

Naval Postgraduate School
Monterey, California 93943-5138



NPS-09-07-007

Compilation of Thesis Abstracts September 2007



Office of the Associate Provost 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 2007 graduation. Classified and restricted distribution abstracts are listed on the NPS SIPRnet.

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
Code 01B3
Naval Postgraduate School
Monterey, CA 93943-5100
Phone: (831) 656-3093
Fax: (831) 656-3093
The World Wide Web edition of the School's catalog is at:
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For further information about student and faculty research at the school, contact the associate provost and dean of research.

Associate Provost and Dean of Research
Code 09
Naval Postgraduate School
Monterey, CA 93943-5138
Phone: (831) 656-2099
Fax: (831) 656-2038
Email: research@nps.edu

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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:

Provide relevant and unique advanced education and research programs in order to increase the combat effectiveness of U.S. and allied armed forces and enhance the security of the United States.

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:

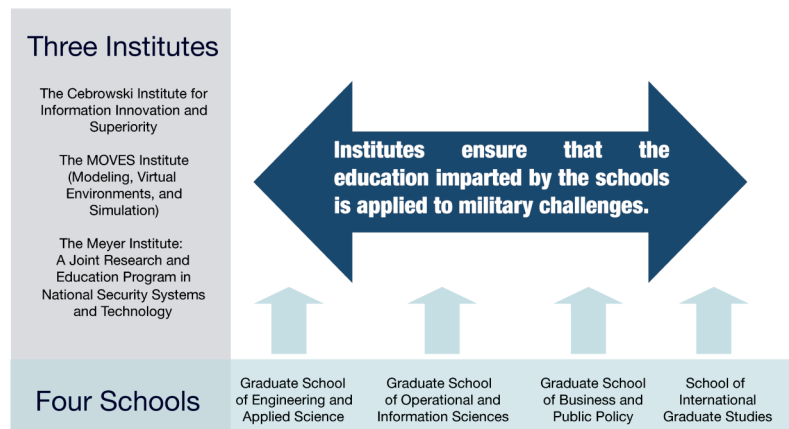
- maintains upper-division course content and programs at cutting edge;
- challenges students with creative problem solving experiences on DoD-relevant issues;
- advances DoN/DoD technology;
- solves warfare problems; and
- attracts and retains quality faculty.

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 Engineering/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

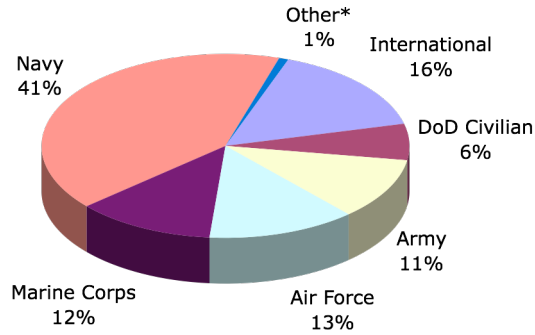
School of International Graduate Studies

- 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 federal government, and military officers and government civilian employees of other countries. The resident degree/subspecialty student population for September 2007 is shown in Figure 1 on the following page.

INTRODUCTION



*Coast Guard, National Oceanographic and Aeronautics Administration

Figure 1: Resident Degrees/Subspecialty Student Population for September 2007 (1714 Concurrently Enrolled)

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 Degrees

National Security Affairs
Security Studies

Master of Business Administration

Master of Science Degrees

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 Degrees

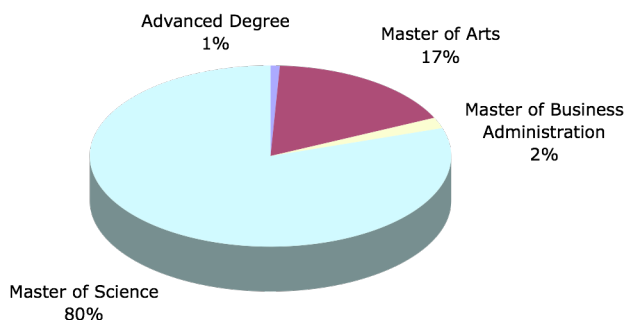
Astronautical Engineer
Electrical Engineer
Mechanical Engineer

Doctor of Philosophy

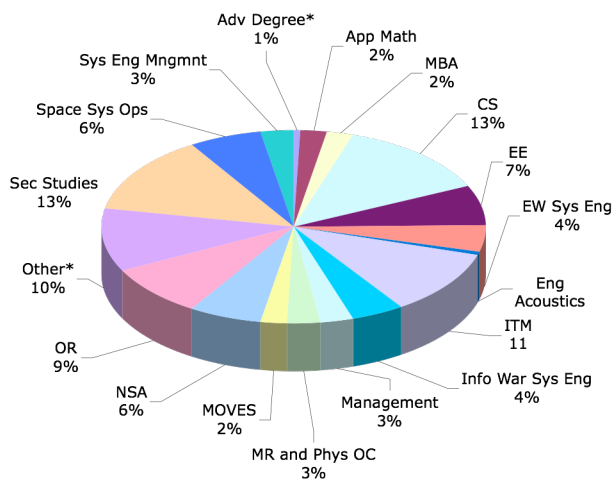
Applied Mathematics
Applied Physics
Astronautical Engineering
Computer Science
Electrical Engineering
Engineering Acoustics
Information Sciences
Mechanical Engineering
Meteorology
Modeling, Virtual Environments, and Simulation
Operations Research
Physical Oceanography
Physics
Security Studies
Software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

INTRODUCTION

In September 2007, 209 degrees were conferred. Figure 2 indicates distribution by type, Figure 3 by degree area.



**Figure 2. Distribution by Degree Type
(209 Degrees Conferred)**



Legend, clockwise: MBA = Business Administration, CS = Computer Science, EE = Electrical Engineering, EW Sys Eng = Electronic Warfare Systems Engineering, ITM = Information Technology Management, Info War Sys Eng = Information Warfare Systems Engineering, , MR and Phys OC = Meteorology and Physical Oceanography, MOVES = Modeling, Virtual Environments, and Simulation, NSA = National Security Affairs, OR = Operations Research, Sec Studies = Security Studies, Space Sys Ops = Space Systems Operations, Sys Eng Mngmnt = Systems Engineering Management

*Advanced degrees, one doctorate each: Electrical Engineering, Information Sciences

**Other master's degree: Applied Physics (2), Defense Analysis (1), Human Systems Integration (2), Information Operations (1), Information Systems Technology (1), Leadership and Human Resource Development (2), Mechanical Engineering (3), Meteorology (3), Oceanography (1), Physical Oceanography (1), Systems Engineering (2), Systems Technology (2)

**Figure 3. Degrees Conferred in September 2007
(209 Degrees Conferred)**

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.

