We have developed a mobile-phone based system to help with the team's safety by providing real-time situational awareness to the team of its surroundings. We have built a sensor grid around the team by networking several mobile phones using Bluetooth and using their built-in components such as accelerometers to capture seismic signals and microphone to capture sound in the area. When the grid is breached by a human, animal or machine, the individual phones capture signals generated by the intruders' movements. These signals are then compiled and analyzed to calculate the position of the intruder and alert the team about its presence. In implementing this system, our goals were to minimize the additional weight to warfighter's gear, run the system on as little power as possible, and to make it easy to install and use the system.

KEYWORDS: Smart Phone, iPhone, Bluetooth, Accelerometer, Mobile Sensing, Sensor Network

MASTER OF SCIENCE IN CONTRACT MANAGEMENT

ANALYSIS OF ARMY CONTRACTING COMMAND'S CONTRACT-SPECIALIST VACANCY ANNOUNCEMENTS

**Vicki J. Carrington—Civilian, United States Army, Atkinson, Illinois
MBA, St. Ambrose University, 2004**

Master of Science in Contract Management—September 2010

Advisor: Deborah E. Gibbons, Graduate School of Business and Public Policy

Second Reader: Harold G. Nelson, Graduate School of Business and Public Policy

This thesis reviewed the current external Contract Specialist vacancy announcements of the Department of the Army—Army Contracting Command, and compared them to vacancy announcements from other government agencies and private industry. Content analysis was used to systematically identify requirements for knowledge, skills and abilities for the entry-, mid- and supervisory-level contract specialist positions in Army Contracting Command.

The following recommendations are made 1) Specify exactly what minimum skills/abilities/experience are required for each position; 2) Incorporate knowledge of the Federal Acquisition Regulations as needed for mid and supervisory levels; 3) Add professional certifications are desired; 4) Utilize the benefits package as a motivator to attract applicants; and 5) Recommend ACC revise and update the introductory statement on the announcements to include what and how it is exciting to be an Army Civilian.

Army Contracting Command can ensure successful contracting outcomes to meet mission requirements by providing applicants with the right information and the right motivation.

KEYWORDS: Contract Specialist, Vacancy Announcement, Army Contracting Command

INNOVATIONS IN E-BUSINESS: CAN GOVERNMENT CONTRACTING BE ADAPTED TO USE CROWDSOURCING AND OPEN INNOVATION?

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Master of Science in Contract Management—September 2010

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Support Advisor: Douglas E. Brinkley, Graduate School of Business and Public Policy

This report investigates the scope and boundaries surrounding Open Innovation methodologies, Web 2.0 technologies and Crowdsourcing to determine their appropriateness for government use and how/when they can be used. Open Innovation methodology revolutionizes the inflow and outflow of organizational information and the administration of intellectual property. It brings together individuals with diverse talents across multiple disciplines to collaborate on projects. Web 2.0 technologies include Wikis, blogs, video-sharing and social-networking sites, used for more efficient communication and knowledge sharing. Crowdsourcing is an online collaborative decision-making effort that reaches thousands of people at one time, who deliver bits and pieces of information, which are compiled into an innovative product or service. This process captures talent from research institutes, universities, non-profit organizations, small businesses, consultants, inventors and others to produce solutions to tasks, pioneer new technologies, or capture, systematize, and examine large amounts of data. Commercial businesses are using these technologies and methodologies to successfully bring new products to market, improve their existing products and improve customer service. The government may benefit in a similar manner.

KEYWORDS: Crowdsourcing, Web 2.0, Open Source, Open Innovation, Social Networking

CONTRACT MANAGEMENT

COST ESTIMATING IN THE DEPARTMENT OF DEFENSE AND AREAS FOR IMPROVEMENT

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The purpose of this Joint applied project was to investigate and provide a comprehensive overview of the current process of cost estimation, preparation of Independent Government Cost Estimates, and Technical Evaluation writing practices within the Army Materiel Command, U.S. Army, JM&L Acquisition Center, ARDEC and CECOM. The goal of this project was to identify and document not only the specific types of cost-estimation practices and reports, but also to show the relationships between the IGCE, the Cost Estimation Process, the Request for Proposal (RFP), and the Technical Evaluation. Our purpose was to highlight and prove that the cost-estimation process is the heart of the acquisition process, and that it merges and coordinates the other processes so that the government can obtain the “Best Value” on both its competitive source selections and noncompetitive acquisitions. The reader will come away with a new appreciation for the concept of “cost as an independent variable” after reading this thesis. Treating cost as an independent variable helps to ensure that acquisitions do not go over budget or get wildly out of control. It also contributes to clear thinking and lessens the likelihood of groupthink or “going along with the crowd,” regardless of the consequences. Good cost analysis leads to good cost avoidance or containment, and is a prudent mindset for program officials who are regulated by budgetary constraints and accountable to Congress, and ultimately to the people, for the money they spend. They have good reason to spend it wisely and effectively

KEYWORDS: Cost Estimating, Independence Government Cost Estimate, Technical Evaluation

ANALYSIS OF ALPHA CONTRACTING FROM THREE PERSPECTIVES- GOVERNMENT CONTRACTING, THE GOVERNMENT PROGRAM OFFICE, AND INDUSTRY

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Since inception as a 1990s-era acquisition reform, alpha contracting has been a collaborative effort in a sole-source environment between government and industry to streamline acquisition from beginning to end. This work examines alpha contracting from the perspectives of the government contracting office, government program office, and industry to provide comprehensive data resulting in best practices for all participants at the Research, Development and Engineering Command (RDECOM). This study analyzes literature review, case studies, and results of a survey distributed to holders of the three perspectives to identify attitudes toward using alpha contracting and audience perceptions of efficacy and self-efficacy. Also, examined are benefits, challenges and risks to each perspectives. Recommendation from this project is to utilize the results of this study to improve alpha contracting at RDECOM.

KEYWORDS: Alpha contracting, Integrated Product Team, Research Development and Engineering Command

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

APPLICATION OF COPPER INDIUM GALLIUM DISELENIDE PHOTOVOLTAIC CELLS TO EXTEND THE ENDURANCE AND CAPABILITIES OF THE RAVEN RQ-11B UNMANNED AERIAL VEHICLE

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Prior thesis work has demonstrated the possibility of extending the flight time of military Small Unmanned Aerial Vehicles (SUAV) by 200% with the implementation of thin-film photovoltaic (TFPV) cells. In this thesis, we investigate how thin-film photovoltaic cells, made out of Copper Indium Gallium Di-Selenide (CIGS) semiconductor materials and mounted on the wings of the Raven RQ-11B SUAV, provide sufficient electrical power to fully operate the UAV for extended periods of time. This research focuses on extending the flight time of the Raven RQ-11B and on minimizing its sole dependence on lithium-ion batteries. This research will also demonstrate that increasing the size of the wings, adding a DC to DC power converter, and using a Maximum Power Point Tracker (MPPT) will enable the Raven RQ-11B to keep its lithium-ion battery charging continuously, while operating under varying daylight conditions. Additionally, this research will investigate the advantage of enabling systems on the ground to “self-charge.” This will enable tactical units to operate in any field, to include areas where power sources are unavailable.

KEYWORDS: Thin-Film Photovoltaics, CIGS, Unmanned Aerial Systems, UAV, Solar Panel, Maximum Power Point Tracker (MPPT), Lithium Ion

USE OF THE REDUCED PRECISION REDUNDANCY (RPR) METHOD IN A RADIX-4 FFT IMPLEMENTATION

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Reduced precision redundancy (RPR), as a new method for improving fault tolerance in FPGAs, appears promising in replacing triple modular redundancy (TMR) to prevent the single event effects due to radiation in arithmetic processes. As a test of this approach, the RPR technique was used to implement a Radix-4 fast Fourier transform (FFT). This design was implemented in a Xilinx Virtex 2 FPGA in order to find the possible gain in speed and power as compared to the TMR method.

This thesis deals with a 64-point Radix-4 in-place FFT, based on an improved FFT algorithm. The whole FFT structure was implemented based on self-designed modules and by manipulating the embedded Virtex II FPGA's modules. The point was to create a fast and small FFT module that could be altered according to specific application requirements. The implementation of the FFT was successful, managing to handle data in real time at a speed of 134MHz.

Based on this FFT design, the next challenge was the implementation of TMR and RPR modules. The

first attempt was the TMR structure, implemented by creating three identical replicas of the FFT and installing a voter per FFT stage. This implementation was unsuccessful due to space limitations. The next step was the alteration of the existing FFT and the creation of a smaller 8 x 8 bit butterfly module for the RPR structure. After the successful completion of this step, implementation of a RPR module with an 8/32 degree was commenced. Ambiguities and inefficient radiation protection were identified in this implementation. Finally, adopting a new RPR approach and a higher degree of 14/32, a smooth and correct RPR module was created that could work in real time, and handle data at a speed of 163MHz. Both TMR and RPR with a degree of 14/32 methods were compared, confirming the RPR's advantage in power consumption and in occupied FPGA's resources.

KEYWORDS: Reduced Precision Redundancy (RPR), Triple Modular Redundancy (TMR), Field Programmable Gate Array (FPGA), Fast Fourier Transform (FFT)

A MINIATURE ELECTROMECHANICAL GENERATOR DESIGN UTILIZING HUMAN MOTION

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The use of Faraday's Law to design and realize a miniature electromechanical generator that converts mechanical energy from human motion into stored electrical energy was investigated in this thesis. The design incorporates simple materials composed of ferrite cores, a coil, springs and permanent magnets to convert mechanical energy provided by a user to electrical energy for storage. The generator takes advantage of a dual air-gapped electromechanical system with permanent magnets to regulate flux through a coil around a high-permeability ferrite core. Use of a compression force provided by the user reduces the air gaps in the system, causing a rapid change in flux resulting in an electromotive force that produces a current in the circuit.

Laboratory testing of a generator prototype design verifies energy production of the mechanism and investigates the relationship between the inductance range of operation for the generator and its performance characteristics. Storage of energy produced by the generator is demonstrated using two different rectification circuits and is examined during different stages of one full stroke of the generator device. Additionally, this thesis presents a simulation that models the electromechanical energy conversion.

KEYWORDS: Generator, Mini-generator, Faraday's Law, Electromechanical, Ferromagnetic, Ferrite Core, Permanent Magnet, Electromotive Force, and Flux

THE CIRCULAR PIPELINE ACHIEVING HIGHER THROUGHPUT IN THE SEARCH FOR BENT FUNCTIONS

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For the first time, the circular pipeline as a means to significantly improve the throughput achieved in the search for bent functions is presented in this thesis. Linear cryptanalysis attack is a threat to modern symmetric encryption systems. A good defense is the use of a primitive based on Boolean functions having the highest nonlinearity possible—a bent function. Bent functions are extremely rare and, therefore, difficult to find. The implementation of a sieve on a field programmable gate array (FPGA) provides a high throughput (one

function per clock) approach to searching for bent functions. With a clock frequency of 100 MHz, throughput is 100,000,000 functions per second. The circular pipeline as a way to achieve an even higher throughput is examined in this thesis. The theoretical maximum speedup is $2n$, where n is the number of variables. The exact achievable speedup has been unknown until now. It is shown that a speedup of 55 is achieved at $n = 6$ with the design proposed in this thesis, which is 86% of the theoretical maximum.

KEYWORDS: Circular Pipeline, Boolean Bent Functions, Hardware Complexity, Circuit Complexity, Non-linearity, Hamming Distance, Cryptography

ANALYSIS AND SIMULATION OF DISADVANTAGED RECEIVERS FOR MULTIPLE-INPUT MULTIPLE-OUTPUT COMMUNICATIONS SYSTEMS

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This thesis investigates the simulation performance of multiple-input multiple-output (MIMO) communication systems. Uncoded narrowband and wideband MIMO systems are presented and simulated. The system is further refined with the addition of Space-Time Codes (STC) and Channel State Information at the Transmitter (CSIT). A disadvantaged receiver is subsequently introduced to the system lacking the optimization enjoyed by the native receiver. Simulation and analysis was conducted with multiple modulation schemes and antenna configurations. Rayleigh and Rician fading models are developed and simulated as the wireless channel. Receiver performance results based on MATLAB simulation are compared and presented.

KEYWORDS: Multiple-Input Multiple Output (MIMO), Orthogonal Frequency Division Multiplexing (OFDM), Binary Phase Shift Keying, Quadrature, Rayleigh Fading Channel, Rician Fading Channel, Space-Time Code (STC), Disadvantaged Receiver, Linear Diversity Precoding, Channel State Information (CSI)

ANALYSIS OF VOLTAGE AND CURRENT SIGNAL PROCESSING IN A LI-ION BATTERY MANAGEMENT SYSTEM

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Co-Advisor: Giovanna Oriti, Department of Electrical and Computer Engineering

The Naval Postgraduate School's Battery Management System (BMS) manages Li-ion batteries in a possible storage system for pulsed power weapons aboard Naval Vessels. The system charges the batteries with a buck converter according to the Constant Current Constant Voltage method. The BMS uses analog equipment to measure signals and then digitally converts signals for transmittal to a Field Programmable Gate Array (FPGA). Software processing controls the voltage and current directed to the batteries to maintain proper control and maintenance of the batteries.

Based on the BMS's successful operation, the processing of voltage and current signals in the BMS is researched and documented in this thesis. The documentation is provided through a thorough signal analysis before and after each component. Specifically, the current signal is analyzed and the processes of a Hall Effect Sensor, an instrument amplifier, and an analog-to-digital converter are described. Additionally, the voltage signal and its processing by a voltage-to-frequency converter are analyzed and the FPGA programming is

described. Accuracy of collected data is shown and possible improvements to the system are documented.

KEYWORDS: Li-ion Batteries, Buck Converter, FPGA, Pulsed Power Weapons

THE EVALUATION OF HOMER AS A MARINE CORPS EXPEDITIONARY ENERGY PREDEPLOYMENT TOOL

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The author evaluated whether HOMER Micropower Optimization should be used by the Marine Corps as a pre-deployment tool for expeditionary energy demands. The author created two unique experiments to facilitate the evaluation of HOMER's modeling capability. First, a grid-tied-photovoltaic (PV) system at NPS was monitored for a one month, during which a HOMER model of the system was created. Actual energy production from the system was compared to the model. Then, the model was calibrated to the particular system to ensure that the model's energy estimate matched that of the actual system. The second experiment involved the use of two different types of PV panels and a small wind turbine. Each system was monitored over a one-month period, and the results were compared to a HOMER model of the systems. The difficulty of modeling wind turbines and the related limitations of HOMER's modeling strategy is discussed in this thesis. The calibration method established in the grid-tied-PV experiment was used to ensure the HOMER models were accurate. Following calibration, the concept of expeditionary energy density as it pertains to power production was defined and used to evaluate the systems. The advantage of using HOMER as part of the Experimental Forward Operating Base (ExFOB) is shown. The ExFOB was conducted by the Marine Corps to evaluate power solutions currently on the market for expeditionary energy purposes. Four power production solutions were chosen by the Marine Corps following the ExFOB and field tested in Morocco and scheduled to be deployed to Afghanistan. This thesis details how HOMER would have benefited the ExFOB process if utilized.

KEYWORDS: HOMER Micropower Optimization, Forward Operating Base, Expeditionary Energy

THE EFFECT OF TEMPERATURE ON THE OPTIMIZATION OF PHOTOVOLTAIC CELLS USING SILVACO ATLAS MODELING

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The author analyzes the effect of temperature on the performance of photovoltaic cells using a virtual wafer fabrication tool called Silvaco ATLAS. Work from a previous NPS thesis provided the initial InGaP/GaAs/Ge triple-junction solar cell design used in this analysis. The previous work on this solar cell involved optimizing at 300 K, though operating temperatures are typically higher. The author models each subcell of the multijunction solar cell at 275 to 400 K in 25-degree increments while varying thicknesses and doping levels as well as molecular composition of InGaP, to observe their effect on performance and suggest a better design for operating at higher temperatures. The percent improvement increases to more than 11.9% as the temperature increases to 400 K when the author increases the mole fraction of InGaP and the doping in the GaAs emitter and the base of each subcell.

KEYWORDS: Silvaco, Simulation, Photovoltaic Cells, Multijunction Indium, Gallium, Phosphide, Arsenide

MASTER OF SCIENCE IN ELECTRONIC WARFARE SYSTEMS ENGINEERING

FREQUENCY DIVERSE ARRAY RADAR

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Master of Science in Electronic Warfare Systems Engineering–September 2010

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Second Reader: Lt. Col. Terry Smith, USAF, Department of Information Sciences

Electronic scanning is the most desirable feature of state-of-the-art radar systems. With electronic scanning, it is possible to steer the main beam of an array antenna instantaneously into a desired direction where no mechanical mechanism is involved in the scanning process. Electronic scanning methods including phase scanning, time delay scanning, and frequency scanning have been used in various radar applications; however new and cheaper scanning methods are still being investigated. It is the purpose of this thesis to investigate an array configuration called frequency diverse array (FDA), which gives rise to range-, time-, and angle-dependent scanning without using phase shifters.

In this thesis, first, frequency diverse array as a time-modulated array is presented. A general analysis and the theory of time domain scanning is given. Equations derived for a time-modulated frequency diverse array are simulated using MATLAB. Amplitude tapering and Fourier series expansion is implemented in MATLAB and the results are provided for comparison.

Secondly, analysis of a frequency diverse array is presented. Time-, range-, and angle-dependent electronic scanning is achieved by applying a small amount of frequency shift among the antenna elements. The simulation results for radiation patterns with various excitation types are given.

Lastly, the radar applications of FDA are considered. The received power from a target at a fixed range is simulated in MATLAB and the results are presented.

KEYWORDS: Array Antenna, Frequency Diversity, Frequency Scanning, Frequency Diverse Array, Radar

ADAPTIVE, TACTICAL MESH NETWORKING: CONTROL BASE MANET MODEL

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Master of Science in Information Technology Management–September 2010

Master of Science in Electronic Warfare Systems Engineering–September 2010

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Mobile Ad Hoc Networks (MANET) do not depend on any kind of established infrastructure; therefore, they can be deployed without any need of fixed infrastructure. MANET are expected to play an important role in delivering real-time services to war fighters in tactical military networks by providing infrastructureless communication. The nature of MANET, such as node mobility, unreliable transmission medium and restricted battery power, makes it more challenging for them to deliver the information warfighters need on tactical missions.

As the demand for higher bandwidth real-time tactical services increases, more bandwidth efficient tactical network solutions must be developed. The goal of the CBMANET program was to develop an adaptive networking capability that dramatically improved performance and reduced communication failures in complex communication networks. However, field experiments showed that the proposed network coding for CBMANET was not adequate to leverage the limited network resources to transport time-critical messages

and interactive video in varying network conditions. Therefore, CBMANET was evaluated as not usable in supporting the tactical network operations in future IT mobile services with its current coding, but it still can be useful in mobile networks that are not transferring time critical information. CBMANET remains a promising technology in the area of MANET improvements.