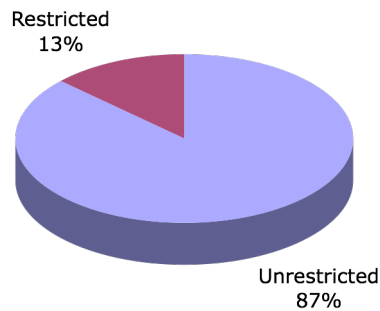


Figure 4. Classification of Theses

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ADVANCED DEGREES

Doctor of Philosophy

DOCTOR OF PHILOSOPHY

EXTENDING ORGANIZATIONAL CONTINGENCY THEORY TO TEAM PERFORMANCE: AN INFORMATION-PROCESSING AND KNOWLEDGE-FLOWS PERSPECTIVE

Tara A. Leweling-Major, United States Air Force

B.A., University of Michigan, 1992

M.S., Troy State University, 2000

M.S., Naval Postgraduate School, 2001

Doctor of Philosophy in Information Sciences-September 2007

Supervisors: Mark E. Nissen, Department of Information Sciences

John Arquilla, Department of Defense Analysis

Contemporary organizational theory posits that teams undertaking complex tasks outperform when lateral, peer-to-peer relationships are emphasized over vertical, subordinate-to-supervisor relationships. Outlining this argument within a structural contingency framework, the author suggests that the intersection of the information processing structures and the contingent influence of knowledge sharing is an under-explored avenue for explaining variance in individual and team performance. A laboratory setting is used to explore this theoretical intersection. The knowledge sharing processes and information processing structures of four multi-person teams are manipulated as they undertake a series of computer-mediated counterterrorism decision-making exercises with high task complexity and reciprocal interdependency. The experimental results are analyzed to explore the relationships between individual team performance and 1) differentiated information processing structures, 2) ability to share knowledge, and 3) interactions between these two manipulations. Each team repeats a variant of the same counterterrorism decision-making exercise four times; two of the four teams switch configurations halfway through the experimental series, allowing the author to explore individual and team performance 1) cross-sectionally, 2) over time (i.e., learning), and 3) across structural reconfigurations. By way of contribution, this work extends structural contingency theory to work groups through the lenses of information processing and knowledge sharing in order to examine their putative effects on individual and team performance cross-sectionally, longitudinally, and when subjected to structural change.

KEYWORDS: Structural Contingency Theory, Team Performance, Information Processing Theory, Knowledge Flows Theory, Counterterrorism, Information Processing Networks

**MASTER
OF
BUSINESS ADMINISTRATION**

MASTER OF BUSINESS ADMINISTRATION

RADIO-FREQUENCY IDENTIFICATION'S POTENTIAL TO MONITOR SMALL VESSELS

John A. Crofts-Lieutenant, National Oceanic and Atmospheric Administration Corps

Master of Business Administration-September 2007

Advisor: Nicholas Dew, Graduate School of Business and Public Policy

Second Reader: Bill Gates, Graduate School of Business and Public Policy

This thesis examines the possibility of applying radio-frequency identification (RFID) technology to monitoring small vessels. The study focuses on the technology's applicability to maritime security, resource management, and the public. The costs and benefits of using RFID on waterways are analyzed, with special attention given to privacy and public acceptance. A completed proof-of-concept study is discussed and preliminary guidelines for creating an RFID-driven, small-vessel monitoring program are provided.

KEYWORDS: RFID, Radio Frequency Identification, Vessel, Monitoring, Homeland Security, Search and Rescue, Human Use Patterns, Fisheries, Privacy, Panopticon Concept, Affordable Loss

POLITICAL AND BUDGETARY OVERSIGHT OF THE UKRAINIAN INTELLIGENCE

COMMUNITY: PROCESSES, PROBLEMS, AND PROSPECTS FOR REFORM

Oleksii I. Petrov-Lieutenant Colonel, Ministry of Defense of Ukraine

Master of Business Administration-September 2007

Advisor: Richard Doyle, Graduate School of Business and Public Policy

Second Reader: Frank Barrett, Graduate School of Business and Public Policy

This thesis addresses the problem of providing policy and budget oversight of Ukrainian intelligence organizations in accordance with norms and practices developed in contemporary western democracies. As Ukraine continues the process of democratic consolidation, the issue of intelligence oversight remains vital to ensuring political accountability and financial efficiency. Oversight of intelligence is also important to the political initiatives Ukraine has undertaken to improve ties to NATO and the EU. Official government documents, news reports and other literature on the intelligence system in Ukraine, and studies of intelligence oversight within democracies are the primary sources of data. This thesis reviews the principles and problems involved in parliamentary and executive oversight of intelligence in western and transitional democracies. The organizations and budgets of Ukrainian intelligence agencies are detailed, as are the legislative and executive systems for providing financial resources to them and for conducting oversight of them. The most important problems identified include the need to separate intelligence functions from security and law-enforcement tasks within Ukrainian intelligence organizations; the need to create an all-source intelligence analysis agency; and the need to establish independent and well-staffed bodies in legislative and executive branches dealing exclusively with intelligence and intelligence budget oversight functions.

KEYWORDS: Intelligence Oversight, Intelligence Budget Oversight, Ukrainian Intelligence Community, Intelligence, Security, Parliamentary Oversight of Intelligence, Executive Oversight of Intelligence, Mechanisms of Intelligence Oversight

MASTER OF BUSINESS ADMINISTRATION

FEASIBILITY STUDY AND BENEFIT ANALYSIS OF APPLICATION VIRTUALIZATION TECHNOLOGY FOR DISTANCE LEARNING EDUCATION AT THE NAVAL POSTGRADUATE SCHOOL

Salma Sallam-DoD Civilian

Master of Business Administration-September 2007

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

Second Reader: Christine M. Cermak, Information Resources and Chief Information Officer

The rapidly changing demands and increasing complexity in software application deployment have necessitated and improved approaches for delivering software application support and updates to nonresident students at the Naval Postgraduate School. The delivery of course material to nonresident students on locked-down computer systems, i.e., NMCI, has become more difficult with the increased security requirements over the past year. Many NPS course offerings require installation and development of various software and programs on student workstations, which is prohibited by policy. Moreover, the process of gaining approval and installation of the course software is often longer than the upgrade cycle of the material, which affects both resident and nonresident students' ability to fully participate and benefit from the learning experience. This problem poses a challenge for the Information Technology and Communication Services (ITACS) department at NPS. To counter this problem, NPS must implement a new system-wide, virtual software-delivery method that would: a) provide easy, clientless, conflict-free application deployment and rollback; b) reduce costs for support and regression testing by delivering fully tested applications to users; c) reduce infrastructure requirements and costs with no client or server components to manage or maintain; and d) improve enterprise security with the power to transparently run applications in user mode on locked-down PCs.

KEYWORDS: Applications Delivery, Virtualization, Virtual Technology, Virtual Machines, Distance Learning, Naval Postgraduate School, NPS

LEADING AIRMEN: A SYSTEMS APPROACH TO SQUADRON LEADERSHIP

Orlando Sanchez, Jr.-Lieutenant Colonel, United States Air Force

Master of Business Administration-September 2007

Advisors: Cary Simon, Graduate School of Business and Public Policy

Alice M. Crawford, Graduate School of Business and Public Policy

The purpose of this MBA project is to investigate systems thinking and apply these principles to Air Force leadership. The paper offers squadron commanders, in particular, a primer in systems thinking that will enable them to approach unit leadership challenges from a systems perspective. The first two chapters examine the origins of systems thinking and present a holistic organizational model as the basis for problem analysis. Chapter II illustrates the importance of correctly interpreting the external environment and dealing with external influencers. Chapter III applies these concepts and introduces a systems approach to financial leadership. Finally, Chapter IV examines the roots of continuous process improvement and offers suggestions for commander implementation of Air Force smart operations for the 21st century. This project is written directly to Air Force squadron commanders. It is the author's hope that these topics will help spur commanders around the Air Force to challenge their mental frameworks towards developing and better enabling airmen leadership to face the challenges of the twenty-first century.