KEYWORDS: Control Based Mobile Ad Hoc Networking, CBMANET, MANET, Network Coding, Tactical Wireless Network

CANCELLATION CIRCUIT FOR TRANSMIT-RECEIVE ISOLATION

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This wireless distributed digital phase array (WDDPA) has been proposed for several military applications in the sensor and communication areas. The idea of WDDPA is to use a wireless network for transmitting and receiving data between a master controller and modules in an active phased array instead of using a conventional wired beamforming network. The WDDPA provides several advantages over conventional networks such as battlefield survivability, digital architecture and flexibility of system installation on platforms.

A phase-synchronization circuit has been developed in the WDDPA application, allowing coherent processing of the data from all elements. There are limitations encountered due to non-ideal hardware, and the performance of the circuit is limited. One of the major problems is the leakage from the circulator. The leakage disrupts the power distributed from the T/R modules. A cancellation circuit has been developed to cancel out the leakage. The performance of the cancellation circuit was investigated by a series of simulations using Agilent ADS (Agilent Advanced Design System), and hardware tests were conducted to characterize the behavior of the circuit. The performance is limited by the accuracy of the attenuator and phase shifter in the cancellation branch. A method for cancelling the residual leakage signal digitally is discussed.

KEYWORDS: distributed digital phase array, beamforming network, Transmit/Receive Module, isolation, leakage cancellation

PERFORMANCE ANALYSIS OF THE LINK-16/JTIDS WAVEFORM WITH CONCATENATED CODING, SOFT-DECISION REED- SOLOMON DECODING, AND NOISE NORMALIZATION

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The Joint Tactical Information Distribution System (JTIDS) is a hybrid frequency-hopped, direct-sequence, spread-spectrum system that employs a (31, 15) Reed-Solomon (RS) code for forward error correction coding. In this thesis, an alternative error correction coding scheme that uses concatenated coding with a (31,) RS inner code and a rate 4/5 convolutional outer code is considered. In addition, a sequential diversity of two, consistent with the JTIDS double-pulse structure, is considered both for soft decision (SD) RS decoding and for soft diversity combining with noise-normalization. Both coherent and noncoherent detection are considered. Based on the analyses, the alternative JTIDS waveform outperforms the original in all cases considered. When only additive white Gaussian noise is present, the best performances, which result in a gain of about 1.4 dB relative to the existing JTIDS waveform, are achieved for (31, 23) RS and (31, 25) RS inner codes for coherent

detection and for (31, 27) RS and (31, 29) RS inner codes for noncoherent detection. For these RS inner codes, a 23.0% and 33.0% improvement in system throughput is achieved, respectively, for coherent detection, and a 44.0% and 55.0% improvement in throughput is achieved, respectively, for noncoherent detection relative to the existing JTIDS waveform. Noise-normalization neutralizes the effects of pulse-noise interference, but no significant benefits are obtained from using SD RS decoding.

KEYWORDS: JTIDS, Link-16, soft decision (SD) Reed-Solomon (RS) codes, cyclic code-shift keying (CCSK), minimum-shift keying (MSK), convolutional codes, concatenated codes, noise-normalization, pulse-noise interference (PNI), diversity, additive white Gaussian noise (AWGN)

DEVELOPMENT OF A RECEIVER PROCESSOR FOR UAV VIDEO SIGNAL ACQUISITION AND TRACKING USING DIGITAL ARRAY ANTENNA

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Master of Science in Electrical Engineering–September 2010

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Air dominance is a key factor concerning today's warfare. Obtaining air dominance requires having a high degree of situational awareness. Unmanned aerial vehicles (UAVs) have gained popularity for surveillance and reconnaissance missions and provide situational awareness to ground-based military units. During operations it is necessary to maintain an uninterrupted data and control link between the UAV and the ground control station (GCS). This requires GCS antennas with signal-tracking capability.

The work on this research was based on an ongoing project that originally started in 2002. The ultimate purpose is to design and build a digital phased-array antenna system that can automatically acquire, track, demodulate and decode video signals from a UAV using commercial-off-the-shelf (COTS) equipment. Previous work done includes integration of hardware components and development of software modules that allow the array system to auto-track signals from a UAV as well as decode the video signals in a standard format. The research in this thesis focused on allowing the system to demodulate the video signals acquired by the digital tracking array. The baseband demodulation technique implemented was previously tested with video signals. A new technique utilizing tangent-type demodulation of signals was also implemented and tested using a bench-top test setup.

KEYWORDS: Air Dominance, Situational Awareness, UAV, Digital Phased Array Antenna, Tracking, Video Signal, Commercial-Off-The-Shelf, Hardware, Software Modules, NTSC, Baseband Demodulation, Tangent Type Demodulation

ATMOSPHERIC EFFECTS ON COMMUNICATION AND ELECTRONIC WARFARE SYSTEMS WITHIN TURKEY AND SURROUNDING AREAS

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Second Reader: Karl D. Pfeiffer, Department of Information Sciences

This thesis presents the most complete climatology of radio wave (VHF and higher frequencies) tropospheric ducting within Turkey and the surrounding areas ever published. This ducting can result in greatly extended propagation ranges. Atmospheric data from radiosonde upper air observations were collected for a five-year period at stations in Adana, Ankara, Diyarbakir, Isparta, Istanbul, Izmir, Athens, Bucharest, Crete Island, and

Tuapse. The upper level and surface ducting yearly average frequencies for these stations were 59.46%, 34.22%, 37.53%, 38.15%, 50.67%, 45.69%, 64.69%, 30.24%, 65.59%, and 21.05%, respectively. Ducts occurred mostly in summer. These frequencies were much higher than previously published climatologies. However, many of these ducts were too shallow to be operationally significant. Atmospheric pressure was correlated with duct heights for some stations, but sometimes the correlation was positive while other times it was negative. In most cases, no correlation was found between duct height and wind speed or direction. Ducts tended to be more common in coastal regions. Regions away from the coast usually have topography limits the effects of the ducts away from the coast, and these inland regions tended to have less ducting occurrence. Therefore, these results are most applicable to the coastal regions.

KEYWORDS: Adana, Ankara, Diyarbakir, Isparta, Istanbul, Izmir, Athens, Bucharest, Crete Island, Tuapse, upper air, ducts, refractivity, electronic warfare.

IMPLEMENTATION OF NETWORKING BY TOUCH TO SMALL-UNIT, NETWORK-ENABLED OPERATIONS.

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Second Reader: CDR John Looney, USN, Department of Information Sciences

Command and control (C2) techniques and procedures radically changed with the emergence of network-centric capabilities. The extensive amount of information distributed to soldiers in the modern battlefield often results in cognitive overload. Utilizing the human sense of touch to convey information may avoid information bottlenecks. Tactile interfaces seem to be an alternate way to manage information efficiently, especially in small network-enabled units, thereby enhancing their performance on the battlefield. This transmission of data via physical or electronic touch can provide a robust, rapid, intuitive and secure means of reliable communications.

In this research, the concept of networking-by-touch (NbT) integrated into human area networks is being explored as a platform for improving information sharing and collaboration, increasing situational awareness and enhancing decision making. Some military applications that address the use of tactile displays for small ground-battle elements (e.g., a special-operations squad) are presented. Additionally, disruption/delay-tolerant networking (DTN) technology is discussed as it relates to challenging military ad hoc networks with frequent partitions and intermittent connectivity due to mobility, environmental factors or jamming.

Finally, within the CENETIX/Tactical Networking Topology (TNT) testbed environment, potential experimentation is proposed for testing proof of concept and evaluation of network performance.

KEYWORDS: Human Area Network (HAN), Delay/Disruption Tolerant Network (DTN), Intra Body Communication (IBC), Near Field Communications (NFC), Tactile Displays, Mobile Social Networks.

MASTER OF SCIENCE IN ENGINEERING ACOUSTICS

TIME/FREQUENCY RELATIONSHIPS FOR AN FFT-BASED ACOUSTIC MODEM

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Second Reader: Lawrence J. Ziomek, Department of Electrical and Computer Engineering

This thesis proposes a scheme for short-range (<500m) underwater acoustic communications in shallow water. The proposed scheme is a variation on an existing commercial modem reliably used for medium-range (<5km) communications in the 9-14 kHz band. The proposed scheme exploits a higher carrier frequency at 45 kHz and increased spectral bandwidth compatible with the short-range link, thus achieving an increased channel capacity. Analytical expressions are provided for the scheme, which combines principles of M-ary frequency-shift keying (MFSK) and orthogonal frequency-division multiplexing (OFDM) in a modulation referred to as multi-channel MFSK. The proposed scheme consists of 32 orthogonally spaced channels, each of which contains a 4-FSK pulse train. Existing medium-range modem algorithms are adapted for the higher carrier frequency and candidate variations are implemented with bandwidths of 10 and 20 kHz. The variations involve bandwidth scaling or multiplexing the original 5 kHz spectral bandwidth. Of concern for short-range links in shallow water is multipath interference, which causes time-spreading and significant intersymbol interference (ISI). Dominant eigenray paths are determined in order to estimate the amount of time-spread expected in various shallow water environments. These are analyzed with respect to the time/frequency relationships of multi-channel MFSK to comparatively evaluate the candidate variations in terms of protection against ISI. On this basis, we propose multiplexing the 5 kHz MFSK modulation across the larger operating band.

KEYWORDS: Acoustics, sound, ocean, acoustic communications, underwater networks, LAN, Seaweb, Seastar, frequency-shift keying, MFSK, multipath propagation, intersymbol interference

PERFORMANCE EVALUATION OF A PROTOTYPE UNDERWATER SHORT-RANGE ACOUSTIC TELEMETRY MODEM

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This thesis documents the evaluation of the transmitter performance of a short-range underwater acoustic modem. This prototype modem was fabricated by contractor Teledyne Benthos, Inc. and is identified as Model ATM-90X. It was developed for use in the Seastar underwater Local Area Network (LAN). The ATM-90X modem is required to be capable of transferring large amounts of digital data at a range up to 500 m using the 33–55 kHz acoustic frequency band. The modem's transmitter performance was evaluated in terms of transmit frequency response, vertical beam pattern, and maximum source level. Underwater acoustic measurements were conducted in an anechoic water tank and the data were analyzed using signal processing techniques including Hilbert transforms, autocorrelation, and cross correlation. The transmission characteristics of the intended underwater acoustic communication channel were modeled to determine the required modem

operating performance in the best and worst case situations. The measured performance characteristics were evaluated in the context of the communication link margin (i.e., the excess signal-to-noise ratio) associated with the modeled channels. The results show that (1) the modem transmit frequency response does not have acceptable flatness across the entire 33–55 kHz band; (2) the beam pattern in the vertical plane has a good hemisphere pattern; (3) estimated maximum source level is 175 dB re 1 μ Pa-m broadside to the modem. Based on the evaluated performance, the ATM-90X modem can provide a successful communication link with the highest data rate at the range of 500 m in the best-case situation (least noise). However, in the worst-case situation, the communication link will fail to reach performance objectives.

KEYWORDS: Acoustic Communications, Acoustic Modem, Seastar LAN

MASTER OF SCIENCE IN INFORMATION SYSTEMS TECHNOLOGY

VIRTUAL MACHINE MODULES FOR USE BY DOD C4I SUPPORT CENTERS

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The mission of DoD C4I Support Centers (DCSCs) is to provide C4I application support to various communities, such as Operations and Experimentation, Training, Acquisition, and Analysis and Assessment. In order to support its respective communities, DCSCs purchases computing equipment (laptops, servers, switches) to create models and/or simulations (M&S) of current IT capabilities of the operating forces. Many times, DCSCs is required to stay up-to-date with DoD operating forces, which leads to excessive expenditures of equipment, maintenance, storage, and personnel costs.

Virtual Machines, or software implementations of real computer machines, aim to address these issues plus more. Three benefits of using virtual machine environments in M&S are: One, it reduces purchasing and maintenance costs of IT systems. Two, it provides a scalable environment that does not require excessive manpower or time to establish. Three, it drastically reduces the footprint required for established environments and gets rid of storage requirements for older systems.

This thesis focuses on the benefits and the methods needed to achieve the benefits of using commercial-off-the-shelf (COTS) virtual environments for C4I modeling and simulations. It will also introduce a modularized and reusable methodology when using the DoD Verification, Validation, and Accreditation (VV&A) process.

IMPLEMENTATION OF SOFTWARE PROGRAMMABLE RADIOS TO FORM AD-HOC MESHED NETWORKS TO ENHANCE MARITIME INTERCEPTION OPERATIONS

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Maritime Interception Operations have become a core competency for United States naval vessels working in conjunction with coalition units in remote waters. An increased need for real-time communication networks exists that will bring VBSS and SOC Teams in contact with experts who can determine the urgency and threat levels of vessels at sea and possible targets on land. The ultimate objective is to deliver timely intelligence, surveillance, and reconnaissance necessary to achieve situational awareness by tactical and strategic decision makers throughout the chain of command. The most critical aspect of this objective is to be able to provide seamless wireless coverage for littoral assets and to provide the security of data for sensitive information exchanged between multinational and coalition partners. The objective of this thesis is to evaluate and compare the suitability of ad-hoc wireless networks using software programmable radios in a maritime environment for employment in military and civilian security operations.

KEYWORDS: Ad-hoc, Wireless Networks, Programmable Radios, MIMO, Ultra-wideband, MIO, VBSS

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

ADAPTIVE, TACTICAL MESH NETWORKING: CONTROL BASE MANET MODEL

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Mobile Ad Hoc Networks (MANET) do not depend on any kind of established infrastructure; therefore, they can be deployed without any need of fixed infrastructure. MANET are expected to play an important role in delivering real-time services to war fighters in tactical military networks by providing infrastructureless communication. The nature of MANET, such as node mobility, unreliable transmission medium and restricted battery power, makes it more challenging for them to deliver the information warfighters need on tactical missions.

As the demand for higher bandwidth real-time tactical services increases, more bandwidth efficient tactical network solutions must be developed. The goal of the CBMANET program was to develop an adaptive networking capability that dramatically improved performance and reduced communication failures in complex communication networks. However, field experiments showed that the proposed network coding for CBMANET was not adequate to leverage the limited network resources to transport time-critical messages and interactive video in varying network conditions. Therefore, CBMANET was evaluated as not usable in supporting the tactical network operations in future IT mobile services with its current coding, but it still can be useful in mobile networks that are not transferring time critical information. CBMANET remains a promising technology in the area of MANET improvements.

KEYWORDS: Control Based Mobile Ad Hoc Networking, CBMANET, MANET, Network Coding, Tactical Wireless Network

ANALYSIS OF MARINE CORPS TACTICAL LEVEL COMMAND AND CONTROL AND DECISION MAKING UTILIZING FBCB2-BFT

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The speed and means at which information is acquired, developed and utilized has changed substantially over the last two decades, as the Marine Corps has made the transition from their traditional means of situational awareness (SA) and common operational picture (COP) development through radio updates and map boards, to the advanced information system enabled graphical user interface (GUI) by means of Force XXI Battle Command Brigade and Below-Blue Force Tracker (FBCB2-BFT). The commander's understanding of the situation formerly relied on the push-pull of information between himself, his subordinates, higher, and adjacent units. Now, the commander and his subordinates share a near-real time enhanced flow of information.

The introduction of FBCB2-BFT greatly improves the ability to obtain SA and knowledge at all levels.

This study examines the impact of FBCB2-BFT on tactical level command and control (C2) and decision making. Via a survey, the researcher's elicited opinions from 114 veterans of Operations Enduring and Iraqi Freedom about the effects of FBCB2-BFT on operational decision making and its impact in real world situations.

The survey results indicate that the categories of operation referenced (OEF/OIF) and Military Occupational Specialty (MOS) domain (Aviation/Ground) are statistically significant factors in influencing how FBCB2-BFT is used.

KEYWORDS: Marine Corps, Decision Making, Command and Control, FBCB2-BFT

**BRIDGING THE GAP IN THE REALM OF INFORMATION DOMINANCE:
A CONCEPT OF OPERATIONS FOR THE NAVAL POSTGRADUATE
SCHOOL CENTER FOR CYBER WARFARE**

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As the information age continues to evolve and technological expansion persists in creating a marked footprint across the four corners of the world, the need arises to protect our prized assets from potential adversarial motives. The extant threat to cyberspace necessitates the need to aptly man, train, and equip our forces to ably combat any untoward incidents. The Naval Postgraduate School with its very diverse population presents an exact medium to develop this next generation of warriors skilled in the field of Cyber Warfare to project both offensively and defensively against any contingent threat. As its mission statement professes, NPS strives to provide relevant and unique advanced education and research to increase the combat effectiveness and enhance the security of the United States.

This thesis will leverage current instructions to bridge the gap and focus on providing a Concept of Operations for the Center for Cyber Warfare that aligns with the Chief of Naval Operations' (CNO) Strategic Focus Areas. This thesis will additionally recommend an architectural framework that addresses the current issues within the cyber domain and/or will allow for future expansion of the NPS mission datasets deemed of importance to the U.S. Military service and its allies.

KEYWORDS: Cyber Warfare, Information Dominance

**NAVAL FUEL MANAGEMENT SYSTEM (NFMS):
A DECISION-SUPPORT SYSTEM FOR A LIMITED RESOURCE**

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The fuel planning for U.S. naval operations at sea is reactive and relies upon pen and paper calculations. Decisions on where and when to refuel are complex and need a Decision Support System (DSS) to help planners maximize the benefits of the limited fuel resource. This thesis defines requirements and outlines a feasible de-

sign to develop a Naval Fuel Management System. The variables that fuel planning rely upon are not just ship course and speed, but also the weather at the time a ship travels through a particular area. The most efficient plant configuration plays a factor in the fuel plan as well. Additionally, there are numerous ports and oilers available at any given time. Up-to-date accurate weather forecast databases are available, predicting currents and winds, which will affect the ship in the future. Fuel burn charts have been developed for each ship class, outlining the most efficient plant configuration for given speeds. Transportation analysis has shown that an optimal path exists for this class of complex problems. By combining these technologies into one system, an application can be developed to accurately plan fueling operations in the future, making Navy refueling more efficient.

KEYWORDS: Naval Fuel Management System, NFMS, shortest path, SOA, VIRT, linear programming

DEVELOPING A KNOWLEDGE-MANAGEMENT FRAMEWORK TO ASSIST WITH CURRENT USMC INFORMATION-MANAGEMENT PRACTICES

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As can be evidenced by the conducting of the Annual Knowledge Management Conferences, held in Washington, DC (most recently the DoD Knowledge Management Conference, October 2009), DoD understands the value of Knowledge Management (KM). The Air Force, Army and Navy appear to have created healthy knowledge sharing environments and practicing KM at mature levels, however the Marine Corps is having a difficult time integrating the practice of KM into daily operations. While the Marine Corps Warfighting Publication (MCWP) 3-40.2 offers a methodology for how four classes of information should flow through the Information Hierarchy, to date, there is no published, standardized framework for how to adequately manage knowledge which exists in the Information Hierarchy, hence the need for an actionable KM Framework that the Marine Corps can use to assist with current Information Management (IM) practices. The focus of this thesis is to assess current KM practices across the DoD, identify KM best practices in industry, as well as, across the DoD, and ultimately develop a KM Framework that will leverage the powerful dynamics of Knowledge Flow Theory to assist in bridging the knowledge gap in the Marine Corps Information Hierarchy.