KEYWORDS: Air Force, Leadership, Squadron Command, Systems Theory, Financial Leadership, Air Force Smart Operations for the 21st Century, AFSO 21, Process Improvement

MASTER OF SCIENCE

Applied Mathematics
Applied Physics
Computer Science
Defense Analysis
Electrical Engineering
Electronic Warfare Systems Engineering
Engineering Acoustics
Human Systems Integration
Information Operations
Information Technology Management
Information Warfare
Information Warfare Systems Engineering
Leadership and Human Resource Development
Management
Mechanical Engineering
Meteorology
Meteorology and Physical Oceanography
Modeling, Virtual Environments, and Simulation
Operations Research
Physical Oceanography
Space Systems Operations
Systems Engineering
Systems Engineering Management
Systems Technology

MASTER OF SCIENCE IN APPLIED MATHEMATICS

PERFORMANCE OF HYBRID EULERIAN-LAGRANGIAN, SEMI-IMPLICIT TIME-INTEGRATORS FOR NON-HYDROSTATIC MESOSCALE ATMOSPHERIC MODELING

Thomas J. De Luca-Second Lieutenant, United States Air Force
B.A., Cornell University, 2004

Master of Science in Meteorology-September 2007

Master of Science in Applied Mathematics-September 2007

Advisors: Francis X. Giraldo, Department of Applied Mathematics
CDR Rebecca E. Stone, USN, Department of Oceanography

In this thesis, the performance and accuracy of explicit, semi-implicit, and hybrid Eulerian-Lagrangian semi-implicit (HELSE) time-integration methods used in atmospheric modeling are examined. Four test cases are analyzed: a density current, an inertial gravity wave, a rising thermal bubble, and a hydrostatic mountain wave. Strict attention is paid to computational time, stability criteria, and accuracy. The project aims to show increased efficiency using the HELSE method over fully semi-implicit methods, which, in turn, should be better than the split-explicit methods currently used in mesoscale models such as WRF, COAMPS, and the German LM model. This increase in efficiency allows for valuable computational resources to be used for other purposes, such as improved data assimilation, increased spatial resolution, or more detailed physics.

KEYWORDS: HELSE, Semi-Implicit, Time-Integration, Atmospheric Modeling, NWP

OPTIMAL AIRCRAFT ROUTING IN A CONSTRAINED PATH-DEPENDENT ENVIRONMENT

Norbert J. Karczewski, III-Major, United States Marine Corps
B.S., United States Naval Academy, 1993

Master of Science in Applied Mathematics-September 2007

Master of Science in Operations Research-September 2007

Advisors: Johannes O. Royset, Department of Operations Research
Raluca M. Gera, Department of Applied Mathematics
Second Reader: Craig W. Rasmussen, Department of Applied Mathematics

A method of automatically generating a route of flight for an aircraft (or group of aircraft flying in formation) from an origin to a destination in the presence of threats is presented. The threats encountered at a point of the route are a function of the route used to arrive there. The route is constrained by limits on one or more resources, such as fuel and time, expended over the course of the route. A C++ program is used to implement the method for two scenarios. In the first scenario, optimal routes for a path-dependent radar threat environment are generated. These results are then compared with routes generated for a path-independent radar threat. In a second scenario, a route is generated for a three-dimensional airspace over terrain in the presence of two constraints and multiple threats that vary dependent upon the route taken. The computing time required to generate a route is sufficiently short for use of the method in mission-planning tools. Recommendations for future research and model improvement conclude the thesis.

KEYWORDS: Flight Planning, Routing, Aircraft, Network Models, Shortest Path, Optimization, Radar Threats, Path-Dependence, Lagrangian Relaxation

APPLIED MATHEMATICS

REFINEMENT COMPOSITION USING DOUBLY LABELED TRANSITION GRAPHS

Thor Martinsen-Lieutenant Commander, United States Navy
B.S., Thomas Edison State College, 1996
Master of Science in Computer Science-September 2007
Master of Science in Applied Mathematics-September 2007
Advisors: George W. Dinolt, Department of Computer Science
Harold M. Fredricksen, Department of Applied Mathematics

Process algebra forms a cornerstone in the formal methods area of computer science. Among the more widely used approaches is Milner's Communication and Concurrency Systems (CCS). Recently, CCS has been extended by Schmidt and Bibighaus through the introduction of doubly labeled transition systems. This framework has enhanced the model's ability to capture security and availability properties. In this thesis Bibighaus' work is reformulated, simplified, and extended using a graph theoretic framework. The intent is that this abstract mathematical view will make the results more accessible and stimulate additional research. Existing definitions and theorems are redefined and proved using Labeled and doubly labeled transition graphs (LTG and DLTG). CCS simulation concepts are recast as graph morphisms and the notion of abstraction and refinement are explained through the use of graphs. Bibighaus' work is extended by showing how to carry out non-atomic DLTG refinement, and by developing a form of graph composition involving graph refinements that share a common abstract graph. This type of composition is proven to always be possible with DLTG refinements, and it is demonstrated that the composite graph is both a refinement of the abstract graph, and an abstract graph for the refinements from which it was made.

KEYWORDS: Security, Formal Methods, Refinement, High Assurance

CONTROLLABILITY OF NON-NEWTONIAN FLUIDS UNDER HOMOGENEOUS FLOWS

Lynda M.Z. Wilson-Major, United States Air Force
B.S., California State University-Chico, 1991
M.A., California State University-Sacramento, 1996
Master of Science in Applied Mathematics-September 2007
Advisor: Hong Zhou, Department of Applied Mathematics
Second Reader: Wei Kang, Department of Applied Mathematics

The ability to control a viscoelastic field is an essential concept that defines some important restrictions and potentials of the influenced material. This thesis investigates the controllability of three popular constitutive models under homogeneous extensional and shear flows via the Lie bracket method. The constitutive models are the Phan-Thien-Tanner model, the Johnson-Segalman model, and the Doi model. The effect of extensional flow on these models and the effect of shear flow on the Doi model have not been explored prior to this work. The main contribution of this thesis is to characterize the submanifolds in the state space on which the non-Newtonian flow fields are weakly controllable. This kind of approach based on the control Lie algebra can be applied to a wider variety of complex models.

KEYWORDS: Controllability, Viscoelastic Field, Extensional Flow, Shear Flow, Constitutive Model, Phan-Thien-Tanner Model, Johnson-Segalman Model, Doi Model, Lie Algebra, Lie Bracket, Weakly Controllable

MASTER OF SCIENCE IN APPLIED PHYSICS

MICROELECTROMECHANICAL SYSTEM, POLYMUMPS-BASED MINIATURE MICROPHONE FOR DIRECTIONAL SOUND SENSING

**Timothy J. Shivok-Lieutenant, United States Navy
B.S., Thomas Edison State College, 2000**

Master of Science in Applied Physics-September 2007

Advisors: Gamani Karunasiri, Department of Physics

Jose Sinibaldi, Department of Mechanical and Astronautical Engineering

A miniature directional sound sensor is fabricated using microelectromechanical system (MEMS) technology based on the operational principle of the Ormia ochracea fly's hearing organism. The fly uses coupled bars hinged at the center to achieve directional sound sensing by monitoring the difference in vibration amplitude between them. The MEMS sensor design employed in this thesis is fabricated using the PolyMUMPs process. The sound sensor has two primary vibrational modes (rocking and bending), which are simulated by finite-element analysis and tested by actuating the sensor using both electrostatics and sound. The experimentally observed vibrational frequencies are found to be in good agreement with that of the modeling, but the amplitudes of vibration are found to be relatively small compared to the expected values. The design of optimized sensors with larger amplitude of vibration, hence high sensitivity, is discussed.

KEYWORDS: PolyMUMPs, MEMS, Ormia, Ormia Ochracea, Biomimetic, Directional Microphone, Sensors, Microphone, USW, Fly Hearing, Undersea Warfare

MASTER OF SCIENCE IN COMPUTER SCIENCE

PERSONAL-INFORMATION SEARCH ON MOBILE DEVICES

Mehmet Akbas-Major, Turkish Army

B.S., Turkish Military Academy, 1992

Master of Science in Computer Science-September 2007

Advisors: Gurminder Singh, Department of Computer Science

Thomas Otani, Department of Computer Science

Today's mobile devices, especially mobile phones, are comparable in computing capability and storage to the desktop computers of a few years ago. The volume and diversity of the information kept on mobile devices has continually increased and users have taken advantage of this increase. Since information is being stored on multiple devices, searching for and retrieving desired information has become an important function.

This thesis focuses on search with regard to personal-information management (PIM) on mobile devices. A search system that involves different types of mobile devices is also introduced.

KEYWORDS: Search, PIM, Mobile Device, Information Management

LEARNING ADVERSARY MODELING FROM GAMES

Paul D. Avellino-Captain, United States Marine Corps

B.S., United States Naval Academy, 1998

Master of Science in Computer Science-September 2007

Advisor: Craig H. Martell, Department of Computer Science

Second Reader: Kevin M. Squire, Department of Computer Science

Since ancient times, adversary modeling has been used during wargaming exercises in which military leaders have recreated past battles or simulated future battles in order to educate military professionals. Although the technology today is much different, adversary modeling still serves the same goals: to help military professionals learn tactics from past successes and mistakes. In the computer age, highly accurate models and simulations of the enemy can be created. However, including the effects of motivations, capabilities, and weaknesses of adversaries in current wars is still extremely difficult.

Limit Texas hold'em poker, with many attributes similar to real-world warfare, is an excellent testbed to study and improve adversary modeling. For example, stochastic outcomes that deal with multiple independent agents, deception, and acting amidst uncertainty are some of the aspects of poker that closely resemble important aspects of warfare. These attributes make poker a better choice as a study platform than other traditional games, such as chess, where there is no deception or uncertainty.

The defined rules of poker provide a controlled environment to improve and test adversary-modeling techniques. Perfecting adversary modeling in poker will allow simulators to improve and generate more accurate models for wargames, giving warfighters the advantage in current and future battles.

KEYWORDS: Adversary Modeling, Opponent Modeling, Computer Poker, Artificial Intelligence

COMPUTER SCIENCE

MISUSE-CASE-DRIVEN DEVELOPMENT OF SECURE INFORMATION SHARING FOR COALITION ENVIRONMENTS

Seung Soo Baek-Captain, Republic of Korea Army
B.S., Korea Military Academy, 2002

Master of Science in Computer Science-September 2007

Advisors: J. Bret Michael, Department of Computer Science
Duminda Wijesekera, Department of Computer Science

Sharing information among communities can result in more-informed decisions being made faster. Information sharing involves the flow of unclassified and classified information, and consequently should be carefully engineered to avoid flow-based mistakes, such as creating covert channels inadvertently. This thesis uses misuse cases to identify such misuses of a sharing system. It is shown that an appropriate, distributed, role-based, access-control model imposed upon information brokers can prevent enumerate misuse cases. The North Korean nuclear proliferation is used as a case study to elucidate these claims.

KEYWORDS: Information Sharing, Use Case, Misuse Case, dRBAC, Access Control Policy, Need to Share, North Korea, Nuclear Weapon's Detection

MAJIC: A JAVA APPLICATION FOR CONTROLLING MULTIPLE, HETEROGENEOUS ROBOTIC AGENTS

Gregory P. Ball-Lieutenant, United States Navy
B.S., Ferris State University, 1991

Master of Science in Computer Science-September 2007

Advisors: Craig H. Martell, Department of Computer Science
Kevin M. Squire, Department of Computer Science

Current capability to command and control a team of heterogeneous robotic agents is limited by proprietary command formats and operating systems. A specific challenge in this context is the specification, programming, and testing of software for such a wide variety of mobile robot teams. This work explores the applicability of an application-program interface (API), called the Multi-Agent Java Interface Controller (MAJIC), that supports command, control, and coordination of heterogeneous robot teams. MAJIC encapsulates scripted commands, preprogrammed behaviors, and simultaneous, multi-agent control.

By exploiting the powerful techniques of polymorphism and object-oriented programming, a generic MajicBot class will provide the necessary level of abstraction between the user and proprietary architectures. Using the technique of inheritance, future Naval Postgraduate School students will be able to extend the generic class in order to easily add new robot-specific libraries. Students will also be able to use existing libraries to program and test their own robot behaviors in real-world environments utilizing the MAJIC package.

A final display of the versatility and power of programming behaviors within the MAJIC software architecture is demonstrated by a series of example programs conducted on a team of robots consisting of a Sony Aibo, a Mobile Robots Pioneer, and a K-Team Hemisson.

KEYWORDS: Robotics, Control Architecture, Heterogeneous Control, Abstraction, Object-Oriented Programming, Java, UML

COMPUTER SCIENCE

A MODULAR APPROACH TO TIME-BASED, UNDERWATER, ACOUSTIC-NETWORK-SIMULATION DEVELOPMENT

**Richard Betancourt-Lieutenant, United States Navy
B.S., San Diego State University, 2000**

Master of Science in Computer Science-September 2007

Advisor: Geoffrey Xie, Department of Computer Science

Second Reader: John Gibson, Department of Computer Science

The necessity to project naval combat power throughout the littorals has resulted in an explosion of growth in the development and implementation of wireless underwater networks. Contrary to terrestrial wireless signal, which use electromagnetic (radio) signals as a medium for the transfer of data, an underwater network utilizes acoustic signals to carry data. Also unlike the terrestrial counterpart, the underwater acoustic network operates in a dynamic, ever-changing environment that is susceptible to dramatic shifts in ocean-water columns that are influenced by numerous parameters, e.g., density, temperature, depth, and current. Couple this with the mechanical impediments of electronic equipment operating in a waterborne environment and problems begin to multiply exponentially. This thesis presents a new, standardized application-programming interface for the development of acoustical physics models and network-protocol stacks that can be dynamically loaded into an underwater acoustic-network simulator. The interface will meet the needs of the United States Navy, scientific organizations, and private parties by providing a key building block of a robust, modular-based simulation framework that will allow rapid and cost-saving research and development and testing of underwater networking technologies.