KEYWORDS: Framework, Information Management, Knowledge Flow Theory, Knowledge Management, Knowledge Gap

CLOUD COMPUTING IN SUPPORT OF SYNCHRONIZED DISASTER RESPONSE OPERATIONS

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During disaster response, key resources are supplied from a variety of channels including: government agencies, volunteer organizations, commercial business, educational institutions and others. While many of the en-

tities have efficient internal methods of communication and coordination, global collaboration has historically been hindered by political, social, and technological challenges. Following Hurricane Katrina this resulted in over-resourcing of some in-need areas with little or no resources reaching others. While there is little argument that a global approach to disaster response should be adopted, political and technical challenges surrounding the integration and ownership of such a system have prevented its emergence. This thesis examines the current challenges to collaboration between responding entities and proposes self-synchronization using a distributed, highly scalable, web application based on cloud computing technologies to facilitate communication between a broad range of public and private entities without requiring them to compromise security or competitive advantage. The proposed design applies the unique benefits of cloud computing architectures such as automatic scaling, geographic distribution, and query performance to the disaster response domain.

KEYWORDS: Cloud Computing, Synchronization, Elasticity, Disaster, Common Operating Picture, Framework

APPLICATION OF UWB AND MIMO WIRELESS TECHNOLOGIES TO TACTICAL NETWORKS IN AUSTERE ENVIRONMENTS

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This thesis explores the utilization of several different types of wireless penetration technologies as an effective means to counter the extreme RF propagation conditions in austere environments. By extending the range and enhancing the available bandwidth at the edge of a tactical network, the warfighter's technological capabilities become enhanced to meet the demand of the information age. Since the concern is adapting technologies to conquer the rigors of an austere environment, this thesis predominantly evaluates UWB and MIMO technologies at the physical and data link layers by researching both employment capabilities into a tactical network and developing data for analysis through various simulations in these types of conditions.

This thesis addresses several of the major challenges and requirements confronting a commander employing a tactical network in this type of environment. Focus of study is directed on the background of UWB and MIMO technologies and how their characteristics will address these challenges and requirements. This thesis provides specific recommendations for using either the UWB or MIMO technology to counter the effects of radio propagation in an austere environment. The ultimate objective is to analyze constraints associated with radio technologies in an austere environment and develop an integration scheme to expand the tactical network. By capturing data of both capabilities through comparative analysis, modeling and simulation, this thesis provides the Department of Defense (DoD) a framework to better understand the effects a triple canopy environment has on radio technologies and aid in the pursuit of a viable solution for extending the tactical network in support of the warfighter during this information age.

KEYWORDS: Ultra Wideband, Multiple In/Multiple Out, 802.11n, 802.16, radio propagation, austere environment, tactical network, integration

INFORMATION TECHNOLOGY MANAGEMENT

AN ANALYSIS OF MARINE CORPS BEYOND-LINE-OF-SIGHT WIDEBAND SATELLITE COMMUNICATIONS REQUIREMENTS

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Satellite communications are critical to Marine Corps command and control. Capabilities in the domain of beyond line of sight systems, such as wideband SATCOM, must periodically be assessed for alignment with relevant strategy, policy, and doctrinal publications. The National Security Strategy and other documents are periodically updated to provide direction to the U.S. Armed Forces. This thesis provides an analysis of a broad range of publications that extend from national level strategy documents down to service level doctrinal publications that specifically address how the Marine Corps conducts military operations. The focus is to identify how beyond LOS SATCOM systems can support the key tenets of the NSS and USMC doctrine. The analysis forms the basis for an assessment of current USMC SATCOM systems and capabilities, followed by considerations for future USMC SATCOM systems and capabilities. SATCOM provides capacity, range, and coverage that allow expeditionary forces such as the Marine Corps to operate anywhere, anytime. Beyond LOS capabilities allow us to mass effects from fewer, more widely dispersed forces. This thesis provides an analytical foundation to help shape future USMC SATCOM operational concepts. It may then help shape USMC SATCOM requirements that must be satisfied by new systems.

KEYWORDS: SATCOM, Beyond Line of Sight, Beyond LOS, BLOS, Wideband, MAGTF Communications, Marine Corps, Satellite Systems

INFORMATION TECHNOLOGY PORTFOLIO MANAGEMENT PROOF OF CONCEPT: MODERN PORTFOLIO THEORY WITH KVA AND ROI ANALYSIS

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The basic research question guiding this thesis is, “How can Modern Portfolio Theory (MPT) be defensibly applied to DoD Information Technology (IT) portfolio optimization problems?” The research will demonstrate how to derive the appropriate raw performance, volatility data, required to remain consistent with MPT assumptions and methodology. This thesis accomplishes this research objective by establishing a notional IT beta (β) to apply a MPT approach for asset allocation within the Department of Defense (DoD). Data from three previous RFID implementation case studies were used, where the Knowledge Value Added (KVA) methodology was applied to estimate the return on investment (ROI) produced by IT. The KVA methodology is essential for the application of this thesis because it provides the framework for the allocation of surrogate revenue and cost streams into core processes where RFID technology was implemented. The ROI estimates of volatility act as a surrogate for equity price volatility, allowing application of the Modern Portfolio Theory (MPT) approach in the nonprofit sector.

KEYWORDS: Modern Portfolio Theory (MPT), Information Technology (IT), Knowledge Value Added (KVA), Return on Investment (ROI), Beta (β), Surrogate Revenue, Nonprofit, Volatilities, Portfolio Optimization

**LEVERAGING SOCIAL NETWORKING TECHNOLOGIES: AN ANALYSIS OF THE
KNOWLEDGE FLOWS FACILITATED BY SOCIAL MEDIA AND THE POTENTIAL
IMPROVEMENTS IN SITUATIONAL AWARENESS, READINESS, AND PRODUCTIVITY**

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The efficient transfer of explicit and tacit knowledge within an organization can yield a distinct competitive advantage in both military and private sector operations. An organization that can adapt faster and operates more efficiently has a winning advantage over its adversary or competition. The research establishes the foundation for knowledge and social dynamics, provides vignettes of knowledge flow facilitated social media, and as a result develops a knowledge facilitation social media framework. The framework is applied to a Type 1 case study involving a Marine Corps combat unit, Air Naval Gunfire Liaison Company (ANGLICO), in order to determine how social media might be leveraged to produce improvements in readiness, productivity, and situational awareness.

KEYWORDS: Networks, Social Media, Social Networking, Knowledge Flow, Knowledge Sharing, Knowledge Transfer, Knowledge Management, Military Operations

MASTER OF SCIENCE IN INFORMATION WARFARE SYSTEMS ENGINEERING

ASSESSING THE FLIGHT QUALITY OF A LARGE UAV FOR SENSORS/GROUND ROBOTS AERIAL DELIVERY

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The new goal for unmanned, aerial systems will be to find creative methods of keeping the cost low and still maintain effectiveness. This thesis discusses the importance of UAVs over the last few years, suggests the development of a low-cost, large UAV and evaluates the results. We also examine the idea of a platform for deploying multiple aerial-delivery, parafoil-based systems and discuss scenarios for the improvement of the collaboration of the large UAV with the Snowflake project.

KEYWORDS: UAV,Network,LinAir software,Simulink,GSM,TNT,VoT,Snowflake,TNT tesbed,MANET

NETWORK-BASED MITIGATION OF ILLEGAL IMMIGRATION IN AEGEAN SEA (GREECE)

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Illegal immigration is a serious concern of countries neighboring devastated parts of the modern world. Illegal migrants dreaming of a new life follow perilous routes, cooperating with smuggling networks. For a significant portion, their dream never comes true. Besides, smugglers are also responsible for other illegal activities, such as drugs and weapons trafficking.

Greece not only faces the problem of absorbing these immigrants from Africa and greater Middle East countries, but also has no chance to filter those migrants involved in dark networks. The Hellenic coast guard, lacking timely information on suspect vessels moving towards its territorial waters in the eastern Aegean Sea, strives to be in the right place at the right time.

The need for an ever-present adaptive networking system able to provide reliable communication and sensor data to and from the areas of responsibility is more profound than ever.

This thesis examines the feasibility and constraints of applying modern networking technology, already successfully tested by NPS CENETIX TNT/test bed, on Aegean Sea islands as a concept of providing information to the Hellenic coast guard to enhance situational awareness and decision-making capability and thus increase overall effectiveness and efficiency while carrying out missions in that area.

KEYWORDS: Networks, Internet, Tactical Network Topology, Mesh, Situational Awareness Multi Agent System, Nodes, Collaborative Environment, Point to Point Communications, Common Operating Picture

FIELD INFORMATION SUPPORT TOOL

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The Field Information Support Tool (FIST) is a field-based collection system using commercial, off-the-shelf (COTS) smartphones, customized software, and a robust information management backend known as FusionPortal with a deployable sensor fusion system known as FusionView that enables information to flow from the point of capture to an analyst in near real-time regardless of location or physical proximity. FIST is designed to operate in a variety of environments and supports a variety of mission sets such as counterinsurgency operations (COIN), counter-narcotic missions (CN), and humanitarian assistance and disaster response (HA/DR). The overarching principle of FIST is the development of a user-friendly data collection tool that utilizes automated information systems to enable unstructured data to be collected, processed, and structured for analysis and visualization in a variety of analytic packages. FusionView enables real-time integration of disparate sensor systems that provides a powerful common operating picture critical for today's decision makers. FusionPortal allows for data to be exported and analyzed using geospatial, geo-statistical, link, and social network analysis in addition to enabling the exchange of information with external databases such as the Worldwide Civil Information Database (WCID), the International Studies of Violent Groups (ISVG), and the Combined Information Data Network Exchange (CIDNE).

KEYWORDS: Sociocultural record, sociocultural report, ethnographic intelligence, ethnographic sensor, cultural intelligence, sociocultural understanding, sociocultural conceptual framework, collection, visualization, analysis, smartphones

**ANALYSIS, DESIGN, AND PROTOTYPING OF ACCOUNTING
SOFTWARE FOR NAVY SIGNAL INTELLIGENCE COLLECTION
SYSTEMS RETURN ON INVESTMENT REPORTING**

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Prior research studies demonstrated a practical methodology for quantifying the return on investment (ROI) of Navy Cryptologic Carry-On Program (CCOP) signals intelligence (SIGINT) collection systems and a practical pathway for implementing a performance accounting system that generates these estimates. This research is a continuation of previous work on the requirements and design of an accounting software to provide return on investment (ROI) estimates for CCOP SIGINT collection systems. We follow the Unified Process, an iterative, incremental software development process and apply Use Case Analysis to obtain requirements of the accounting software. We then develop a high-level architecture design for a software meeting the requirements, and provide a proof-of-concept prototype to demonstrate the ROI analysis functions in Microsoft Excel.

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

ANALYSIS OF MICROSTRUCTURE REFINEMENT DURING SINGLE-PASS AND MULTI-PASS FRICTION STIR PROCESSING OF NIAL PROPELLER BRONZE.

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High strength, corrosion resistance, ductility, and toughness are material properties required for United States Navy (USN) Propellers. Propellers for both surface ships and submarines in the USN are currently made from cast Nickel Aluminum Bronze (NAB) Wrought NAB exhibits strength, corrosion resistance, high dampening capacity, low friction coefficients, and good fracture toughness for a wide range of temperatures [1].

Casting NAB into large structures lowers some of the qualities seen in wrought material and sought after for the propellers. After casting, some of the structure exhibits high porosity and an undesirable grain structure. Friction Stir Processing (FSP) can be used to refine grain structures and remove pores created during casting. This would reduce or eliminate the need for heat treatment and fusion welding currently being used to prepare Navy propellers.

Orientation imaging microscopy was used to aid understanding of friction stir process's effects on grain structure evolution and processes of recrystallization in Nickel Aluminum Bronze. Observations were made about the grain orientation, size, and texture within the stir zone, thermal-mechanically affected zone, and the heat-affected zone for both a single-pass and a multi pass processed pieces of bronze.

KEYWORDS: Friction Stir Processing, NAB, Propellers, Microstructural, Orientation Imaging Microscopy

IMPROVING THE NPSCUL STRUCTURE: OPTIMIZING THE MASS

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This thesis presents the mass optimization of the Naval Postgraduate School Cube Satellite Launcher. The current structure weights 170.63 lbs and can hold up to 24 Cube Satellites. The weight of the whole system, which includes the launcher and all contained satellites, cannot exceed 177 lbs or be lighter than 169 lbs. By reducing the mass of the launcher, the freed weight can then be reallocated to the Cube Satellites. This will increase the maximum allowed weight per satellite.

The current design has six pounds of available free weight. During the course of the analysis, it is found that removal of unused portions of the four side walls of the launcher structure will reduce the weight without undermining the strength. Additionally, when looking at the use of different metal options for the launcher, it is found that the structure needs to maintain the use of an aluminum alloy. Maintaining space-grade aluminum in conjunction with the removal of unused sections of the side walls frees an additional four pounds. This totals ten pounds that can be allocated back into the Cube Satellites.

KEYWORDS: Cube Satellites, CubeSats, Mass Optimization, NPSCuL

**OPTIMAL ARTIFICIAL BOUNDARY CONDITION CONFIGURATIONS FOR
SENSITIVITY-BASED MODEL UPDATING AND DAMAGE DETECTION**

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Frequently, in structural system identification (model updating or damage detection), the available set of data is incomplete, both spatially and in modal content. This incompleteness leads to the solution of underdetermined linear systems. In order to improve the identification, additional independent measured data must be found. In the past, it has been shown that such data can be easily obtained from the application of Artificial Boundary Conditions (ABC), imposed on both the baseline FE models and the measured frequency response data. This can be accomplished without any physical modifications to the experiment, and, hence, no additional expense on different systems, or more than once, in order to get the modal data needed for the analysis. In this thesis, the procedure of sensitivity-based structural system identification, using ABCs, and enhanced by parameter grouping/clustering, is examined. It is shown that the optimal sensitivity matrix is a square and diagonal dominant one, which can be used with quite accurate results both for localization of parameter errors, and the determination of the magnitude of parameter error. The numerous ABC configurations available, even from a small measured data set, allow an optimal sensitivity matrix to be found for many parameters. These concepts are demonstrated using simulated measurements along with finite element models.

**COST BENEFIT ANALYSIS OF THE INSTALLATION OF A WIND TURBINE
ON A NAVAL SHIP**

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In order to reduce environmental pollution, reduce dependability from foreign energy sources, and avoid the uncertainty associated with an unpredictable rise in the price of oil, the use of alternative forms of energy is in worldwide demand. A popular and rapidly developing alternative form of energy is wind energy. The use of wind energy on a naval ship is the subject of this thesis. A preliminary feasibility study has been undertaken in order to evaluate wind energy potential and drawbacks.

As expected, installation of a wind turbine on a ship must meet several conflicting requirements and is subject to environmental uncertainties. Such uncertainties are in turn coupled with the geographic area of operations of the ship, which makes the problem highly dependent on the overall operational concept and mission of the ship. A coupled ocean/atmosphere mesoscale prediction software (COAMPS) developed by the Naval Research Laboratory is used in order to obtain realistic wind profiles. During this study, the vital electrical circuit elements of the hybrid system are analyzed along with their performance and restrictions of their use. The operational requirements of the ship are taken into account with regards to tower and turbine sizing and its position on the ship as well as all relevant naval architecture characteristics of the ship after installation. A hybrid system is designed and analyzed to cope with the uncertainty associated with wind power. Finally, an economic evaluation of the hybrid system is performed, in order to evaluate if and under what circumstances the use of the hybrid system is a profitable investment.

KEYWORDS: Wind Turbine, Hybrid System, Cost Analysis, Case Study Evaluation, Naval Architecture

CONSOLIDATION OF SURFACE COATINGS USING FRICTION STIR

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Friction Stir Processing (FSP) is an emerging technology that allows for the processing of regions near the surface of a material in order to improve upon the existing mechanical properties. Aluminum alloy samples were plasma sprayed with a titanium-nickel-chrome coating or a titanium coating. Single and multiple pass experiments were performed with both a pinned and a pinless FSP tool at rotation speeds of 400, 800 and 1500 revolutions per minute, all traverses were done at four inches per minute. Optical and electron microscopy methods were then used to determine the success at consolidating the relatively hard and porous titanium based coatings onto the aluminum-alloy surface. Results showed that the most successful results were accomplished using a flat, pinless tool, with minimal downward force applied to the sample. The titanium coatings were visibly less porous at microscopic levels, and there was also considerably less separation at the coating-base interface. Energy dispersive x-ray spectrometry showed very little mixing of the base material and the plasma sprayed coating.

MASTER OF SCIENCE IN METEOROLOGY

LONG-RANGE FORECASTING IN SUPPORT OF OPERATIONS IN THE HORN OF AFRICA

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Master of Science in Meteorology—September 2010

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Over the past several decades, the Horn of Africa (HOA) has experienced recurring climate variations, including droughts and floods that have devastated the region's livelihoods and prompted increased investment in strategies to minimize the negative effects of climate variations. These preventative strategies include the enactment of early warning systems, such as the Famine Early Warning System Network, and military commands such as U.S. Africa Command. If these organizations are to be successful, they must account for the many climate factors that affect Africa, including seasonal climate variations and climate change. Thus, skillful long-range forecasts, especially of precipitation, have become increasingly valuable in planning the operations of these organizations. In this study, we focused on assessing the potential for predicting HOA precipitation rate (PR) during the October–November rain season at lead times of several seasons. We correlated HOA PR and remote climate variables, and discovered a strong potential for skillful long-range forecasts of HOA PR using sea surface temperatures (SST) near New Zealand, the Philippines, and Namibia as predictors. Our forecast methods included deterministic (tercile matching, linear regression, optimal climate normals) and probabilistic (composite analysis) methods. Our verification metrics showed a definite improvement in forecast skill over existing long-range forecasts based on long term means, and indicated that our forecasting methods have the potential to improve the planning of military and non-military operations in the HOA.

KEYWORDS: Horn of Africa, HOA, Precipitation Rate, Early Warning Systems, Long-Range Forecasting, Climate, Climate Analysis, Climate Prediction, Reanalysis, Smart Climatology, AFRICOM, Statistical Forecast

EVALUATING ATLANTIC TROPICAL CYCLONE TRACK ERROR DISTRIBUTIONS FOR USE IN PROBABILISTIC FORECASTS OF WIND DISTRIBUTIONS

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Master of Science in Meteorology—September 2009

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This thesis investigates whether the National Hurricane Center (NHC) operational product for producing probabilistic forecasts of tropical cyclone (TC) wind distributions could be further improved by examining the distributions of track errors it draws upon to calculate probabilities. The track spread/skill relationship for several global ensemble prediction system forecasts is examined as a condition for a description of a full probability distribution function. The 2007, 2008, and 2009 NHC official track forecasts are compared to the ensemble prediction system model along-, cross-, and forecast-track errors. Significant differences in statistical properties were then identified among the groups to determine whether conditioning based on geographic location was warranted. Examination of each regional distribution interval suggests that differences in distributions existed for along-track and cross-track errors. Because errors for ensemble mean and deterministic

forecasts typically have larger mean errors and larger variance than official forecast errors, it is unlikely that independent error distributions based on these models would refine the PDFs used in the probabilistic model. However, this should be tested with a sensitivity analysis and verified with the probability swath. Overall, conditional formatting suggests that the NHC probability product may be improved if the Monte Carlo model would draw from refined distributions of track errors based on TC location.