KEYWORDS: Underwater Acoustic Networks, Time-Based Simulation, Delay Tolerant Networks, High Latency Protocols

PROPAGATING A*: SEARCHING STATE GRAPHS IN ORDER TO FIND A VALID INSTRUMENT-APPROACH CONFIGURATION

**Trent L. Bottin-Captain, United States Marine Corps
B.S., The Citadel, 1998**

Master of Science in Computer Science-September 2007

Advisors: Christian J. Darken, Department of Computer Science

CDR Joseph A. Sullivan, USN, Department of Computer Science

The helicopter community has consistently been overlooked in the development of the national airspace system. The unique flight characteristics of these aircraft make them ideally suited for a wide range of missions that are critical to national defense, medical first response, and disaster relief. Full exploitation of these capabilities is limited during inclement weather because the existing airspace plan was developed around fixed-wing aircraft. More specifically, the Federal Aviation Administration lacks the resources to generate terminal-area procedures for aircraft not restricted to prepared landing surfaces.

This thesis focuses on the development of a suitable terminal instrument-approach procedure-generation capability. Artificially intelligent path planning and computer-graphics-based collision detection techniques are used to find valid approach procedures that are compliant with the requirements set forth by the Federal Aviation Administration. A variant of the classic A* graph search algorithm is introduced that propagates state change information to successor nodes. The propagation technique allows the algorithm to search the graph in a single pass even though children nodes often impose a state change on their parent nodes.

KEYWORDS: Terminal Area Procedures, Path Planning, A* Search Algorithm, Helicopter Instrument Approach, Global Positioning Navigation, Collision Detection

COMPUTER SCIENCE

TWIDDLENET: METADATA TAGGING AND DATA DISSEMINATION IN MOBILE-DEVICE NETWORKS

**Christopher T. Clotfelter-Lieutenant, United States Navy
B.S., University of Tennessee at Knoxville, 2000**

Master of Science in Computer Science-September 2007

**Jonathan E. Towle-Captain, United States Marine Corps
B.S., California State University at Humboldt, 1995**

Master of Science in Computer Science-September 2007

Advisors: Gurminder Singh, Department of Computer Science

Arijit Das, Department of Computer Science

Current mobile devices are much more than the limited-modality communication tools or digital assistants they were only a few years ago; instead, they offer a range of content-capture capabilities, including high-resolution photos, videos, and sound recordings. Their communication modalities and processing power have also evolved significantly. Modern mobile devices are very capable platforms, many surpassing their desktop cousins only a few years removed. TwiddleNet is a distributed architecture of personal servers that harnesses the power of these mobile devices, enabling real-time information dissemination and file sharing of multiple data types from commercial, off-the-shelf platforms.

This thesis focuses on two specific issues of the TwiddleNet design: metadata tagging and data dissemination. Through a combination of automatically generated and user-input metadata tag values, TwiddleNet users can locate files across participating devices. Metaphor-appropriate custom tags can be added as needed to insure efficient, rich, and successful file searches. Intelligent data-dissemination algorithms provide context-sensitive governance to the file-transfer scheme. Smart dissemination reconciles device and operational states with the amount of requested data and content to send, enabling providers to meet their most pressing needs, whether that is continuing to generate content or servicing requests.

KEYWORDS: Mobile File Sharing, Distributed Computing, Peer-to-Peer Networking, Tagging, Metadata, Data Dissemination

TECHNIQUES FOR AUTOMATICALLY GENERATING BIOGRAPHICAL SUMMARIES FROM NEWS ARTICLES

Matthew W. Esparza-DoD Civilian

B.S., The Master's College, 2004

Master of Science in Computer Science-September 2007

Advisor: Craig H. Martell, Department of Computer Science

Second Reader: Kevin M. Squire, Department of Computer Science

The work of manually creating a biographical summary from multiple information sources is both time intensive and detail oriented. Automating the task is also nontrivial because of the many natural language processing (NLP) areas that must be used to efficiently extract the relevant facts. Yet no study has been conducted to determine how powerful a biographical-summarization system must be in order to achieve the basic goal of filling slots in a biographical template. Equally important, the simplest approaches to discovering and extracting biographical information from text have not been implemented. Further, no standard evaluations have been developed for summarization in general, but an evaluation methodology for this research is described and performed.

KEYWORDS: Automatic Biography Summarization, Biography Generation, Dossier Creation, Term Frequency, Multi-Document Summarization, Automatic Summarization

COMPUTER SCIENCE

IMPROVING AUTOMATED LEXICAL- AND DISCOURSE ANALYSIS OF ONLINE CHAT DIALOG

Eric N. Forsyth-Major, United States Air Force

B.S., University of Michigan, 1991

M.S., Purdue University, 1993

Master of Science in Computer Science-September 2007

Advisor: Craig H. Martell, Department of Computer Science

Second Reader: Kevin M. Squire, Department of Computer Science

One of the goals of natural-language processing (NLP) systems is to determine the meaning of what is being transmitted. Although much work has been accomplished in traditional written and spoken language domains, little has been performed in the newer computer-mediated communication domain enabled by the Internet, to include text-based chat. This is due in part to the fact that there are no annotated chat corpora available to the broader research community. The purpose of this research is to build a chat corpus, initially tagged with lexical and discourse information. Such a corpus could be used to develop stochastic NLP applications that perform tasks such as conversation-thread topic detection, author profiling, entity identification, and social-network analysis.

During the course of this research, 477,835 chat posts and associated user profiles are preserved in an XML format for future investigation. Ten thousand, five hundred and sixty seven of those posts are privacy masked and a total of 45,068 tokens are part-of-speech tagged. Using the Penn Treebank and annotated chat data, part-of-speech tagging accuracy of 90.8% is achieved. Also, each of the privacy-masked corpus's 10,567 posts is annotated with a chat dialog act. Using a neural network with 23 input features, 83.2% dialog act classification accuracy is achieved.

KEYWORDS: Computer Mediated Communication, Chat, Natural Language Processing, Part-of-Speech Tagging, Discourse, Dialog Act

DISTRIBUTION OF INFORMATION IN AD-HOC NETWORKS

Wijden Ben Hassine-Captain, Tunisia Air Force

B.S., Aviation School Borj El Amri, 1996

Master of Science in Computer Science-September 2007

Advisor: Gurminder Singh, Department of Computer Science

Second Reader: Arijit Das, Department of Computer Science

Ad-hoc networks are distributed, self-organized networks that do not need a fixed infrastructure. Entities in networks of this sort must collaborate to make network services, such as routing, functional. In these environments, many algorithms from wired networks cannot be naively adapted without congesting the network. This work focuses on the study of the information distribution protocol. Indeed, without application, ad-hoc network technologies are useless. Managing services consists of providing a reliable and easy way to develop distributed applications.

This work contributes to this study in two specific ways. First, a mathematical model that deals with the best possible site of information source nodes in a graph of infinite density is provided. Thus, nodes can be laid out where desired. Second, an algorithm that achieves an effective distribution of information among the nodes of the network is provided. This algorithm can then be used to publish the description of a service among the network to make its research easy.

Results provide a settlement for the design of distribution of information in ad-hoc networks. Moreover, the results can be used in other application fields, such as QoS multipath routing.

KEYWORDS: Ad-Hoc Networks, Mobility, Information, Distribution, Information Source, Self-Organized Networks

COMPUTER SCIENCE

VULNERABILITY ANALYSIS OF HD-PHOTO IMAGE-VIEWER APPLICATIONS

Clifford C. Juan-DoD Civilian, Federal Cyber Corps

B.S., University of Missouri-Kansas City, 2005

Master of Science in Computer Science-September 2007

Advisor: J. Bret Michael, Department of Computer Science

Second Reader: Chris S. Eagle, Department of Computer Science

This thesis addresses the security of handling the HD-Photo file format as it pertains to image viewer applications. Whenever an application is updated to accommodate a new file format, it is possible that the application in question can be vulnerable to exploitation. This is a concern, especially if a malformed instance of that file format can make the application deviate from its specified behavior and cause the execution of arbitrary code. This thesis investigates whether some existing applications that render image files are susceptible to compromise by opening a malformed HD Photo image file.

The goal of this thesis is to test the security of various image viewer applications compatible with the HD Photo file format. MiniFuzz, an automated fuzzing tool, is modified to conduct mutation-based smart fuzzing and generation-based fuzzing. The test instrumentation worked correctly, but the test cases did not reveal any security vulnerabilities.

KEYWORDS: Information Assurance, Vulnerability Analysis, File Format Fuzzing, HD Photo Image File Format

REFINEMENT COMPOSITION USING DOUBLY LABELED TRANSITION GRAPHS

Thor Martinsen-Lieutenant Commander, United States Navy

B.S., Thomas Edison State College, 1996

Master of Science in Computer Science-September 2007

Master of Science in Applied Mathematics-September 2007

Advisors: George W. Dinolt, Department of Computer Science

Harold M. Fredricksen, Department of Applied Mathematics

Process algebra forms a cornerstone in the formal methods area of computer science. Among the more widely used approaches is Milner's communication and concurrency Systems (CCS). Recently, CCS has been extended by Schmidt and Bibighaus through the introduction of doubly labeled transition systems. This framework has enhanced the model's ability to capture security and availability properties. In this thesis Bibighaus' work is reformulated, simplified, and extended using a graph theoretic framework. The intent is that this abstract mathematical view will make the results more accessible and stimulate additional research. Existing definitions and theorems are redefined and proved using Labeled and doubly labeled transition graphs (LTG and DLTG). CCS simulation concepts are recast as graph morphisms and the notion of abstraction and refinement are explained through the use of graphs. Bibighaus' work is extended by showing how to carry out non-atomic DLTG refinement, and by developing a form of graph composition involving graph refinements that share a common abstract graph. This type of composition is proven to always be possible with DLTG refinements, and it is demonstrated that the composite graph is both a refinement of the abstract graph, and an abstract graph for the refinements from which it was made.

KEYWORDS: Security, Formal Methods, Refinement, High Assurance

FUSION OF MULTIPLE SENSOR TYPES IN COMPUTER VISION SYSTEMS

Donald R. Mayo, Jr.-Captain, United States Marine Corps

B.S., Oregon State University, 2001

Master of Science in Computer Science-September 2007

Advisors: Mathias Kölsch, Department of Computer Science

Kevin M. Squire, Department of Computer Science

This research provides analysis of several approaches to the fusion of multiple dissimilar sensors to supplement simple color vision detection and recognition. Non-visible sensor systems can enhance computer vision systems. This research investigates using thermal infrared (IR) sensors in combination

with color data for object detection and recognition. Several types of high-level and low-level sensor fusion are analyzed to compare error rates with raw color and raw IR error rates in detection and recognition of vehicles in a scene. Principal components analysis is used to reduce the dimensionality of sensor input data in order to discard nonessential data, while preserving data important to classification. One recognition method showing promise is to exploit the strength of non-visible information (low light, shadows, etc.) to reduce the search space for color data by replacing the V channel in the HSV color sensor data with IR. For detection, one method showing promise is replacement or averaging of the dominant color channel with IR.

KEYWORDS: Sensor Fusion, Principal Components Analysis, PCA, Infrared Imagery, Computer Vision, Dissimilar Sensor Fusion, Object Detection, Object Recognition, High-Level Fusion, Low-Level Fusion, Vehicle Recognition

PREDICTING HOST-LEVEL REACHABILITY VIA STATIC ANALYSIS OF ROUTING PROTOCOL CONFIGURATION

Stephen C. McManus, Jr.- DoD Civilian, Federal Cyber Corps
B.S., Saint Louis University Parks College, 2005
Master of Science in Computer Science-September 2007
Advisor: Geoffrey Xie, Department of Computer Science
Second Reader: J.D. Fulp, Department of Computer Science

Static analysis refers to techniques that extract and check the semantics of a program *entirely* from examining its source code. In this case, router configuration files can be thought of as the source code of a distributed program whose execution determines the host-level reachability of the network. Static analysis brings about new challenges. Unlike a regular computer program, router-configuration commands hide the detailed logic of routing protocols. Completely constructing the logic for static analysis of router configuration files is difficult, even impossible in some cases where the network has a large number of concurrently running routing processes distributed over many routers and variable network delays make the interactions between these processes too complex to understand exactly.

This research takes an initial step in understanding the power of static analysis. A system is built to infer the packet-forwarding table of each router from the router configuration files. The scope of the work is confined to networks where OSPF is used exclusively for routing. The system is able to infer the exact forwarding tables of the Cisco routers for several lab test networks.

KEYWORDS: OSPF, Static Analysis, Packet Forwarding Table, Forwarding Information Base, Router Redistribution, Route Selection

EFFECTS OF DIFFERENT CAMERA MOTIONS ON THE ERROR IN ESTIMATES OF EPIPOLAR GEOMETRY BETWEEN TWO DIMENSIONAL IMAGES IN ORDER TO PROVIDE A FRAMEWORK FOR SOLUTIONS TO VISION-BASED SIMULTANEOUS LOCALIZATION AND MAPPING

Michael Charles McVicker-Captain, United States Marine Corps
B.A., University of Michigan, 1997
Master of Science in Computer Science-September 2007
Advisors: Mathias Kölsch, Department of Computer Science
Kevin M. Squire, Department of Computer Science

This thesis explores the effect camera motion and feature tracking have on the estimations of an epipolar geometry at different stages of a 3D reconstruction and relates the findings to a framework for vision-based simultaneous localization and mapping (SLAM). Although there have been previous attempts to determine the quality of algorithms that calculate a fundamental matrix, both robust and linear, the authors have found no study that explores the relationship between camera motion, or likewise the different types of parallax, and errors in the epipolar geometry between two images as defined by an estimated fundamental matrix. The interest comes from the fact that there are claims to this end made by two prominent textbooks in this area. By using synthetic scenes that are projected with and without noise by camera matrices that define different camera motions between the projections, the authors are able to isolate the three different types of

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parallax that can be experienced between projections: no parallax shift from rotational movement, high parallax shift from translational movement in the camera's xy-plane, and high parallax shift from translational movement along the camera's optical axis (z-plane). An unconstrained movement with components of each of the previous three types is also studied. The different camera motions are equivalent to the different motions a robot would experience when performing SLAM: specifically, rotational, lateral, forward, and unconstrained motions. There are multiple experiments that explore the effect motion has at every stage of a projective-reconstruction algorithm.