KEYWORDS: Tropical Cyclone Track Errors, Tropical Cyclone Winds, Probabilistic Forecast Confidence

MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

DECADAL FRESHENING AND WARMING OF THE WESTERN ARCTIC UPPER OCEAN

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Master of Science in Meteorology and Physical Oceanography—September 2010

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Upper-ocean freshness and heat content are important components of the coupled Arctic system, especially within the context on ongoing Arctic change. High-resolution hydrographic profile data collected from Arctic research expeditions and autonomous systems are analyzed to generate a 30+ year record of upper-ocean fresh water content and heat content evolution. Vertical integrals of Heat Content (HC) and Fresh Water Content (FWC) are calculated in three layers: Surface(Sfc)-150m, Sfc-Mixed Layer Depth (MLD), and MLD-150m. Vertical averages of Departure From Freezing Point (DFFP), Salinity(z), and Temperature(z) are also calculated for all three layers. Spatial and temporal constraints allow for seasonal and regional signals to be separated from decadal trend signals. Sub-regions (Beaufort Shelf, Beaufort Gyre, and Trans-polar Drift) are chosen with respect to hydrographically uniform characteristics. In the Beaufort Gyre, Sfc-150m vertically averaged salinity decreases by -0.04 psu/yr while FWC increases by +0.15 m/yr, and HC rises by +3.8 MJ/m²/yr. Mixed layer vs. Halocline trend separation (Sfc-MLD vs. MLD-150m) shows accumulation of FWC in both layers definitively, while the halocline hosts almost all of the accumulation of HC. The trends in FWC are consistent with the observed decline in Arctic sea-ice cover.

KEYWORDS: Arctic Ocean, Mixed Layer, Halocline, Fresh Water Content, Heat Content, Temperature, Salinity, Departure From Freezing Point, Canada Basin, Beaufort Gyre, Beaufort Shelf, Trans Polar Drift.

SENSITIVITY OF THE MERIDIONAL OVERTURNING CIRCULATION TO THICE PATTERN OF THE SURFACE DENSITY FLUX

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The dynamic response of the thermocline to the thermodynamic forcing at the sea surface is analyzed in terms of its ability to influence the pattern of the oceanic meridional overturning. The technique utilized in this study expands upon an improved version of Walin's (1982) water-mass transformation theory, developed by Radko et al (2008). Utilizing a general circulation model (GCM), two series of experiments are performed where surface air-sea density flux distributions are systematically perturbed in different locations to test the Meridional Overturning Circulation (MOC) response. The experiments are diagnosed using the water-mass transformation theory, which makes it possible to quantify the role of adiabatic processes in the global overturning circulation.

Through these tests, this study finds that adiabatic processes dominate the MOC in the upper ocean and that the general circulation structure can be described using the improved water-mass transformation model. However, strength of flow in the Western Boundary regions is not well described by the theoretical model. The highest sensitivity of the MOC to thermodynamic forcing is found in the eastern Atlantic circumpolar regions while western boundary regions are characterized by low sensitivity. Further, the MOC does not show high sensitivity

to heating perturbations in the context of a larger zonal temperature structure. The finding is significant in its potential application to U.S. Navy's ocean modeling efforts and long-term strategy related to climate change.

KEYWORDS: Meridional Overturning Circulation, Thermohaline, Residual-Mean, Air-Sea Fluxes, Surface Density

**THE NAVY'S N-LAYER MAGNETIC MODEL WITH
APPLICATION TO NAVAL MAGNETIC DE-MINING**

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Master of Science in Meteorology and Physical Oceanography–September 2010

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The Navy and Marine Corps' "Forward From the Sea" strategic concept has expanded naval operations from open-ocean, blue-water combat environments to the littoral regions in which naval mines can both be an extremely menacing threat to U.S. forces and an effective force multiplier for the fleet. The Navy/Marine Corps must have efficient mine-warfare (MIW) forces to ensure the fleet can carry out operations in the open ocean and littorals, including maintaining open sea lanes of communication and supporting ship-to-objective maneuver warfare from the sea while denying operating areas to the enemy. Every ship has a magnetic signature, caused by iron and steel components, and the earth's magnetic field induces magnetization in a ship depending on latitude, longitude, and heading. Exploitation of surface ship and submarine magnetic field signatures by naval influence mines has occurred throughout time. In order to calculate the swept path width for magnetic minesweeping systems currently in use by the U.S. MIW forces, it is necessary to calculate the vector components of the magnetic field strength which are generated by each of several possible system configurations. The Navy's N-Layer Magnetic Model (NLMM) is used to predict the expected performance of magnetic minesweeping equipment in a complex environment consisting of N layers, each with arbitrary conductivity and thickness. The model is used to compute the magnetic field strength produced by various U.S. Navy magnetic minesweeping configurations using a random environmental vertical conductivity structure. To better determine which parameters had the greatest effect on the model and which could be simplified or enhanced, a series of tests were run on actual data sets.

KEYWORDS: Magnetic de-mining, field strength, N-Layer Magnetic Model, minesweeping equipment

**A PROCESS FOR APPLYING FORECAST UNCERTAINTY IN PLANNING
FOR UNDERWAY EVOLUTIONS ALONG INTENDED TRACK**

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The sensitivity of operational decision making to atmospheric forecasts is a key component of the Decision Tier of Battlespace on Demand, naval oceanography's operational concept. Effects of wind forecast inputs were analyzed within a modeled decision context for an aircraft carrier ammunition offload. Development of the decision context using expected distance as the utility measurement was followed by an examination of the climatology of wind events that could adversely affect an offload evolution. Two high-wind event cases from 2009 were chosen for analysis. Ensembles from numerical weather prediction models were formed into probabilistic wind forecasts and applied to several decision scenarios. Slight changes to the forecast inputs and the decision context itself produced different outcomes, which emphasized the interdependency between forecasts and optimum decisions in the modeled scenario.

MASTER OF SCIENCE IN MODELING, VIRTUAL ENVIRONMENTS, AND SIMULATION

MODELING RECONNAISSANCE SQUADRON WORKFLOW USING DISCRETE-EVENT SIMULATION AND ANALYZING SEVERAL MEASURES OF EFFECTIVENESS

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Master of Science in Modeling, Virtual Environments, and Simulation—September 2010

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Master of Science in Modeling, Virtual Environments, and Simulation—September 2010

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Reconnaissance missions are not only a vital mode of intelligence-gathering, they are one of the most important contributors of military intelligence as well. They show the battlefield as it is to the commander. A simplified reconnaissance cycle includes the arrival of reconnaissance requests, planning of reconnaissance flights, flying the mission and exploitation of the films or images, and then dissemination of the intelligence reports. The reconnaissance cycle is modeled for four different scenarios (peace and war as situations, RF-4 and F-16 as configurations). There are two points of view regarding this cycle. The first is the reconnaissance requesters' view: they want to know the estimated time it would take for a request to be answered, based on the resources and other factors, before an actual request was made. The second is the reconnaissance squadron commanders' perspective: they want to respond to as many reconnaissance requests as possible. For that reason, they want to know and revise the ideal numbers of personnel and equipment. For answering these questions, satisfying these requests, and having a better understanding of the reconnaissance cycle, Reconnaissance Squadron Workflow is modeled, experimented and analyzed. Analysis includes regression models and partition trees. When results are considered, we see that there is no common rule to determine which factors (either decision or noise) are the key determinants for each scenario. But we noticed that noise factors have much more impact on several measures of effectiveness than decision factors in each model. Some of these noise factors could be controllable, including aircraft, camera and pod defect probabilities and their repair times. Therefore, some precautionary measures should be taken to reduce these defect probabilities and repair times. Specifically, in the RF-4 configuration models, pilot filming error is a significant factor, which shows that training of the pilots cannot be ignored. When the F-16 models are considered, we see that data link defect probability is a significant factor too. This suggests that special precautions should be taken to keep this capability working.

KEYWORDS: Simkit, Reconnaissance Squadron Workflow, NOLH, Orthogonal Design, Regression Analysis

THE IMPACT OF USER-INPUT DEVICES ON VIRTUAL DESKTOP TRAINERS

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Master of Science in Modeling, Virtual Environments, and Simulation—September 2010

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Co-Advisor: Quinn Kennedy, Department of Operations Research

Virtual desktop trainers have become ubiquitous in the U.S. military and have the capability of altering their user interface. The military will gladly pay for additional peripheral devices but only if they can demonstrate

improved training effectiveness. This research project seeks to establish an input device configuration solution for virtual desktop trainers. Specifically, we compared the standard laptop keyboard and mouse to a configuration incorporating a game controller. Additionally, we investigated the value of incorporating a head-tracking device. These peripheral devices could minimize the time required to gain sufficient gaming proficiency, resulting in more time dedicated to training military skills. We employed a within subjects experimental design to evaluate young active duty Soldier's ability to move and shoot in a virtual environment using different input devices.

We found the keyboard and mouse configuration was superior to the game controller configuration in overall performance. The one exception was during the driving event. The head tracker was found to be detrimental to overall performance. Our recommended configuration consisted of the keyboard and mouse without the head tracker for standard users and only providing game controllers to Soldiers who drive vehicles.

KEYWORDS: Virtual Battlespace 2, Virtual Desktop Trainer, Input Device, Game Controller, Head Tracker

DEFINING A SIMULATION CAPABILITY HIERARCHY FOR THE MODELING OF A SEABASE ENABLER (SBE)

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Development of SeaBase Operations has brought about the need for Modeling and Simulation (M&S) analysis of prototypes like the Transformable Craft (T-craft) as a SeaBase Enablers (SBE). The uses of M&S tools for the modeling of new capabilities have been problematic, since there are no standard requirements for simulation development. The accreditation process of M&S tools also offers no guidance into the functionalities of simulations. The goal of this thesis was to define a hierarchical framework of capabilities for evaluating a simulation or "suite of simulations" suitable for modeling SBEs. A capability hierarchy is needed to enable decision-makers to compare end user needs with M&S tools' abilities. An analysis of alternatives was conducted on six M&S tools to develop a capability hierarchy. The three top level capabilities that were defined in an M&S setting were Usability, Flexibility, and Scalability. A roll-up method was then used to evaluate three time-step and three next-event based models. The end result of the comparisons showed that a "suite of simulations" was more capable of modeling SBEs than a single simulation. The results provide decision-makers with a standard approach to define user needs and how to apply them to M&S tools.

KEYWORDS: SeaBase Enabler, Capability Hierarchy, Transformable Craft, T-craft, Usability, Flexibility, Scalability, Time-Step Based Model, Next-Event Based Model, "Suite of Simulations".

THE LITTORAL-COMBAT SHIP SURFACE-WARFARE MODULE: DETERMINING THE SURFACE-TO-SURFACE MISSILE AND AIR-TO-SURFACE MISSILE MIX

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Asymmetric threats pose increasing challenges to the United States Navy in littoral environments. To address the Navy's need for a new platform to serve in this area, the Littoral Combat Ship (LCS) was designed and put into service. What still has yet to be determined is what surface-to-surface capability the LCS will have as well

as what air-to-surface capability the LCS helicopter/unmanned aerial vehicle (UAV) will have.

This study uses freely available data to build a simulation utilizing an agent-based modeling platform known as MANA. The simulation is exercised over a broad range of different weapon systems types with their capabilities ranged across the spectrum of possibilities based on their effectiveness as well as potential difficulties in targeting small boat threats. Using linear regression and partition trees, an analysis is performed on the resulting dataset to address the research question.

The results show that the NLOS system is the best surface-to-surface missile system for the LCS as long as the expected rate of fire is obtained. The best air-to-surface missile system is either APKWS or LOGIR, depending on which can obtain a rate of fire of one missile every nine seconds or faster. Lastly, the rate of fire has been shown to be the most important factor in determining the effectiveness of the different missiles.

KEYWORDS: Littoral Combat Ship, MH-60R, Fire Scout UAV, Surface Warfare Module, Air-to-Surface, Surface-to-Surface, Over-the-Horizon

**REINFORCEMENT LEARNING: A NEW APPROACH FOR
THE CULTURAL GEOGRAPHY MODEL**

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Master of Science in Modeling, Virtual Environments, and Simulation—September 2010

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The cultural geography (CG) model under development in TRAC Monterey is an open-source agent-based social simulation, designed to offer an insight into the response of the civilian population during irregular warfare (IW) operations. It implements social and behavioral science theories that govern the behaviors of agents within the simulation using Bayesian belief networks.

At this stage, the agents within the CG model do not select their actions at all. Instead, all their actions are hard coded into the model's scenario file. As part of an attempt to improve the model, this effort sought to enhance the functionality within the model by exploring the use of utility functions and, more specifically, the concept of reinforcement learning.

This study began with the development of a learning agent prototype. After the initial testing for its functionality, the code that was developed was inserted into the main CG model. Based on specially developed scenarios, and by employing a design of experiments methodology, we created experimental runs. By applying statistical and analysis techniques, we showed that reinforcement learning works properly inside the Social Network environment and produces the desired results.

This study can be used as a starting point for the research of the effects of reinforcement learning in social modeling in general.

KEYWORDS: Reinforcement learning, Social modeling, Cultural Geography, Agent-based modeling

X3D-EARTH: FULL-GLOBE COVERAGE UTILIZING MULTIPLE DATASETS

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U.S. Armed Forces are typically utilizing and paying for commercial proprietary licensed products to visualize geospatial scenes, which nevertheless are themselves derived from government-produced data. This is unsatisfactory. This thesis has developed an open-source, royalty-free method for generating full-coverage 3D globes

using the Extensible 3D (X3D) Graphics international standard. Specifically this thesis designs and generates robust globe models developing an instance of full global coverage utilizing X3D-Earth. In order to show interoperability and “mash up” capabilities, multiple formats are used including DTED Level 0 and NGA-produced satellite imagery. Imagery and corresponding terrain datasets are preprocessed using image processing and terrain parsing software, creating the X3D-Earth quad-tree tiles into multiple level-of-detail (LOD) file archives. Finally these pyramidal, locale scenes are grouped and connected to form an overall X3D-Earth globe. Preprocessing, processing and data storage are performed with the NPS Hamming Supercomputer. The result of this work is a methodology for generating X3D-Earth locales that is suitable for massive replication, optimization and reuse. Current results are promising and further work is warranted. The ultimate product is expected to further enable new tactical capabilities, provide direct end-user control of visualization-data pedigrees, and enable improved operational and navigational situational awareness for all deployed warfighters.

KEYWORDS: X3D, X3D-Earth, Geospatial, Globe, Super Computer, Imagery, Terrain Datasets

MASTER OF SCIENCE IN OPERATIONS RESEARCH

OPTIMAL INTERDICTION OF AN ADAPTIVE SMUGGLER

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Master of Science in Operations Research—September 2010

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Counterdrug operations are of national interest to the U.S. and our allies because the illegal production and trafficking of drugs threatens U.S. national security and undermines security and stability in Latin America. Since law enforcement tasked with counterdrug operations is not given enough platforms to search every location at all times, they must decide how to employ their scarce platforms.

To assist law enforcement, we develop a defender-attacker optimization model that utilizes actionable intelligence to coordinate the simultaneous, cooperative disposition of law enforcement platforms in an optimal manner against a smuggler. The model utilizes stochastic dynamic programming to represent an intelligent smuggler, who has the ability to reevaluate his remaining path at decision points along his journey, based on knowledge obtained en route and expectations previously derived. The model employs global Benders' decomposition to determine the optimal placement of three different types of law enforcement platforms simultaneously prosecuting one of three possible types of smuggler. We show that such computations cannot be performed fast enough to be used in a tactical decision aid, since they typically require in excess of two hours.

Upon further analysis using our model, we determine a large number of defender missions do not have a substantial impact on the attacker's risk. Based on the results of our model, we believe further algorithmic development is needed for implementation into a tactical decision aid to assist in counter drug operations.

KEYWORDS: Stochastic Optimization, Dynamic Programming, Defender-Attacker Optimization, Global Bender's Decomposition, Search and Detection

AN ANALYSIS OF COUNTERINSURGENCY CAMPAIGNS USING LANCHESTRIAN-BASED MARKETING DIFFERENTIAL EQUATIONS

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This study developed a campaign model for counterinsurgency that is derived from the Lanchester-inspired Vidale-Wolfe marketing model utilized in the analysis of a consumer population's dynamics. We adapt this approach for a situation in which the output of our differential equation model is not attrition but the percentage of a given population that supports a particular side in the insurgency.

The model is descriptive, providing a structured framework to analyze complex inputs in a simple, straightforward and easily understood framework. Parametric observations reveal that a fledgling insurgency will grow to be a major concern if left unaddressed by the government. Data from Colombia's insurgency demonstrates that the model is well suited to reflect the movement of a population's support away from the government and toward an insurgency.

KEYWORDS: Counterinsurgency, Campaign Models, Irregular Warfare.

**ASSESSING THE OPERATIONAL READINESS OF LANDING CRAFT
AIR CUSHION VESSELS USING STATISTICAL MODELING**

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A fleet of forty Landing Craft Air Cushion (LCAC) vessels is managed by Assault Craft Unit 5 located at Camp Pendleton, CA. LCACs are used to transport weapons systems, equipment, cargo, and personnel of the assault element of the Marine Air/Ground Task Force from ship to shore and across the beach. It is important that the Commanding Officer be able to forecast, with a reasonable degree of accuracy, the number of LCACs that will be available for tasking a fixed number of days in advance. As the LCAC fleet ages its time in maintenance increases, which in turn increases the uncertainty of achieving availability targets. This thesis examines factors that contribute to the availability of LCACs on a daily basis. Using logistic regression, a forecast model is developed from past data on availability and maintenance that has a prediction standard error of approximately two to three craft. The model can be used not only to forecast the number of available LCACs, but also to assist in planning and scheduling to better manage availability.

KEYWORDS: Landing Craft Air Cushion, LCAC, Assault Craft Unit – 5, ACU-5

**AN ANALYSIS OF MOBILE AD-HOC NETWORK PERFORMANCE TO RECOMMEND
A BASIS OF ISSUE FOR THE U.S. ARMY NETT WARRIOR SYSTEM**

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Master of Science in Operations Research—September 2010

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The U.S. Army Nett Warrior System is a type of mobile, ad-hoc network (MANET) designed to enhance situational awareness and communications within a U.S. Army Brigade Combat Team. It depends on reliable wireless communication provided by Enhanced Position Location Reporting System (EPLRS) radio sets. This study investigates the appropriate basis of issue for the fielding of these systems by examining how varying the number of fielded radios affects the system's ability to support Army communications requirements. In this thesis, we model network operations in three ways to evaluate the effects of varying the number of radios. The first model provides an idealized representation of network performance by calculating total throughput in the best case. The second model estimates the percentage of potential links that can be established simultaneously using a greedy heuristic and in a manner consistent with EPLRS design. The final model examines the ability of the network to support the distribution of situational awareness information using discrete event simulation to evaluate the percentage of successful transmissions for networks of varying radio densities. We exercise these models under various deployment scenarios and make recommendations regarding the fielding of these systems.