KEYWORDS: Parallax Shift, Parallax, Epipolar Geometry, Fundamental Matrix, Camera Motion, 3D Reconstruction, Vision SLAM, Simultaneous Localization and Mapping

LINKING INFORMATION FOR MOBILE USE

**Robert N. Myers-Captain, United States Marine Corps
B.S., St. Peter's College, 1999**

Master of Science in Computer Science-September 2007

**Edwar Zapata-Captain, United States Marine Corps
B.S., University of Illinois at Chicago, 2001**

Master of Science in Computer Science-September 2007

**Advisors: Gurminder Singh, Department of Computer Science
Arijit Das, Department of Computer Science**

Information management (IM) has been an area of research and discussion for several decades. Studies have been conducted by behavioral and computer scientists on how people organize their information and workspaces in order to come up with efficient ways to store, organize, and retrieve information on personal computers. This thesis explores improving a user's ability to manage information on mobile devices. The goal is to make placing information on such devices a more attractive prospect, with an emphasis on retrieval of stored information regardless of the document type. This will result in mobile users having quick access to the right information at the right time while away from the office or home. This thesis describes the challenges inherent in a mobile scenario and the system designed to address those challenges. The system provides visual and navigational features that are not currently available on mobile devices, specifically, the ability to view multiple types of items in a single interface. Additionally, the ability to logically link related items as an IM tool is examined.

KEYWORDS: Mobility, Personal Information Management, User Interface, Interactive Information Retrieval, Groups, Linking

JOINT MOBILE-NETWORK OPERATIONS: ROUTING DESIGN AND QUALITY-OF-SERVICE CONFIGURATION

**David K. Norton-Captain, United States Marine Corps
B.S., Oregon State University, 1998**

Master of Science in Computer Science-September 2007

**Advisor: Geoffrey Xie, Department of Computer Science
Second Reader: John Gibson, Department of Computer Science**

Current inter-service military networking is inefficient and lacks the desired level of joint interoperability. Generally, the different service branches build stove-piped networks that do not allow sharing of resources with the other branches. This approach is taken because the individual networks do not see the benefits of interconnectivity as worth the effort required to build secure, stable, and operationally effective network solutions.

The Joint Mobile Network Operations (JMNO) project seeks standard solutions to the networking challenges of tactical military units. Through the publication of these standards, the intent is to reduce the complexity of finding networking solutions. This, in turn, reduces the perceived cost of inter-service networking, making it more attractive to military units.

This thesis provides some specific solutions that can be included in the JMNO standards. Network routing is examined and recommendations for protocol selection and configuration are provided. The

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authors also recommend implementing certain quality-of-service (QoS) controls to make more efficient use of available bandwidth, to provide preferred handling of critical, time-sensitive traffic, and to provide individual networks a means of protecting their links from misuse by mobile units.

KEYWORDS: Network, Routing, Mobile, Border Gateway Protocol, BGP, Dynamic Host Configuration Protocol, DHCP, Quality of Service, QoS, Differentiated Services, DiffServ

EXPERIMENTATION AND EVALUATION OF IPV6 SECURE NEIGHBOR-DISCOVERY PROTOCOL

**Marcin Pohl-DoD Civilian, Federal Cyber Corp
B.S., North Central College, 2000**

Master of Science in Computer Science-September 2007

Advisor: Geoffrey Xie, Department of Computer Science

Second Reader: J.D. Fulp, Department of Computer Science

The Department of Defense is expected to transition to IPv6 networking within the next few years. The IPv6 Neighbor-Discovery Protocol is responsible for autoconfiguration and neighbor-address resolution, which establishes hosts on the network and allows communication between hosts. IPsec, the default security mechanism for IPv6, does not allow for automatic protection of the autoconfiguration process. Thus, the Secure Neighbor Discovery Protocol (SeND) was created. SeND uses cryptographically generated addresses (CGA) and asymmetric cryptography as a first line of defense against attacks on integrity and identity. It claims to achieve mutual authentication of hosts and routers without the need for a certification authority (CA). This thesis evaluates this claim by building a testbed of SeND-enabled hosts. The major findings include: i) that SeND does not really offer mutual authentication without a CA; and ii) using computationally intensive cryptography as the first line of defense allows CPU exhaustion attacks.

KEYWORDS: IPv6, Secure Neighbor Discovery Protocol, Cryptographically Generated Addresses, Hardware Address Resolution, Router Discovery, Neighbor Discovery

A PROTOTYPE OF MULTILEVEL DATA INTEGRATION IN THE MONTEREY SECURITY ARCHITECTURE TESTBED

**Andrew D. Portner-DoD Civilian, Federal Cyber Corps
B.S., Catholic University of America, 2005**

Master of Science in Computer Science-September 2007

Advisors: Cynthia E. Irvine, Department of Computer Science

Thuy D. Nguyen, Department of Computer Science

Much of the information managed by government agencies is stored in databases. Mission-assurance objectives often require the synthesis of data from separate databases. Data integration is used to address this need for combining sets of data. However, because many government organizations store data in databases with different syntactic characteristics and at different classification levels, they will necessarily want to combine data from these divergent data sources. This requires a secure system to ensure that sensitive information is not disclosed to unauthorized parties.

The Monterey Security Architecture (MYSEA) is an experimental and extensible distributed Multilevel Secure (MLS) computing. This project set out to determine if a data-integration application could be supported by the MYSEA environment. Through research on MLS database architectures, existing data-integration technologies, and previous work to implement applications on MYSEA, this project both defined a high-level design for data fusion support in MYSEA and developed a proof-of-concept application to demonstrate that support.

KEYWORDS: Multilevel Security, MLS, Information Assurance, IA, Monterey Security Architecture, MYSEA, Data Integration

COMPUTER SCIENCE

AUTOMATED ALERTING FOR BLACK-HOLE ROUTING

Vinay Puri-Squadron Leader, Indian Air Force

B.E., Manipal Institute of Technology-Manipal, 1993

Master of Science in Information Warfare-September 2007

Master of Science in Computer Science-September 2007

Advisors: Geoffrey Xie, Department of Computer Science

J.D. Fulp, Department of Computer Science

Distributed denial-of-service (DDoS) attacks are the most common and easy-to-launch attacks against a computer or network. Once a DDoS attack is recognized, there are several methods available to mitigate its impact. One of the methods is to drop the attacker's traffic at the edge of the network via null routing—also called black-hole routing (BHR). BHR is more efficient than the creation and processing of access-control lists. Prior work has validated the effectiveness of BHR in mitigating DDoS attacks in a setting where the defense is activated manually. This research builds upon that work and develops a proof-of-concept, automated, BHR process that is integrated with Snort, an open-source, intrusion-detection system (IDS), to facilitate a faster reaction to a DDoS attack. A real test bed consisting of Cisco routers is created to evaluate the performance of the developed system. Results demonstrate that the automation of BHR is both possible and desirable in mitigating DDoS attacks.