KEYWORDS: EPLRS, Enhanced Position Location Reporting System, TIREM, Terrain Integrated Rough Earth Model, MANET, Mobile Ad-Hoc Network, Wireless Network Performance, Wireless Communication, SRRA

**PLANNING FOR AN ADAPTIVE EVADER WITH APPLICATION
TO DRUG-INTERDICTION OPERATIONS**

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In an effort to impede the flow of drugs from South America, a Coalition Force headed by Joint Interagency Task Force (JIATF) – South allocates its assets to detect and interdict drug smuggling vessels such as the self-propelled semi-submersible (SPSS) used by a Drug Trafficking Organization (DTO). In this thesis, we develop an interdiction model to place the Coalition Force assets optimally. We also develop a model – known as the Adaptive Evader Model – for a DTO that is able to learn the placement of the Coalition Force assets. This model is akin to the multi-armed bandit problem. We create two algorithms for the Adapting Evader Model. One algorithm uses an optimal learning policy and the other uses a heuristic learning policy. We also create an algorithm for the interdiction model using the Cross-Entropy method. Finally, we construct a case study that we use to draw some insights about how a DTO, that is capable of learning, reacts to different optimal plans. This information can be used by the Coalition Force to more effectively allocate their limited number of assets during drug interdiction operations.

KEYWORDS: Stochastic model, Dynamic programming, optimization, Multi-armed bandit problem, Cross Entropy Method, Interdiction model, Search and detection, Self-propelled semi-submersible, SPSS

**ASSESSING THE EFFECTIVENESS OF THE EARLY ABERRATION REPORTING
SYSTEM (EARS) FOR EARLY EVENT DETECTION OF THE H1N1 (“SWINE FLU”) VIRUS**

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Master of Science in Operations Research—September 2010

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Second Reader: Rachel Johnson, Department of Operations Research

The Monterey County Health Department (MCHD) in California uses the Early Aberration Reporting System (EARS) to monitor emergency room and clinic data for biosurveillance, particularly as an alert system for various types of disease outbreaks. The flexibility of the system has proven to be a very useful feature of EARS; however, little research has been conducted to assess its performance. In this thesis, a quantitative analysis based on modifications to EARS’ internal logic and algorithms is assessed. Logic is used as a counting tool for potential cases of outbreak, and the Early Event Detection (EED) algorithms are used to determine whether or not an outbreak is about to occur. The EED methods are compared by assessing their ability to detect the presence of a known H1N1 outbreak in Monterey County. This research found the cumulative sum (CUSUM) detection method to be the most reliable in signaling the H1N1 outbreak, across all combination of logic explored.

KEYWORDS: Biosurveillance, Syndromic Surveillance, Early Event Detection, Aberration Reporting System

ASSESSING THE EFFECT OF MOBILIZATION ON ENLISTED RESERVE RETENTION

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Retention of personnel is as important for United States military organizations as it is for any organization to ensure continuity and effectiveness. The demands that the current long-term conflicts place on the military have affected the Navy, both Active and Reserves. Naval personnel are asked to do missions on shore with ground units in an Individual Augmentation (IA) billet. Many of these IA billets have been filled by mobilized reservists, particularly to the operations in Iraq (OIF) and Afghanistan (OEF). This thesis uses standard statistical modeling techniques to quantify the effects of these mobilizations on enlisted and officer retention, and in particular, mobilizations to certain operations, on retention. The results concluded that the operation that the enlisted reservist was mobilized to was the most important factor in determining retention. The reservist's paygrade and rating were also significant factors in predicting attrition. These results can help the Naval Reserve manage its manpower flows.

KEYWORDS: Mobilization, enlisted retention, officer retention, Navy Reserve retention

OPTIMAL OPERATION OF SURVEILLANCE TOWERS WITH LIMITED MANPOWER

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Second Reader: CDR Douglas R. Burton, USN, Department of Operations Research

Tower-based surveillance systems have been employed by the U.S. military to enhance intelligence, surveillance, and reconnaissance capabilities in Iraq and Afghanistan. We consider a scenario wherein two surveillance towers are installed in separate locations; however, the surveillance team does not have enough operators to operate both towers to their capacity. Two strategies can be used to operate these two towers: stationary allocation and dynamic allocation. We formulate a two-person nonzero-sum game to analyze these strategies, in which the surveillance team wants to maintain regional stability while insurgents carry out attacks to disrupt it.

Our analysis suggests that the dynamic allocation strategy can improve the performance of surveillance towers over stationary allocation under most circumstances. The improvement tends to be more significant when the surveillance team has more surveillance resource. The dynamic allocation tends to be less effective when (1) a detected attack has a smaller negative impact on the insurgent operations, or when (2) a detected attack brings a larger immediate benefit to the surveillance team.

KEYWORDS: Surveillance Tower, Dynamic Allocation, Two-Person Nonzero-Sum Game

**OPTIMIZING ASSIGNMENTS OF STRIKE-FIGHTER SQUADRONS
TO CARRIER-AIRWING DEPLOYMENTS**

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Master of Science in Operations Research—September 2010

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Second Reader: Douglas E. Otte, Department of Operations Research

The Department of the Navy currently has 11 nuclear-powered aircraft carriers (CVN), which are the centerpiece of carrier strike groups (CSG). The Fleet Response Plan (FRP) dictates CSG deployment and readiness cycles. Based on the FRP, the Navy produces a Master Aviation Plan that assigns 10 carrier-airwings (CVW) to CVNs and carrier-based squadrons to CVWs. At any given time, there are at most 38 strike-fighter squadrons to fill 40 possible assignments. Because there are not enough to fill every possible assignment at one time, strike-fighter squadrons must move between carrier-airwings. Currently, heuristics determine moves using a set of predetermined rules. This thesis presents the Carrier Optimal Strike-fighter Scheduling Tool (COSST), which uses an integer-linear program that optimally assigns strike-fighter squadrons to carrier-airwings over a 10-year period. Assignments minimize moves and ensure sufficient time between deployments. Compared to an existing schedule, our analysis shows that COSST reduces the number of strike-fighter squadron moves from eleven to five in the first four years. Our analysis also examines the impact of reducing strike-fighter squadron availability and transitioning squadrons.

KEYWORDS: Optimization, Integer-linear Program, Scheduling, F/A-18, Super Hornet, Strike Fighter Squadron. Carrier Air Wing

PREDICTING ENLISTED REENLISTMENT RATES

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Second Reader: CDR Kevin J. Maher, USN, Department of Operations Research

Manpower management and retention has been an issue for the military since the military became an all-volunteer force in 1973. Annually, the Bureau of Personnel Metrics and Analytics Branch (BUPERS-34) predicts Navy reenlistment rates and sets numeric reenlistment goals for the upcoming fiscal year. These goals ultimately take into account end strength considerations as well as Enlisted Community Manager requirements. BUPERS-34 uses linear regression to forecast what the expected reenlistment rate will be, given current conditions; if no force shaping actions (e.g., reduce accessions, change personnel policies) are taken. If the forecasted reenlistment rate is different than requirements from an end strength/community management perspective, then the force shapers in the Manpower, Personnel, Training and Education Policy Division (N13) have a signal that steps may need to be taken to bring the two in line. In this thesis, the current BUPERS-34 Navy reenlistment prediction method is evaluated and alternative models to improve the prediction accuracy are suggested. Results of the analysis suggest the removal of several variables from the current model, due to lack of statistical significance, and the addition of Selected Reenlistment Bonus as a predictive variable for reenlistment.

KEYWORDS: Forecasting Reenlistment Rates, Manpower Modeling, Enlisted Modeling, Prediction Models, Predicting Reenlistment Rates, Regression Analysis, Design of Experiments.

**A COMPARISON OF THE FULLY BURDENED COST OF FUEL METHODOLOGIES
EMPLOYED ACROSS THE DEPARTMENT OF DEFENSE**

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Master of Science in Operations Research—September 2010

Thesis Advisor – Daniel A. Nussbaum, Department of Operations Research

Second Reader – Douglas R. Burton, Department of Operations Research

This thesis describes the various Fully Burdened Cost of Fuel (FBCF) methodologies under development across the Department of Defense. A comparison of the Air Force FBCF calculator and the OSD (AT&I) FBCF calculator is performed and identifies the similarities and differences between the methodologies to include an analysis of the output of each calculator.

Our analysis indicates that while the methodologies used to calculate the FBCF vary among the services, the underlying principles that those calculations are based upon are common. The FBCF methodologies can produce similar results.

Recommendations for follow-on studies are provided.

KEYWORDS: Fully Burdened Cost of Fuel, FBCF, Analysis of Alternatives, AOA, acquisition, lifecycle costs, Monte Carlo

MASTER OF SCIENCE IN PHYSICAL OCEANOGRAPHY

FIELD EVALUATION OF OCEAN WAVE MEASUREMENTS WITH GPS BUOYS

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Masters of Science in Physical Oceanography—September 2010

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Second Reader: Jamie MacMahan, Department of Oceanography

An intercomparison of Datawell accelerometer buoys, Datawell GPS buoys, and prototype GPS buoys was conducted to determine the viability of using off-the-shelf GPS receivers to measure ocean surface waves. In the experiment, conducted off the coast of California near Bodega Bay, clusters of Datawell and prototype GPS buoys were deployed to collect ocean surface wave measurements. The first phase of the research was an intercomparison of wave measurements from a Datawell accelerometer sensor, the Magellan MMCX GPS receiver and the GlobalSat MR-350 GPS receiver. The Datawell accelerometer and the Magellan MMCX receiver measurements of both vertical and horizontal wave orbital excursions are in good agreement. The GlobalSat MR-350 receiver also accurately resolved horizontal wave orbital displacements but failed to reproduce the vertical wave excursion measurement by the accelerometer sensors. The second phase of the project was an independent intercomparison between the Datawell MK-II accelerometer buoys, Datawell Waverider GPS buoys, and the prototype GPS buoys built by the NPS team using the Magellan MMCX receiver. The intercomparison showed good agreement between the off-the-shelf GPS buoys, the newer Datawell GPS buoys as well as the traditional Datawell accelerometer buoys in the energetic part of the wave spectrum.

KEYWORDS: GPS Buoys, Wave Measurements, Wave Buoy

MASTER OF SCIENCE IN REMOTE SENSING TECHNOLOGY

**COASTAL BATHYMETRY USING 8-COLOR MULTISPECTRAL
SATELLITE OBSERVATION OF WAVE MOTION**
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Master of Science in Remote Sensing Intelligence—September 2010
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Second Reader: Fred A. Kruse, Department of Physics

Coastal bathymetry was measured using wave motion as observed by a commercial satellite imaging system. The linear finite depth dispersion relation for surface gravity waves was used to determine nearshore ocean depth from successive images acquired by the WorldView-2 satellite of the coastal area near Camp Pendleton, California.

Principal component transforms were performed on co-registered images and principal component four was found to very effectively highlight wave crests in the surf zone. Change detection images, which included principal component four from successive images, contained both spatial and temporal information. From these change detection images, wave celerity could be determined and depth inversion could be performed.

For waves farther from shore, principal component four no longer highlighted wave crests. Waves could be resolved within a single RGB composite image with equalization enhancement. The wavelength of a wave above a known depth was measured and the wave period method was used to determine depth for other waves in the propagation direction of this wave. Our depth calculations compared favorably to our reference bathymetry. The spatial resolution for this method of determining depth is higher and perhaps more accurate than our reference bathymetry, particularly in the surf zone.

KEYWORDS: Remote Sensing, Multispectral, 8-Color, Bathymetry, WorldView-2, ENVI, Principal Component Transform, Depth Inversion, Wave Methods, Dispersion Relation

MASTER OF SCIENCE IN SOFTWARE ENGINEERING

USE CASE ANALYSIS FOR ADOPTING CLOUD COMPUTING IN ARMY TEST AND EVALUATION

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Co-Advisor: Man-Tak Shing, Department of Computer Science

Co-Advisor: James B. Michael, Department of Computer Science

Cloud computing in theory can reduce the total IT lifecycle cost for the US Department of Defense by enabling the enterprise to provision shared software-, platform-, and infrastructure-level services in an on-demand pay-as-you-go fashion. One of the hurdles faced by the Department of Defense is that of developing an enterprise-wide strategy and policy for migrating the enterprise's data and applications to the cloud. This thesis supports the formulation of such a strategy and the accompanying policy by providing a concrete example of how the standard workflow processes used across the US Army test and evaluation programs can be modified to take advantage of cloud computing. The thesis presents a Use Case analysis of the existing collaboration and communication that takes place in these processes, focusing on three specific workflow processes—program management, report collaboration, and de-confliction of contention for test and evaluation resources—that could be improved upon through the use of cloud-based collaboration and communication services. Our results indicate that the cloud-based collaboration and communication services are much better suited to distributed large-scale planning, execution, and reporting of program test and evaluation than those used in the existing test and evaluation workflow processes. The thesis also provides recommendations on migration to cloud computing, how some of the results from this thesis are applicable to the entire Department of Defense enterprise, and suggestions for follow-on research.

KEYWORDS: Cloud Computing, Army Test and Evaluation (T&E) Command (ATEC), Data Center Consolidation, Area Processing Center (APC), Use Case Analysis, Program Management, Test Report, Document

CLOUD COMPUTING IN SUPPORT OF SYNCHRONIZED DISASTER RESPONSE OPERATIONS

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Master of Science in Software Engineering—September 2010

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During disaster response, key resources are supplied from a variety of channels including: government agencies, volunteer organizations, commercial business, educational institutions and others. While many of the entities have efficient internal methods of communication and coordination, global collaboration has historically been hindered by political, social, and technological challenges. Following Hurricane Katrina this resulted in over-resourcing of some in-need areas with little or no resources reaching others. While there is little argu-

ment that a global approach to disaster response should be adopted, political and technical challenges surrounding the integration and ownership of such a system have prevented its emergence.

This thesis examines the current challenges to collaboration between responding entities and proposes self-synchronization using a distributed, highly scalable, web application based on cloud computing technologies to facilitate communication between a broad range of public and private entities without requiring them to compromise security or competitive advantage. The proposed design applies the unique benefits of cloud computing architectures such as automatic scaling, geographic distribution, and query performance to the disaster response domain.

KEYWORDS: Cloud Computing, Synchronization, Collaboration, Elasticity, Disaster, Synchronized, Common Operating Picture, Framework

MASTER OF SCIENCE IN SPACE SYSTEMS OPERATIONS

NPS-SCAT; COMMUNICATIONS SYSTEM DESIGN, TEST, AND INTEGRATION OF NPS' FIRST CUBESAT

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Second Reader: James A. Horning, Space Systems Academic Group

The Naval Postgraduate School's (NPS) first CubeSat, NPS Solar Cell Array Tester (NPS-SCAT), will be the foundation for future advances in CubeSats at NPS. NPS-SCAT demonstrates the capability of the CubeSat form factor as a technology test bed for a single experiment – a solar cell tester. This thesis discusses and explains the design, testing, and integration of two full TT&C sub-system for NPS-SCAT. The primary and secondary transceivers will both use the amateur frequency band through an approved AMSAT license. This thesis explains the concept of operations of NPS-SCAT, which drove the data requirements for the TT&C. This thesis also explains the testing of the primary and secondary transceivers and the design, test and integration of the antennas. Finally, this thesis will discuss the TT&C ground station construction, methodology, testing and the frequency coordination access.

KEYWORDS: CubeSat, NPS-SCAT, S, Half-Wave Dipole Antenna, Beacon, Anechoic Chamber

NPS TINYScope PROGRAM MANAGEMENT

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This master's thesis introduces the program management and concept of operations of the TINYScope Program. TINYScope is a 6U CubeSat designed as a low-cost and easily replaceable imaging spacecraft that can produce tactically relevant imagery data. Tactical requirements in this context would emphasize “good enough” image resolution with a rapid-response tasking loop and high revisit rate. The TINYScope project intends to demonstrate the utility of small, risk tolerant spacecraft for tactical imagery.

The program management section of the thesis discusses the relationships of cost, performance, risk, and schedule and the impact of each on the program. The program's successes and failures are examined to glean lessons for future program managers of university projects. The remainder of the thesis develops a comprehensive concept of operations for the prototype spacecraft. Areas of discussion include overviews of the ground, space and launch segments of the mission architecture, and proposed conduct of operations for those segments. Finally, relevant program management and systems engineering documentation are presented as appendices.

KEYWORDS: Program Management, TINYScope, Mission Operations Concept, Tactical Satellite

PREDICTING SOIL STRENGTH WITH REMOTE-SENSING DATA

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Predicting soil strength from hyperspectral imagery enables amphibious planners to determine trafficability in the littorals. Trafficability maps can then be generated and used during the intelligence preparation of the battlespace allowing amphibious planners to select a suitable landing zone. In February and March 2010, the Naval Research Laboratory sponsored a multi-sensor remote sensing and field calibration and field validation campaign (CNMI'10). The team traveled to the islands of Pagan, Tinian, and Guam located in the Marianas archipelago. Airborne hyperspectral imagery along with ground truth data was collected from shallow water lagoons, beachfronts, vegetation, and anomalies such as World War II relics.

In this thesis, beachfront hyperspectral data obtained on site was used as a reference library for evaluation against airborne hyperspectral data and ground truth data in order to determine soil strength for creating trafficability maps. Evaluation of the airborne hyperspectral images was accomplished by comparing the reference library spectra to the airborne images. The spectral angle between the reference library and airborne images was calculated producing the trafficability maps amphibious planners can use during the IBP.

KEYWORDS: Hyperspectral, Littoral, Amphibious Landing, Trafficability, HyMap, HyVista, Northern Mariana

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

SYSTEMS ARCHITECTURE OF A SEA BASE SURFACE CONNECTOR SYSTEM IN A 2020 HUMANITARIAN ASSISTANCE/DISASTER RELIEF JOINT OPERATIONAL ENVIRONMENT

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In this thesis, an Expeditionary Warrior 2010 based humanitarian assistance/disaster relief mission conducted by U.S. forces set in the 2020 Joint Operational Environment is evaluated to determine potential surface connector system alternatives. The Sea Base surface connector system is tasked with not only supporting the Sea Base logistics sustainment, but also critically enabling delivery of commercially transported relief support cargo to austere coastal and inland destinations. Utilizing Dr. Steven H. Dam's methodology in developing vision architectures, a DoDAF 1.5 compliant architecture was created using Vitech's CORE© model-based systems engineering software. Within the backdrop of both Navy and Army operational concepts current watercraft programs of record were evaluated to assess the impact of potential capabilities of ONR's Transformable Craft. Through operational and functional model evaluation of the planned 2020 surface connectors through assembly, employment, and early sustainment amphibious operations, four discrete Transformable Craft capabilities were identified and discussed. An alternative Army-centric operation was encompassed for later consideration of the Transformable Craft's capabilities within the context of their watercraft activities. It is recommended that this architecture and its generated system configurations be used in further Modeling and Simulation (M&S) to refine Transformable Craft capabilities.

KEYWORDS: Systems Architecture, Sea Base, Surface Connectors, Transformable Craft, DoDAF, Vitech, Nigeria, Humanitarian Assistance, Disaster Relief

ENERGY CAPTURE MODULE (ECM) FOR USE IN UNMANNED, MOBILE VEHICLES WITH A SPECIFIC STUDY OF THE DRAGANFLYER X6 UAV

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Master of Science in Systems Engineering, September 2010

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Co-Advisor: Rachel Goshorn, Department of Systems Engineering

Second Reader: Mark Stevens, Department of Systems Engineering

Unmanned drones, robots, and vehicles are often chosen to perform tasks in harsh and dangerous environments. Autonomous vehicles are ideal in tactical situations when these vehicles can perform functions for warfighters when the risk to human life is significantly too high. In particular, unmanned aerial vehicles (UAVs) have become a common staple of military operations. Common sizes range from slingshot-launched spy bots to global guardians. Small UAV of all types have limited mission endurance due to volume and weight constraints of their energy storage and power sources. In many cases, UAVs are limited in the extent to which they could provide tactical advantage because of their need to be recharged or refueled. Even with the use of highly efficient energy and power sources, it is extremely difficult to design a feasible energy system that will provide power for prolonged duration missions. A method, energy capture, exists to provide recharging of an

energy source remotely. By utilizing electromagnetic waves, energy can be transmitted wirelessly over great distances. This method has been implemented in several forms today, and shows promise as a possible way to provide for much greater UAV mission endurance. An Energy Control Module (ECM) is proposed as a scalable and Modular Open System (MOS) design concept that can utilize either a tuned laser photovoltaic cell or a microwave receiver to convert received electromagnetic energy to maintain the onboard UAV platform battery charged. The ECM can utilize ground or shipboard based power supply to wirelessly transmit power to a UAV. This thesis presents a study of the characteristics needed for an ECM that allows a small UAV platform to remain on station and perform its designed functions while recharging its energy source for prolonged duration missions.

KEYWORDS: Energy Capture, Microwave, Laser Power Beaming

**ANALYSIS OF UNMANNED UNDERSEA VEHICLE (UUV) ARCHITECTURES AND
AN ASSESSMENT OF UUV INTEGRATION INTO UNDERSEA APPLICATIONS**

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Second Reader: James S. Griffin, Naval Undersea Warfare Center

There are prominent unmanned undersea vehicle (UUV) systems existing in the commercial marketplace today, but these systems have a relatively small role and presence in U.S. Navy application. This thesis will suggest what existing commercially available UUV system architectural attributes could be used now in U.S. Navy applications. After a survey of multiple existing commercial UUV systems, five of the prevalent systems in the marketplace were selected for analysis and comparison of their system architecture. This thesis included a comprehensive architectural analysis on seven specific architectural attributes of these UUV systems. Other UUV systems were also analyzed to support specific system architecture discussion. Major architecture considerations were made by the UUV system designers and likely drivers of existing system attributes were discussed as well as the benefits and disadvantages of these system attributes. Finally, based on the material and findings of the thesis, recommendations for a notional UUV system design and architecture for the U.S. Navy was presented.

KEYWORDS: UUV, Autonomous Undersea, AUV, system architecture

**WARSHIP COMBAT SYSTEM SELECTION METHODOLOGY
BASED ON DISCRETE EVENT SIMULATION**

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Master of Science in Systems Engineering—September 2010

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This thesis presents the development of a methodology for the conceptual design of a medium tonnage warship's combat system for the Colombian Navy. The methodology is oriented toward the optimization of the operational effectiveness within the naval ship design constraints of weight, electrical power, volume, cost, and risk. The methodology is based on a Design Reference Mission (DRM) which is composed of four Operational Situations (OPSITs), which cover antisubmarine warfare, anti-air warfare, mine warfare, and surface warfare. The OPSITs are represented by coupled physics based models and probabilistic models. A discrete event simulation tool, ExtendSim, is used to implement these models, yielding quantitative results for mis-

sion success. Design of Experiments (DOE) is used to explore the design space, allowing identification of the main effects in each OPSIT model, and the impact of each variable in the respective Measure of Effectiveness (MOE). The four OPSIT MOEs are integrated in a single Overall Measure of Effectiveness (OMOE) allowing the comparison between different configurations of combat systems, which is then used to determine the best overall ship design to meet operational requirements.

KEYWORDS: Combat System Design, Discrete Event Simulation, Measure of Effectiveness

PRODUCT LIFECYCLE MANAGEMENT: A COLLABORATIVE TOOL FOR DEFENSE ACQUISITIONS

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Master of Science in Systems Engineering—September 2010

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A 2010 review of 96 defense acquisition programs showed average delivery rates are 22 months behind schedule and the cumulative cost growth exceeded \$296 billion. With budget cuts looming, a small window of opportunity exists to enact reforms improving the health and solvency of the defense acquisition portfolio. First, we must leverage the technology investments made into collaborative software suites such as product lifecycle management (PLM) to align the requirements, design, engineering, logistics, maintenance, and operational data environments into one comprehensive activity. Implementing a PLM strategy will present cost-saving opportunities through faster information access, improved data reuse, social networking, and virtual collaboration and testing. PLM systems have the ability to capture and organize vast amounts of data. Because through human interaction data becomes knowledge, lean product design is a philosophy that can change how we think, learn, use, and build up on that knowledge. By going beyond merely attacking waste by finding a balance between waste reduction and value addition, total ownership costs can be reduced drastically. These reforms have the ability to fundamentally change how we design, build, and maintain the fleet, making the defense portfolio solvent and thus continuing to fulfill the needs of the warfighter.

KEYWORDS: Product lifecycle management, lean product design, shipbuilding, defense acquisition

DEVELOPMENT AND IMPLEMENTATION OF LOW-COST MOBILE SENSOR PLATFORMS WITHIN A WIRELESS SENSOR NETWORK

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Sensor networks are used throughout the government and industry for a wide variety of purposes. Mobile Sensor Platforms (MSPs), from surface combatant vessels to unmanned aerial vehicles, have been integrated into these sensor networks since their inception. Unmanned MSPs currently used in sensor networks have two major drawbacks: They are extremely expensive and they require the control of a human operator. Remote controlled unmanned systems currently do not eliminate risk to personnel entirely, because they are typically too expensive to be considered expendable. If these standard unmanned systems are downed in a hostile environment, their recovery is often attempted by personnel on the ground; thus, still risking human lives. The military is exploring the use of low-cost Unmanned MSPs to eliminate the need to risk personnel in their recovery. One of the greatest expenses in the life cycle of any system is operator cost. To reduce or eliminate operator cost a platform must be autonomous. Though algorithms exist for adding autonomous capabilities

to a mobile platform, such algorithms are typically designed for robust systems with a great deal of processing power. Low-cost systems are typically limited in capability by a low-processing power CPU. For this reason small footprint alternatives to existing autonomous control algorithms must be developed to truly implement a low-cost MSP. This thesis applies the systems engineering process to developing a generic system solution for the need of a low-cost MSP, with concept of operations, external systems diagram, generic requirements, functional architecture and decompositions developed. The proposed generic system solution is then further designed in a scoped environment and implemented as a proof of concept prototype.

KEYWORDS: Systems Engineering, Intelligence Collection, Wireless Networks, Unmanned Vehicles.

MANNING AND MAINTAINABILITY OF A SUBMARINE UNMANNED UNDERSEA VEHICLE (UUV) PROGRAM: A SYSTEMS ENGINEERING CASE STUDY

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Second Reader: RADM W.G. “Jerry” Ellis, USN (ret), Undersea Warfare Academic Group

This thesis studies the manning and maintainability requirements of a submarine unmanned undersea vehicle (UUV) program. This case study reviews current commercial and military applications of UUVs and applies their principles to the missions of the Navy’s submarine force. Past and current UUV efforts are lacking requirements documents and the formal systems engineering process necessary to produce a successful program of record. Therefore, they are not being funded for use by the war-fighter. The Navy must develop formal concepts of operations (CONOPS) for the missions and systems that it wants to produce and allow industry to begin development for a formal future UUV program. Furthermore, the military has developed countless unmanned systems that have been developed for use in the water, on the ground and in the air, from which the Navy can apply important lessons learned. Lastly, analysis suggests that the Navy should continue to support the use of a submarine detachment for operation and maintainability of future vehicle programs.

KEYWORDS: Unmanned Undersea Vehicles, UUV, Manning, Maintainability, Submarine Missions

EVALUATION OF CUSUM AND EWMA CONTROL CHARTS TO DETECT CHANGES IN UNDERLYING DEMAND TRENDS OF NAVAL AVIATION SPARES

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Master of Science in Systems Engineering–September 2010

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The Navy must keep aircraft in a high state of readiness, requiring spare parts when and where needed. Managers need to know when changes in demand patterns far enough in advance to ensure continued availability. This thesis evaluates two techniques using widely available Windows-based software to determine if changes are occurring in underlying demand patterns. These techniques are Cumulative Sum Control Charting and Exponentially Weighted Moving Average Control Charting. These techniques was validated using a computer-generated data set with known variation characteristics, and related processes were developed. After validation, the techniques were applied to four actual data sets with demand information from Navy aircraft. Both proved effective with Cumulative Sum Charting providing slightly earlier alarms, and Exponentially Weighted Moving Averages easier to use. Use of these techniques could allow detection of changes in time to mitigate the negative effects of the change and could be applied to a very wide range of processes. For the Navy, the widespread use of these techniques could lead to more aircraft being available for combat missions.

MASTER OF SCIENCE IN SYSTEMS ENGINEERING MANAGEMENT

RECOMMENDED ARCHITECTURE FOR A KNOWLEDGE MANAGEMENT SYSTEM FOR THE UNDERSEA LAUNCHERS DIVISION AT THE NAVAL UNDERSEA WARFARE CENTER

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Second Reader: Rene Rendon, Graduate School of Business and Public Policy

This thesis used systems engineering to create an architecture description for Knowledge Management (KM) at the Launchers Division of the Platform and Payload Integration Department at the Naval Undersea Warfare Center. The Launchers Division stores and shares technical information poorly, resulting in inefficiencies and design rework. A formal KM system could improve the situation. The architecture description addresses stakeholder needs while using KM best practices. This study consisted of problem definition, requirements development, and an architecture description. The resulting system top-level requirements include create, store, analyze, and report submarine launchers knowledge across Naval Sea Systems Command (NAVSEA) and the Fleet. The resulting architecture description integrates people, processes, and technology. The architecture description is recommended for use in developing a more detailed system design for the Launchers Division.

KEYWORDS: Knowledge Management, Systems Engineering

TAILORING SYSTEMS ENGINEERING PROCESSES FOR RAPID SPACE ACQUISITIONS

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Second Reader: Joseph DeVenuto, DoD Contractor

The Self-Awareness Space Situational Awareness (SASSA) program is a congressionally initiated technology demonstration program run by the Air Force, Space and Missile System Center (SMC), Los Angeles Air Force Base. Initiated October 2008, SASSA is investigating the feasibility of a highly flexible and adaptable satellite payload system for detecting satellite threats, both natural and manmade. The SASSA program was given cost and schedule limitations with a mandate to deliver hardware for demonstration in 24 months, considered a “rapid acquisition” by AF and SMC standards. This study provides an assessment of how the SASSA program tailored standard SE processes to implement a “rapid space acquisition”. These SE standards define a roadmap for all military acquisitions to produce the most effective product at the most reasonable cost. Refinement of these standards over time is critical to the continued success of acquisition systems to evolve a current and effective military. This study will review the SASSA concept and technology demonstration, survey standard SE guidance, catalogue SE processes tailored, and assess effectiveness of this tailoring. This study will provide observation and assessment of real world results, successful and unsuccessful, for the purposes of capturing and documenting lessons learned towards successfully accomplishing rapid space acquisitions.

SYSTEMS ENGINEERING MANAGEMENT

IMPLEMENTATION CHALLENGES FOR DOD LOGISTICS ENTERPRISE RESOURCE PLANNING IT SYSTEMS

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**Master of Science in Systems Engineering Management—September 2010
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Second Reader: Mark M. Rhoades, Department of Systems Engineering**

In the summer of 2008, the Global Combat Support System—Marine Corps (GCSS-MC) breached both cost and schedule in development of their ERP system. In addition, Navy ERP has had problems, GCSS-Army has been delayed, and the Air Force Expeditionary Combat Support System (ECSS) is currently rebaselining their program. Why are all of these DoD ERP system development efforts having difficulty and is there a better way to implement ERP systems in the DoD?

This research focuses on DoD ERP implementation efforts ongoing in the Army, Navy, Air Force, and Marine Corps. A macro-level review of six DoD ERP implementations provides a historical perspective reflecting the difficulty all have had in developing their respective ERP systems. A micro-level review of the GCSS-MC program identifies systems engineering challenges the program has faced. The conclusion is that all Service Components have similar requirements and all struggle with development of their respective ERP solution. Much money has been and continues to be spent on ERP implementation and each implementation has taken much more time than was originally planned. It is important for the DoD to take a hard look at how the current ERP solutions have been developed and determine alternate ways to develop similar systems in the future. The DoD cannot afford the billions of dollars that have been spent on multiple system developments and needs to figure out a way to consolidate efforts between the Service Components. These consolidated efforts may provide not only an expedited system development effort but also a common system that can be centrally managed and used to breakdown the unique stove pipe processes within each Service and transform logistics chain management as it is known today.

KEYWORDS: Enterprise Resource Planning, ERP, Logistics, IT, USMC, Army, Navy, Air Force

LOWER TOTAL COST OF OWNERSHIP OF ONE-NET BY USING THIN-CLIENT DESKTOP DEPLOYMENT AND VIRTUALIZATION-BASED SERVER TECHNOLOGY

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Co-Advisor: John S. Osmundson, Department of Information Sciences**

The U.S. Navy (USN) has a large enterprise network outside the continental U.S. (OCONUS) that is complex and expensive to maintain. The problem addressed by this thesis is to determine which alternative desktop deployment technology is more cost effective over time while maintaining the users' operational requirements. The USN is conducting a technology refresh of its OCONUS navy enterprise network (ONE-NET) with thick-client desktop computers. This thesis proposes an alternative solution using thin-client desktops with data center server virtualization-based technology as a lower cost option. To back up this claim of lower cost, an analysis was carried out to determine the total ownership costs (TCO) of both the current thick-client and proposed thin-client solutions. A cost per seat (CPS) model developed by Naval Network Warfare Command (NNWC) was used to calculate major cost components—labor, hardware, software, and transport, while a VMware tool was used to calculate power and cooling costs for both solutions. In addition, VMware provided a cost estimate for the upfront hardware and software licensing costs needed to support the virtualization support for the thin-clients solution. The conclusion of the TCO comparison is that, for the 27,284 users, the thin-client solution would save \$238 million over seven years.

KEYWORDS: Thick-Client, Thin, Server Virtualization, Total Cost of Ownership, OCONUS Enterprise Network

**APPLICABILITY OF PERFORMANCE ASSESSMENT TOOLS TO MARINE CORPS AIR
GROUND TASK FORCE C4 SYSTEM OF SYSTEMS PERFORMANCE ASSESSMENT**

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Master of Science in Systems Engineering Management-September 2010

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Second Reader: David Rathgeber, United States Marine Corps Civilian

This research focuses on the application of existing assessment tools that may be applicable to Marine Air Ground Task Force (MAGTF) Command, Control, Communications and Computers (C4) System of Systems (SoS) performance assessment efforts. An analysis of the Marine Corps Tactical Systems Support Activity's (MCTSSA's) C4 SoS assessment approach provides a means for defining a MAGTF C4 SoS and for illustrating how that SoS is represented in the assessment environment. This provides the framework and context for follow-on examination of SoS performance metrics. The challenges with defining specific performance metrics and examination of past assessment events using those metrics provide the basis for discussion of alternative approaches and application of assessment tools specifically tailored for SoS assessment efforts. Three specific tools, i-Score, Interoperability Quotient (IQ), and Dynamic Software Architecture Visualization and Evaluation (DynSAVE), are examined. The results indicate i-Score and DynSAVE offer the greatest potential applicability to the MAGTF SoS assessment effort. In a culminating discussion, applying a multicriteria identification process to obtain a mathematical model that correlates an interoperability measure with measurable SoS performance criteria is proposed as a means of extending the i-Score model for greater applicability to SoS assessment and performance improvement efforts.

KEYWORDS: SoS, Interoperability, IQ, SAVE, i-Score, MAGTF

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY

VIRTUAL MACHINE MODULES FOR USE BY DOD C4I SUPPORT CENTERS

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Master of Science in Systems Technology—September 2010

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Co-Advisor: Karl Pfeiffer, Department of Information Sciences

The mission of DoD C4I Support Centers (DCSCs) is to provide C4I application support to various communities, such as Operations and Experimentation, Training, Acquisition, and Analysis and Assessment. In order to support its respective communities, DCSCs purchases computing equipment (laptops, servers, switches) to create models and/or simulations (M&S) of current IT capabilities of the operating forces. Many times, DCSCs is required to stay up-to-date with DoD operating forces, which leads to excessive expenditures of equipment, maintenance, storage, and personnel costs.

Virtual Machines, or software implementations of real computer machines, aim to address these issues plus more. Three benefits of using virtual machine environments in M&S are: One, it reduces purchasing and maintenance costs of IT systems. Two, it provides a scalable environment that does not require excessive manpower or time to establish. Three, it drastically reduces the footprint required for established environments and gets rid of storage requirements for older systems.

This thesis focuses on the benefits and the methods needed to achieve the benefits of using commercial-off-the-shelf (COTS) virtual environments for C4I modeling and simulations. It will also introduce a modularized and reusable methodology when using the DoD Verification, Validation, and Accreditation (VV&A) process.

KEYWORDS: VM, C4I, Virtual Machine, Virtualization, Module, Reuse

MASTER OF ARTS

Security Studies

MASTER OF SCIENCE IN SECURITY STUDIES

TRADING NETS FOR GUNS: THE IMPACT OF ILLEGAL FISHING ON PIRACY IN SOMALIA

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Co-Advisor: Sophal Ear, Department of National Security Affairs

Somali piracy reached a record high level in 2008, with 111 of the 293 worldwide attacks occurring in the waters surrounding Somalia. The incidence of piracy in Somali waters almost doubled in 2009, and the Somali share of total piracy attacks worldwide increased from under 40% to over 50%. Often overlooked is the initial upsurge in piracy, following the Indian Ocean tsunami in December 2004, which contributed to a sharp increase in piracy in 2005 and again in 2008. This thesis addresses why this initial surge occurred when it did. This increase can be attributed to the transformation of the pirate business model from fishermen who started to defend themselves, to the organized crime that displaced them in 2004 due to the opportunistic behavior of warlords. A convergence of factors contributing to the conditions at the time of the tsunami had short-term effects in 2005 that were enough to provide a boost to the already increasing business model of piracy.

KEYWORDS: Somalia, Gulf of Aden, IUU, Illegal Fishing, Piracy, Tsunami

HOMELAND SECURITY WITHIN STATE DEPARTMENTS OF AGRICULTURE: COMPONENTS OF AN EFFECTIVE SECURITY PROGRAM

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Co-Advisor: Gail F. Thomas, Graduate School of Business and Public Policy

The food and agriculture sector in the United States is vulnerable to attack. One solution is to ensure that homeland security programs within the state departments of agriculture have the necessary support and resources. However, there is little understanding of the abilities and capabilities of state departments of agriculture related to homeland security initiatives. The challenge is that these programs tend to fall between agriculture and homeland security programs.

This research involved interviewing representatives of 24 state departments of agriculture to identify success factors and barriers related to homeland security programs. Respondents reported multi-state agriculture groups, public-private partnerships, and organizational structure as success factors in building successful homeland security programs. This research found that lack of information sharing, a disconnect between the federal and state government, and inadequate funding created barriers to the implementation of constructive homeland security programs.

To better position the homeland security programs within state departments of agriculture, this research provides several recommendations. Given the diversity of the roles and responsibilities in agriculture agencies, it is not possible to develop a model program for every state. These recommendations identify components of

a model program that agencies could selectively use to enhance the effectiveness of homeland security programs.

KEYWORDS: Agriculture, Homeland Security, Interviews, Agroterrorism, State Departments of Agriculture

WHO'S IN CHARGE? DEFENSE POLICY FORMATION IN JAPAN

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Second Reader: Michael S. Malley, Department of National Security Affairs

Considerable analytic effort has been expended explaining the Japanese government's economic and industrial policy formation processes. These theories, however, have seldom been applied to defense policy. This thesis tests the applicability of these theories, notably the plan-rational and principal-agent models, to the relationship between bureaucrats, the Diet, and the Cabinet during defense policy formation. The interaction between these three groups and the applicability of these two models are analyzed in case studies on Japan's ballistic missile defense program and the relocation of Marine Corps Air Station Futenma. Both these case studies indicate that bureaucrats hold a subordinate position to both the Diet and Cabinet. Consequently, the plan-rational model appears to have little utility when it is applied to defense policy, but a revised principal-agent model may be applicable.

KEYWORDS: Japan, defense policy, plan-rational, principal-agent, ballistic missile defense, Futenma

CAN LOCAL POLICE AND SHERIFF'S DEPARTMENTS PROVIDE A HIGHER DEGREE OF HOMELAND SECURITY COORDINATION AND COLLABORATION THROUGH CONSOLIDATION OF POLICE SERVICES?

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MPA, Notre Dame de Namur University, 2001

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Police consolidation is examined as fitting with the homeland-security mission of integrating and coordinating intelligence information, standardizing policies, procedures, and training, leveraging police resources in combating terrorism, while working to create a uniform response system to major police incidents. Though this thesis has a special focus on San Mateo County, California, the makeup of the San Mateo County system of small jurisdictional policing within specific boundaries is replicated throughout the United States. The claim of this thesis is in order to provide integrated homeland security protection to communities, cities must abandon decentralization for consolidated policing. This thesis will use a comparative case study model and policy options analysis to examine the benefits of police consolidation. The overarching theme is this country continues to face challenging threats against determined terrorist and local police agencies have an obligation to become an integral part of the homeland security mission. To fulfill that obligation, cities must explore abandoning the current fragmented system of policing for a system that promotes coordination of intelligence, uniformity of policy and procedures, standardization of training, comprehensive prevention plans and unified response procedures that address the unique challenges facing police in the twenty-first century.

**FORMAL CRITIQUES AND AFTER ACTION REPORTS FROM CONVENTIONAL
EMERGENCIES: TOOLS FOR HOMELAND SECURITY TRAINING AND EDUCATION**

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Master of Arts in Security Studies—September 2010

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Co-Advisor: Robert Josefek, DoD Contractor

The activities and tasks performed by firefighters when responding to emergencies caused by asymmetric threats to homeland security mirror the activities and tasks that firefighters regularly employ when responding to conventional emergencies. However, the learning opportunities created by conventional incidents are not routinely exploited for the purposes of preparing firefighters to respond to incidents of asymmetric origin. Instead, homeland security training and education is often conducted in a manner that is stand-alone and requires a dedicated budget.

The policy analysis conducted assesses the similarities and differences between mitigation procedures and technical skills used when responding to incidents of similar nature but different origin and whether or not formal critiques and after action reports from conventional incidents can be used to effectively support the long-term sustainment of specialized training and education. Efficiency, process values, and robustness and improbability are the criterion used to conduct a modified cost-benefit analysis. The findings suggest that expanding the scope of formal critiques and after action reports from conventional incidents to include “what if” questions about potential incidents of asymmetric origin does facilitate the long-term sustainment of specialized training and education programs in a manner that capitalizes on adult and organizational learning theory principles.

KEYWORDS: Asymmetric Threats, Formal Critiques, After Action Reports, Adult Learning Theory, Organizational Learning Theory, Surprise Avoidance

WHERE DO I START? DECISION MAKING IN COMPLEX, NOVEL ENVIRONMENTS

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Threats to our country have never been more real, nor had more potential to impact large populations of Americans. From the homeland defense perspective, some ideology-based groups have the ability and intention to attack the United States in ways that we as a nation have never imagined. As our world grows more complex and unpredictable, our first responders need tools to enable them to operate in this space.

This thesis focuses on how decisions are made in complex novel environments. Using Grounded Theory methodology, interviews were conducted with public safety personnel who had past experience managing incidents that matched the study criteria. Aspects of Complexity Theory and Recognition-Primed Decision Making were identified as core components. Based on these findings, a descriptive process model was developed that modifies the existing Recognition-Primed Decision Making model in order to account for novel situations, in addition to those cases where the decision maker has previous experience. The Exploration and Exploitation Decision Making model (Ex2DM) is based on actual practices by both law enforcement and fire-rescue professionals. With an understanding of the unique characteristics of complex environments and how decisions are made under these conditions, public safety personnel will be better prepared to manage complex incidents.

KEYWORDS: Complex, Novel, Incident Management, Decision Making, Recognition-Primed Decision Making, Complexity Theory, Grounded Theory

**OUTSOURCING, MANAGING, SUPERVISING, AND REGULATING PRIVATE
MILITARY COMPANIES (PMCS) IN CONTINGENCY OPERATIONS**

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This thesis examines the utilization of PMCs by government agencies of the United States in contingency operations in Iraq and Afghanistan. The aim of this thesis is to investigate the roles that PMCs play in current contingency operations, and to analyze how PMCs can become more useful instruments in contingency operations if they are properly outsourced, managed, supervised, and regulated. In this regard, this study largely rests on transaction cost economics to explain the logic of outsourcing from governmental agencies' perspectives. Furthermore, principal-agent theory and new institutionalism provide the theoretical basis of using effective oversight mechanisms to exert better control over the activities of PMCs in contingency operations. This thesis recommends the United States, Iraq, and Afghanistan use the Montreux Document as a guide to better regulate PMCs in contingency operations.

KEYWORDS: Private military companies, contingency operations, outsourcing, transaction cost economics, contract management, oversight, principal-agent theory, new institutionalism, inherently governmental functions, the Montreux Document, regulation of private military companies.

**MEASURING DISASTER PREPAREDNESS OF LOCAL
EMERGENCY MEDICAL SERVICES AGENCIES**

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Second Reader: Michael G. Petrie, Department of National Security Affairs

Emergency Medical Services (EMS) plays a key role in disaster response. Yet, determining how much preparedness is enough to achieve an acceptable level of preparedness is challenging. After conducting an extensive literature review, it is evident no nationally accepted method exists to evaluate an EMS system's level of disaster preparedness systematically.

Research was conducted to define the skills and equipment that local emergency medical services agencies (LEMSA) or a similar entity needs to perform strategic disaster response duties and identify performance indicators for measuring preparedness. Using an appreciative inquiry approach, surveys and interviews of EMS personnel from across the nation were conducted. Interview questions focused on the positive aspects of each response with an effort to understand what might be possible in future events. Research subjects had first-hand experience in managing the EMS response during a disaster. Multiple types and sizes of events were studied.

A framework for defining minimum standards for adequate disaster preparedness for LEMSAs is constructed, including core EMS disaster response roles; essential competencies; skills needed to perform the core roles; and tools or equipment used for core roles. Training strategies for developing experience, competencies, and skills are identified, and metrics listed for measuring the level of preparedness.

KEYWORDS: Emergency Medical Services, EMS, Disaster, Disaster Response, Preparedness, Disaster Preparedness, Emergency Preparedness, Local EMS Agency, LEMSA, Measure, Performance Measures, Perfor-

mance Indicators, Metrics, Measuring Preparedness, Preparedness Assessment, Appreciative Inquiry, Skills, Competencies

**AMERICAN RESISTANCE TO ESTABLISHING A
STANDING STABILITY OPERATIONS FORCE**

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The United States is currently involved in stability operations in Afghanistan and Iraq, and will likely continue this involvement in the future. Currently, general-purpose forces, the majority of which are U.S. Army soldiers, conduct these operations. As of this writing, the U.S. Army has resisted establishing a standing, dedicated, stability operations force. Such a force would, at first glance, seem to be a logical progression of American military force structure, based upon current Department of Defense directives and publicly stated policy. This thesis will explore the reasons behind the lack of this force. It will analyze costs and benefits of a stability operations force with regards to military readiness, domestic politics, and international politics. It will also consider the role of organization inertia. Finally, it will recommend a workable framework for such a stability operations force, using the lessons learned from the analysis within this thesis, making the most of the advantages described and mitigating the costs.

KEYWORDS: Stability Operations, Army, General-Purpose Forces, United Nations, Peacekeeping

**ENHANCING FBI TERRORISM AND HOMELAND SECURITY INFORMATION
SHARING WITH STATE, LOCAL AND TRIBAL AGENCIES**

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Second Reader: Edward J. Valla, DoD Contractor

This thesis examines FBI terrorism and homeland security information sharing with state, local and tribal homeland security agencies mandated by presidents Bush and Obama, and the U.S. Congress. The thesis compares this “status quo” with three new proposed approaches that use technology and modify the FBI “routine use” exceptions to the Privacy Act to improve overall FBI information sharing. The thesis rates the following approaches: (1) “status quo,” (2) new homeland security “routine use” exception, (3) Discoverability of Information and (4) XML Segregation of Information. All four options are analyzed using a two-phase analysis to determine their effectiveness and likelihood of successful implementation. The effectiveness is evaluated by judging the information shared, the privacy protected and the security of each approach. The likelihood of successful implementation is evaluated by judging the impact of FBI cultural resistance, fiscal performance, utilization of technology and training requirements. This thesis proposes the implementation of all three proposed approaches to enhance overall FBI terrorism and homeland security information sharing.

KEYWORDS: Information Sharing; Federal Bureau of Investigation, Privacy Act of 1974, “routine use” exceptions; Extensible Markup Language (XML); Law Enforcement National Data Exchange (N-DEx); FBI Culture

**TRANSFORMING EXECUTIVE FIRE OFFICERS—A PARADIGM SHIFT TO MEET
THE INTELLIGENCE NEEDS OF THE 21ST CENTURY FIRE SERVICE**

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Second Reader: Jay Hagen, Seattle Fire Department

Executive Fire Officers (EFOs) routinely face complex strategic challenges, but none are as multifaceted or as intractable as the expansion of the fire service's core mission to embody intelligence functions. Given the emerging public expectation that the fire service be a critical partner in efforts to secure the homeland, it is imperative that EFOs be prepared to lead their respective departments into this uncharted territory.

Most EFOs agree that adjusting strategies is necessary to adapt to emerging threats of terrorism. Moreover, this concept is widely accepted and embraced by the fire service in the context of its traditional core disciplines. Where philosophies diverge is how each envisions the fire service's role related to intelligence sensing, collecting and sharing.

While the threat of terrorism prevails, the fire service is challenged to adapt its practices, policies and strategic objectives if it is to maintain the highest state of operational readiness. Inclusion of firefighters into the information and intelligence-sharing framework will require a systemic transformation by both the fire service and its law enforcement partners. Central to this transformation are national guidance documents on folding counterterrorism strategies into fire departments' policies, procedures and operating guidelines. Incorporating such guidance will enhance the homeland security by making EFOs better "first preventers" and "first responders."

KEYWORDS: Fire service, executive fire officers, intelligence, intelligence partnership, intelligence sharing, fire service role in intelligence, fire service and law enforcement collaboration, fire service transformation, Seattle Fire Department

**SINO–RUSSIAN RELATIONS IN THE TWENTY-FIRST
CENTURY: PROSPECTS AND ISSUES**

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Master of Arts in Security Studies

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This thesis analyzes major aspects of Sino–Russian relations during the first decade of the twenty-first century. It has two main objectives. First, it provides a more detailed understanding of Sino–Russian relations as they pertain to the dynamics affecting the relationship in the Russian Far East (RFE), the formation and evolution of the Shanghai Cooperation Organization (SCO), and Sino-Russian trends and dynamics regarding arms sales. This endeavor is accomplished by a detailed historical analysis of the background and developments over the past decade as they relate to each subject area.

In addition, relevant examples or cases have been provided to amplify the analytical value in each area. This historical analysis will assist with constructing the second, more important objective of this research: To identify the general themes and trends that permeate each aspect of Sino–Russian interactions analyzed in order to decipher the substance of the relationship, and how it is maintained, under the current state of affairs. Identifying these will allow for a more cogent projection of short- and long-term prospects for Sino–Russian relations as they move forward in the twenty-first century.

KEYWORDS: Russia, China, Strategic Partnership, Sino–Russian Relations, Arms Sales, Shanghai Cooperation Organization, Russian Far East, People's Liberation Army, Military-Technical Cooperation.

**RUSSIA'S PROPOSAL FOR A EUROPEAN SECURITY TREATY:
MOTIVES AND IMPLICATIONS**

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Russian President Dmitry Medvedev's proposal for a European Security Treaty (EST) is an ambitious attempt to reshape the current Euro-Atlantic order, and thereby, advance Moscow's security interests. The EST proposed by Moscow would be a legally binding agreement. According to Moscow, it would uphold the principles of international law and achieve equal security for all states in the Euro-Atlantic region. However, the North Atlantic Treaty Organization (NATO) allies generally view this treaty proposal as an attempt to undermine existing Euro-Atlantic security institutions, such as NATO and the Organization for Security and Cooperation in Europe (OSCE). The EST proposal reflects Russian discontent with the current Euro-Atlantic security order. Many Russians hold that NATO has disregarded Russia's security interests since the collapse of the Soviet Union, notably in the Alliance enlargement process. Although the EST proposal has been dismissed by some observers as a Russian ploy to fracture NATO, governments in the Euro-Atlantic region have acknowledged the need to ensure that Russia's legitimate security interests are respected. NATO and Russia may find it to their advantage to pursue long-term cooperation on the basis of shared interests. They may then together deal effectively with the emerging threats of the twenty-first century.

KEYWORDS: European Security Treaty (EST), Euro-Atlantic Region, NATO, OSCE, Euro-Atlantic Security Order, Dmitry Medvedev

DESIGNATING DOMESTIC TERRORIST INDIVIDUALS OR GROUPS

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Terrorism is a crime committed by individuals with a political or social agenda designed to influence a government or its population. The U.S. government, state and local law enforcement agencies have, as a priority, the mission of protecting the homeland from the threats of terrorism-domestic or foreign. However, the U.S. government has not effectively defined what constitutes a domestic terrorist with the same processes and vigor used to identify international terrorists, gang members, or sex offenders. The lack of a workable definition and validation process for identifying a "domestic terrorist" places law enforcement and homeland security agencies in a position of having to balance the need to protect constitutional rights and the need to protect against the nation's security threats. To this end, this thesis will identify the problems associated with a lack of a comprehensive definition, address the safeguards required in a definition to ensure constitutionally protected rights are not impinged, and will offer a working definition and designation process.

KEYWORDS: Watch list, domestic terrorism, validation, designation, domestic terrorism organization, material support, domestic surveillance, SHAC, animal rights, civil liberties

THE IMPACT OF INCENTIVES AND REQUIREMENTS ON GROUP COLLABORATION

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In the aftermath of catastrophic incidents that have stressed emergency response capabilities there is a growing national awareness that risks and threats exist that are complex, wide reaching, and will require a response effort that crosses jurisdictional boundaries. Response to these incidents will require a coordinated regional response effort that did not exist in many areas prior to 9/11. In an effort to build a regional response capability, as well as the collaborative regional infrastructure to support it, DHS has committed grant funding to the emergency response community. Regional collaboration is a condition of receipt of these funds. Because collaboration has been required, it is difficult to know whether cooperation is the result of that requirement or whether it is the result of a cultural norm that values collaboration. It is also unclear whether groups that were created due to federal requirements are meeting to collaborate or meeting to fulfill requirements. The purpose of this thesis is to further the national dialogue about regional collaboration and its dependence on federal grants, as well as gauge the success of groups created due to grant requirements.

KEYWORDS: collaboration, regionalization, Urban Area Security Initiative (UASI), cross-organizational relationships, collaborative advantage, collaborative capacity, Washington State Emergency Management

**A TRUSTED NATIONAL FUSION CENTER NETWORK: ARE
BASELINE CAPABILITIES AND ACCREDITATION NEEDED?**

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Second Reader: Lauren Wollman, DoD Contractor

Much of the current fusion center debate focuses on three areas of concern: the ability of the centers to be a vital link in the national counterterrorism effort while maintaining their state and local autonomy, the lack of consistency in the development and operation of the centers, and the potential for violation of civil liberties. This thesis analyzes the two handbooks most widely adopted by fusion center leadership, explores the disparity among the centers and their continuing challenges, and applies the characteristics of accreditation programs to the issues at hand in an effort to determine whether published baseline capabilities coupled with an accreditation process is the solution to the long-term success of fusion centers.

KEYWORDS: Fusion center, baseline capabilities, fusion center guidelines, accreditation, fusion process, intelligence cycle

SUSTAINABLE CONSTRUCTION IN AFGHANISTAN

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Second Reader: Thomas Bruneau, Department of National Security Affairs

This thesis examines whether current reconstruction methods in Afghanistan are economically efficient and effective with respect to the counterinsurgency mission. My argument is that they are not, due to the absence of culturally correct, indigenous construction materials and techniques.

This research explores the impact of construction as a part of a counterinsurgency mission, drawing on local cultural factors and building techniques in constructing new facilities in Afghanistan. If current methods are not sustainable either culturally or economically, then the reconstruction efforts are likely to fail, incentivize corruption, and weaken the legitimacy of the Afghan government. If, on the other hand, they are sustainable and sensitive to local cultural norms and economic capacity, the likelihood of these projects increasing the quality of life, building positive relationships, and decreasing violence, increases significantly.

If reconstruction fails to increase the ability of the Afghan government to develop the capacity at the local level, the International Security Assistance Force (ISAF) will not have anyone to which it can transfer responsibility for local government services. This would seriously inhibit the ability of ISAF to transition to Afghan control and, given the current political environment in the United States, potentially lead to the failure of the Afghan campaign.

KEYWORDS: Afghanistan, Construction, Contracting, NGOs, Sustainability, Sustainable, Reconstruction, Architecture, Cultural Norms, Indigenous Materials and Techniques, Indigenous, PRT, Provincial Reconstruction Teams, Counterinsurgency, Stability Operations

ARCTIC REGION POLICY: INFORMATION SHARING MODEL OPTIONS

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Continued climate change and minimum ice conditions over the past several years is allowing for increased maritime activity in the Arctic, which may lead to potential homeland security/defense missions. In January 2009, the U.S. government acknowledged the probability of these missions with an updated Arctic Region Policy, which highlighted the need to develop capabilities to protect U.S. air, land and sea borders, military/civilian vessels and aircraft, maritime commerce, critical infrastructure and key resources. Successfully supporting these missions will depend on a coherent understanding of all the activities taking place in the Arctic region. Achieving this level of “situational awareness” will only be possible when all equity partners and stakeholders are sharing relevant information. This thesis examined three popular information-sharing models, Alaska Information Analysis Center, Joint Interagency Coordination Group, and the Alaska Partnership for Infrastructure Protection to determine which would work best for a broad array of Arctic partners and stakeholders. The thesis’ research and analysis shows that none of the models are sufficient or stand-alone; rather a megacommunity is necessary, consisting of all equity partners interfacing with the stakeholders, managed by leaders that will motivate the community to achieve a high degree of awareness for all Arctic activity.

KEYWORDS: Arctic Region Policy, interagency, collaboration, information sharing, megacommunity, Joint Interagency Coordination Group, Alaska Information Sharing and Analysis Center, Alaska Partnership for Infrastructure Protection, fusion center, information sharing strategies

COLLABORATION IN THE SAN FRANCISCO BAY AREA

METROPOLITAN MEDICAL RESPONSE SYSTEM

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Within the San Francisco Bay Area there are four cities that host a Metropolitan Medical Response System

(MMRS) program: San Francisco, San Jose, Oakland and Fremont. The four Bay Area MMRS cities are within fifty miles of each other. The MMRS resources could be used to reinforce each other's planning and response. The 103-city, 10-county Bay Area is under one Urban Area Security Initiative (UASI). Currently though, the MMRS programs in the four cities work independently of each other and of the UASI. How can these agencies collaborate to address mission gaps and overlaps?

This thesis uses a Delphi survey methodology to ascertain institutional perspectives on benefits, processes, enablers and barriers to collaboration in the San Francisco Bay Area. With collaborative effort, gaps and overlaps in San Francisco Bay Area mass casualty preparedness and response can be mitigated. This thesis recommends short term and long term actions to encourage collaboration in the Bay Area, which, in turn, can lead to better patient outcomes in infrequent mass casualty incidents.

KEYWORDS: Collaboration, Metropolitan Medical Response System (MMRS), Urban Area Security Initiative (UASI), San Francisco Bay Area, benefits of collaboration, barriers, enablers, interorganizational collaboration, Fremont Fire Department

HOMELAND SECURITY INTELLIGENCE: TO WHAT END?

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This thesis presents potential solution sets to the question of why homeland security leaders and practitioners use intelligence to improve homeland security decisions. Specific roles and benefits of intelligence are identified, analyzed, and where applicable, extended to domestic security objectives across the homeland security community spectrum. This thesis purports and defends the theory that there are many and varied roles for intelligence for homeland security stakeholders. Six categories of benefits are presented as a frame work for homeland security decision makers, especially those with limited prior knowledge of threat intelligence, to consider as they conceptualize the employment or expectations of intelligence in a homeland security context. The adaptive threat orientation is introduced as a model for acquisition and maintenance of persistent decision advantage in the homeland security threat-scape.

The adaptive threat orientation model relies on a continual, repeatable and consistent process, whereby homeland security leaders can acquire and maintain decision advantage over an adversary in the homeland security decision space. This thesis defines homeland security decision advantage, the elements necessary for its acquisition and maintenance, and ultimately defines and defends the value of intelligence in improving homeland security decisions.

KEYWORDS: adaptive threat orientation, homeland security, homeland security intelligence, intelligence, intelligence theory, decision making, decision science, domestic intelligence, threat awareness, decision advantage, Washington State Air National Guard

FILLING THE GAP BETWEEN NIMS/ICS AND THE LAW ENFORCEMENT

INITIAL RESPONSE IN THE AGE OF THE URBAN JIHAD

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The National Incident Management (NIMS) and Incident Command Systems (ICS) are important tools that can be adapted to establish command and control in coordinating some aspects of the response and recovery phases of many major incidents, including some types of terrorist attacks. These command and control paradigms, however, are heavily reliant on communications technology and other social and organizational preconditions, and may fail to adequately support the initial law enforcement response to some types of incidents, such as the attacks that occurred in Mumbai, India and Lahore, Pakistan. This thesis will suggest that recent developments in tactics employed by terrorists in India, Pakistan and elsewhere demand an urgent re-examination of the urban policing model currently employed in the United States.

The American urban policing model is well suited for response to ordinary domestic criminal activity and, through the use of command and control tools such as NIMS, works adequately for many unusual occurrences. The NIMS-based model alone, however, including the current National Response Scenarios, seems ill suited for response to acts of paramilitary terrorism. American law enforcement may require a supplemental response paradigm that envisions an effective initial response when faced with degraded communications capabilities and uncertain command and control structures.

KEYWORDS: National Incident Management System, Incident Command System (ICS), first responders, North Hollywood, Columbine High School, Lashkar-e-Taiba (LeT), Mumbai, Bombay, Las Vegas

THE ARAB MEDIA: LOCALIZING ITS DEMOCRATIC POTENTIAL
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The role of the media in society is an important consideration for policymakers and analysts when creating and implementing policies. In the Middle East, the Arab media's role in society has emerged as a crucial concern for US policymakers who examine its potential to aid in social and democratic movements. The media provides the means to connect democratic movements to the both the masses and to the regimes in power; it is an important communication channel. The Middle East, despite the increase in the number of media outlets since 1991, has yet to experience a systemic change towards democracy or generate viable social movement organizations. Why has the media not promoted democracy in the Middle East as it has in other parts of the world? By comparing the relevant aspects of social movement theory and democratic media theory with the issues and events being covered by the Arab media, I demonstrate the Arab media does not provide viable support for sustained social movements or democracy. Specifically, I argue that the media has not aided the critical relationship between social movement organizations and democratic development due to the nature of its audience and subsequent focus on regional and pan-Arab issues. This is not to suggest that Arabs are indifferent towards democracy or local issues; rather, pan-Arabism is a significant consideration for the media due to the audience structure of the non-censored media in the Arab world.

KEYWORDS: Middle East, Social Movement Theory, Media, Arab Media, Democracy, Promotion

MAKING SENSE IN THE EDGE OF CHAOS:
A FRAMEWORK FOR EFFECTIVE INITIAL RESPONSE
EFFORTS TO LARGE-SCALE INCIDENTS
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A review of response efforts to 9/11 revealed considerable challenges to resolving an event of this magnitude. To cope with these challenges, the federal government created the National Incident Management System (NIMS), an organizational structure intended to manage resources and channel communication between disparate agencies working together to solve a catastrophic crisis. Yet, first responders who have been on-scene at large-scale events know there is an initial phase of chaos during which the forms, checklists and organizational structure of NIMS offer them little help for making sense of the situation. A large-scale event moves through the four phases of the cynefin framework: chaotic, complex, complicated and simple. First responders must insert themselves into the initial chaos and begin to move it toward complexity. NIMS, then, becomes a valuable tool in the complicated arena to help restore the simple order of pre-event normalcy. This thesis draws from sensemaking theory, human resource management literature, social science, and biological science to create a framework for first responder use during the initial chaos inherent in large-scale incidents. It recommends expanding NIMS to include recognition and discussion of this initial phase. Using a combination of classroom and scenario-based training, it also suggests a template to better educate first responders.

KEYWORDS: Cynefin Framework, Chaos, Complexity, Large-Scale Event Response, Edge Of Chaos, Sense-making, High Reliability Organization, Reliability Oriented Employee Behaviors, NIMS, ICS.

**IDENTIFYING BEST PRACTICES IN THE DISSEMINATION OF INTELLIGENCE
TO FIRST RESPONDERS IN THE FIRE AND EMS SERVICES**

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September 11, 2001 thrust the fire service into the world of intelligence but the evolution of its involvement has been slow and challenging. The evolving role in the intelligence process presents unprecedented challenges. This expanded role has presented an opportunity to contribute to the homeland security prevention and protection mission in addition to their traditionally recognized role in response and recovery.

As fire service participation expands and the macro level sharing of intelligence between the fire service and the intelligence/law enforcement communities becomes more recognized as a matter of course, it will be necessary for fire service agencies also to develop internal mechanisms of disseminating intelligence to field level personnel. If field level personnel do not receive timely, credible, and actionable information, driven by the intelligence process, before, during and after an incident, their lives, as well as the lives of the public they are trying to help, can be jeopardized.

This thesis presents research to answer the question, “how can information and intelligence be better disseminated to local first responders to enhance situational awareness, provide a higher degree of responder safety, and better protect the public?” Structured interviews were conducted to examine existing models being used to disseminate intelligence to first responders who were surveyed to determine what type of intelligence they preferred to receive, and in what format they would prefer to receive it. The findings revealed that first responders want intelligence products in an easily accessible concise format available in real time.

**ABANDONED IDEOLOGY: HOW THE IRANIAN REVOLUTION
FAILED ISLAMIC ECONOMICS AND EMBRACED POPULISM**

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In the three decades since the Islamic revolution overturned the Pahlavi regime and ushered in the Islamic Republic, the world has seen the effects, not of Shi'a Islamic philosophy constituted as government, but more accurately of the personal vision of Ayatollah Khomeini regarding the state. While Khomeini promised the regime to be the embodiment of Islamic social justice, the reality was a failure to deliver a consistent philosophy of Islamic government that could survive after his death. In no area was that more evident than the economy.

The formation of the Islamic government in Iran offered the potential for one of the first modern examples of Islamic economic theory instituted on a national scale. The ideology had been well thought out by some scholars, and was fully in keeping with the espoused ideas of equality and social justice of the revolution. The implementation was never fulfilled, however, due to Khomeini's lack of interest in economic theory writ large, the influence of left-leaning populist elements of the revolution and early Islamic government, and Khomeini's creation of perennially deadlocked institutions of government. As a result, Iran has followed the same path of poor economic development common to most hydrocarbon rentier states.

STRATEGIC POLICY FOR PANDEMIC VACCINE DISTRIBUTION

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Within the San Francisco Bay Area there are four cities that host a Metropolitan Medical The traditional public health model for mass vaccination, which is based on the assumption that workforce will be sufficient to mount a campaign, is flawed. Funding initiatives by Congress, while addressing certain inadequacies, have failed to consider workforce capacity that continued to decline resulting from state and local budget cuts. Thus, as the nation prepared for its first pandemic in 40 years and first of the twenty-first century, it found itself unprepared for a mass vaccination campaign.

This thesis explores pandemic vaccine distribution, contrasting Department of Health and Human Service guidance with pandemic gap analyses and the recent H1N1 vaccination campaign. An analysis of the literature revealed that unresolved state and federal distribution issues contributed to distribution delays during the H1N1 call for mass vaccination.

Policy analysis was used to evaluate public health and private sector vaccine distribution models, and a third hybrid model was proposed to improve support for public health emergencies. Adoption of the hybrid model will enhance the vaccination process from production through distribution along with administration to support U.S. national security interest in biosecurity. The hybrid model offers a strategic solution for pandemic vaccine distribution and proposes a new approach for efficient, rapid distribution of biological countermeasures.

KEYWORDS: Pandemic Policy, Pandemic Vaccination Policy, Pandemic Vaccine Distribution, Vaccine Distribution Policy, Public Health Mass Vaccination Campaigns

**THE IDLE THREAT? AN ASSESSMENT OF THE ECONOMIC,
MILITARY, AND STRATEGIC CONSEQUENCES OF AN
IRANIAN CLOSURE OF THE STRAIT OF HORMUZ**

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The continual developments in the Iranian nuclear program have caused increased concern not only for the United States but the majority of the international community as well. While several rounds of United Nations sanctions have been placed on Iran, this has not deterred it from continuing its nuclear advancements. The United States has publicly announced that it does not support Iran's developing nuclear program and will inflict measures to ensure that it discontinues these advances. While these measures have not been clearly defined, Iran has stated that hostile actions taken by the international community, specifically the United States or Israel may result in the closure of the Strait of Hormuz. While Iran has used this threat in the past, primarily in the Iraq-Iran War its full strength has never come to fruition. This thesis aims to determine whether closing the Strait of Hormuz is a viable option as an Iranian retaliation mechanism against increased sanctions from the international community and the United States or a direct attack from either Israel or the United States by analyzing the economic, strategic, and military consequences for Iran, the United States and the Gulf Cooperation Council States.

KEYWORDS: Strait of Hormuz, U.S., GCC, and Iranian Military, Persian Gulf Oil Economics

STRIKING THE RIGHT BALANCE: FUSION CENTERS AND PRIVACY

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After the events of 9/11, the number of fusion centers rapidly multiplied. As a result, state and local agencies that operated the centers adopted a myriad of policies. This thesis seeks to answer how fusion centers can implement policies as to operational structure and transparency that simultaneously safeguard against abuse of citizens' privacy while facilitating the collection, maintenance, and dissemination of information. Two methods of research are utilized: policy analysis and policy options analysis. This thesis examines existing federal guidelines, federal case law, and various federal statutes and regulations. Moreover, the thesis explores three policy options as possible decision-making tools for fusion centers: 1) mandatory federal guidelines, 2) imposition of a balancing test and administrative review process, and 3) a compulsory reasonable-suspicion requirement. In the end, this thesis recommends imposition of all three policies.

KEYWORDS: Fusion Center Privacy Policies, Mandatory Guidelines, Balancing Test

**THE ENGAGED AND EMPOWERED COMMUNITY: AN
ESSENTIAL INGREDIENT OF HOMELAND SECURITY**

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Countless dollars have been spent on various programs and initiatives over the past decade to enhance homeland security. Although great strides have been made in many areas, one that continues to lag behind is preparedness at the local level. Documents ranging from the National Response Framework to the recently completed Quadrennial Homeland Security Review emphasize the need for both the public and private sectors to embrace the responsibility they have concerning community readiness efforts. The primary focus of this thesis is to determine what factors contribute to successful community preparedness efforts, as well as identifying

those barriers that impede such progress from being realized. To that end, a variety of group structures and approaches currently in use are recognized and discussed. In addition, cases located both within the United States and abroad are identified and examined. Interviews conducted with members of these groups provide a first-hand account of what steps are being made to improve emergency preparedness within their local jurisdictions. This thesis culminates with the offering of the Community Oriented Readiness Effort. This program incorporates those recommendation produced by this research and provides the core components needed to adequately engage and empower required resources at the local level.

KEYWORDS: Public-private partnerships, community emergency preparedness, public sector, private sector, non-governmental organizations, engage, empower, community oriented readiness effort.

**INSTABILITY IN THE HORN OF AFRICA: AN ASSESSMENT
OF THE ETHIOPIA-ERITREAN CONFLICT**

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This thesis analyzes instability in the Horn of Africa focusing specifically to the Ethiopia-Eritrea border conflict fought between the two countries in 1998-2000. It provides a historical background of both countries and how they were influenced by external actors and subsequent federation of Eritrea into Ethiopia in 1950. The study then examines the termination of Eritrean federation which sparked the emergence of secession movements culminating to Eritrea's independence in 1993.

Among the notable findings of the study are that the two countries signed a total of twenty five protocols by September 1993 which included among other things, a joint defense pact and trade agreements but were not implemented. Economic and border incompatibilities served as sources of tension between the two countries. Despite the signing of a Comprehensive Peace Agreement, the African Union and the international community have failed to resolve this conflict and it remains a potential flashpoint in the Horn of Africa.

The recommendations include pursuing a political compromise over the symbolic village of Badme and placing it under the sovereignty of a condominium administered by both states and then addressing other sources of interdependence. Additionally the international community needs to pressurize both countries to fully democratize.

**EMERGING THREAT TO AMERICA: NON-STATE ENTITIES
FIGHTING FOURTH GENERATION WARFARE IN MEXICO**

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The 2007 Merida Initiative provides the framework for the cooperation between America and Mexico, supporting the fight against the Pack Virus in Mexico. The new American-Mexican policy of combating the drug cartels, transnational gangs, and paramilitaries is a first step in creating a real U.S. Northern Command (US-NORTHCOM) theater defense. The USNORTHCOM Mexico strategy is a supporting effort to the U.S. defense strategy, the Mexican strategy to counter the violence, and national policies of the U.S. government. The USNORTHCOM-Mexico strategy emphasizes the U.S. and Mexican military role in collaborating to create a solid institution to be utilized in support of the Mexican government. The partnering of the two militaries creates the conditions for increasing Mexican capabilities in eight functional areas. An emphasis on intelligence

surveillance, reconnaissance (ISR), Mexican Special Forces, and consequence management operations are factors that would contribute to the transformation of the Mexican military into a counter insurgency force. A list of recommendations for policy makers and military leaders is provided to strengthen the gains created by the Merida Initiative. The increase in capabilities and credibility of the Mexican military benefits both the economic and security policies of Mexico and the U.S.

**SECURING THE NORTHERN MARITIME BORDER
THROUGH MARITIME DOMAIN AWARENESS**

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Since September 11, 2001, both the United States and the Canadian governments have established plans and initiatives to improve maritime domain awareness (MDA) in their nations' ports and maritime approaches. Agencies entrusted with maritime homeland security for the United States are challenged to push detection, identification, and surveillance of maritime threats away from the U.S. shoreline. In the Great Lakes region, the proximity of the U.S.–Canada border complicates these efforts. A system-wide approach to homeland security on the Great Lakes is needed. Creation of a formal U.S.–Canada joint organizational entity with full-time representation from each federal agency, state, and province adjoining the Great Lakes would establish a binational MDA common operating picture while facilitating a timely, effective flow of information, intelligence, and resources. This research project describes the unique maritime homeland security issues confronting the Great Lakes, discusses requirements to achieve complete MDA and establish a common operating picture (COP), and reviews several models currently utilized for binational and port-centric collaboration. Finally, it recommends combining the port-centric concept of interagency operations centers required by the SAFE Port Act of 2006 with binational collaboration into a system-wide approach for a Great Lakes Maritime Operations Center.

**BEFORE THE EMERGENCY: A FRAMEWORK FOR EVALUATING EMERGENCY PRE-
PAREDNESS ALTERNATIVES AT HIGHER EDUCATION INSTITUTIONS**

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The U.S. is making decisions about which emergency preparedness activities to pursue and how those most familiar with emergency management at HEIs think these decisions should be made. Using this information, in concert with principles from decision analysis, a conceptual framework was developed for decision makers to evaluate proposed preparedness alternatives using a normative approach. A simplified version of the framework was presented to demonstrate how a proposed preparedness activity could be evaluated using the model and how proposed alternatives could be compared. In addition to presenting an analytical framework for evaluating preparedness options, recommendations were offered for optimizing preparedness and preparedness decision making at HEIs. These recommendations centered on the organizational structure of an emergency management program, including roles and responsibilities; strategic planning efforts specific to emergency management; and innovative practices currently being utilized by the HEIs involved in this study.

KEYWORDS: Higher education, emergency management, campus, decision analysis, Stanford

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