KEYWORDS: Automated Alerting for Black Hole Routing, Black Hole Routing, Intrusion Detection System, IDS, Automation of Black Hole Routing, DDoS Attacks, Network Security, ISP Network Security, Snort, Null Routing, Customer Triggered Black Hole Routing, Mitigating DDoS Attacks, BGP, iBGP

AUTONOMOUS COORDINATION AND ONLINE MOTION MODELING FOR MOBILE ROBOTS

Eric J. Sjoberg-Captain, United States Marine Corps

B.S., Iowa State University, 2001

Master of Science in Computer Science-September 2007

Advisors: Kevin M. Squire, Department of Computer Science

Craig H. Martell, Department of Computer Science

Robots are rapidly becoming more involved in everyday military operations. As robots become more capable, their tasks will increase to include such roles as exploring enemy controlled buildings and caves. The goal of this thesis is to explore methodologies that allow robots to operate more autonomously. The first goal is to develop an algorithm that allows groups of robots to construct controlled formations with only local information. Experiments investigate the ability of this algorithm to handle obstacles, dynamic conditions, and varying number of robots. The second goal of this work is to demonstrate a method by which a robot can automatically determine how it is moving. Experiments demonstrate the ability of the algorithm to learn new models given models from other surfaces and robots. This work facilitates further research into creating complex formations using only local information and in fully automating current Simultaneous Localization and Mapping (SLAM) applications.

KEYWORDS: Simultaneous Localization and Mapping, Motion Model, Coordination, Online Parameter Estimation, Sony AIBO

COMPUTER SCIENCE

AN ANALYSIS OF IEEE 802.16 AND WIMAX MULTICAST DELIVERY

Patrick A. Staub-Lieutenant, United States Navy

B.S., Indiana University of Pennsylvania, 1994

B.A., York College of Pennsylvania, 1997

Master of Science in Computer Science-September 2007

Advisor: Bert Lundy, Department of Computer Science

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

Broadband and wireless have enjoyed a massive mass-market adoption in the past twenty years. Users want to be able to enjoy all applications, including multimedia, voice, and data, while still being able to access them in mobile and fixed environments. Multicasting is a tool used in networking that allows for transmitting information to a select group of users and is especially useful for time-sensitive data, which can be very large in terms of bandwidth. Current technologies, including WiFi, have difficulty handling such applications because they were not designed to handle multi-service flows concurrently. IEEE 802.16 and its emerging WiMAX technology will enable that sort of uncompromised data transmission in a wireless environment. WiMAX was designed primarily for that reason: to deliver different types of data simultaneously in fixed and mobile environments at broadband levels and ranges only dreamed of. The analysis described in this thesis focuses on the design of WiMAX, specifically the MAC layer, and describes how its features are better suited for multicasting than WiFi. This research also includes an evaluation of potential applications and services of WiMAX in the telecommunications industry.

KEYWORDS: Broadband, Wireless, Multicast, WiFi, IEEE 802.16, WiMAX

MASTER OF SCIENCE IN DEFENSE ANALYSIS

PROVINCIAL RECONSTRUCTION TEAMS: IMPROVING EFFECTIVENESS

Cameron S. Sellers-Major, United States Army Reserve

B.A., Wheaton College, 1990

Master of Science in Defense Analysis-September 2007

Master of Arts in National Security Affairs (Stabilization and Reconstruction)-September 2007

Advisors: Karen Guttieri, Cebrowski Institute

Anna Simons, Department of Defense Analysis

Provincial reconstruction teams (PRT) are currently prominent constructs for stabilization and reconstruction in Afghanistan and Iraq. PRTs are composed of civil–military teams, including elements from coalition partners and the host-nation, and involve multiple military services and civilian agencies. Their missions are to extend the legitimacy of the central government throughout the country and to use civil military operations to counter anti-government forces. PRTs are prominent, but controversial. Nongovernmental organizations (NGO) complain that the U.S. military blurs the lines between humanitarian assistance and military operations. Other critics have called PRTs interagency failures because the U.S. Department of State, the Department of Defense, and other government agencies have not contributed the personnel, resources, or training required to make PRTs operationally functional. The result is a lack of both integration and effectiveness. The purpose of this thesis is to determine how to make PRTs more effective in the future. While host-nation participation is necessary for success, this thesis focuses only on the controversies involving NGOs and interagency communities. These include humanitarian space, general attributes, and the effectiveness of PRTs. The policy prescription for future PRTs is found in the concept of a Civil Military Operations Center (CMOC), which is described in the U.S. Army’s *FM 3-05.40, Civil Affairs Operations*. The core tasks of a CMOC, especially those of civil information management, are designed to accomplish a variety of missions relating to post-conflict reconstruction. They would serve well as foundational components of a PRT. Also, because of the interagency nature of PRTs, commanders of these teams must have the right character and skill sets to operate in this complex environment.

KEYWORDS: Provincial Reconstruction Teams, Army Civil Affairs, Civil Military Operations Center, Civil Military Operations, Civil Affairs Operations, Measures of Effectiveness, Nongovernmental Organizations, International Organizations, Interagency, Iraq, Afghanistan, Operation Enduring Freedom, Operation Iraqi Freedom, North Atlantic Treaty Organization, International Security Assistance Force, Civil Information Management, Military Selection Process, Boundary Spanner, Bureaucracy

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

WAVELET-BASED SIGNAL PROCESSING OF ELECTROMAGNETIC-PULSE-GENERATED WAVEFORMS

**Richard S. Ardolino-Lieutenant Commander, United States Navy Reserve
B.S.E., United States Naval Academy, 1997**

Master of Science in Electrical Engineering-September 2007

Advisor: Murali Tummala, Department of Electrical and Computer Engineering

Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

This thesis investigates and compares alternative signal-processing techniques that use wavelet-based methods instead of traditional frequency-domain methods for processing measured electromagnetic-pulse (EMP) waveforms. The primary focus of the research is equalization and filtering techniques for processing EMP signals in additive white noise. Signal equalization is conducted at the sub-band level through the use of infinite impulse response (IIR) filters and channel response characteristics. A brief investigation of signal de-noising through wavelet thresholding is also conducted. This thesis also addresses and provides viable methods for signal extraction and DC bias removal for a given measured EMP waveform. The mean squared error is used as the basis for the comparison of the effectiveness of the equalization algorithm. It is found that wavelet techniques provide results that are as good or better than traditional Fourier techniques. In systems with additive noise, wavelet-based techniques exceed the performance of the Fourier-based methods and surpass them when de-noising techniques are used.

KEYWORDS: Electromagnetic Pulse Waveforms, Wavelets, Aircraft Testing, Equalization, Wideband Signal Processing

AUTONOMOUS, NONLINEAR CLASSIFICATION OF LOW-PROBABILITY-OF-INTERCEPT RADAR-SIGNAL MODULATIONS

**Taylan O. Gulum-Lieutenant Junior Grade, Turkish Navy
B.S., Turkish Naval Academy, 2001**

Master of Science in Electronic Warfare Systems Engineering-September 2007

Master of Science in Electrical Engineering-September 2007

Advisors: Phillip E. Pace, Department of Electrical and Computer Engineering

Roberto Cristi, Department of Electrical and Computer Engineering

In this thesis, an autonomous feature-extraction algorithm for classification of low-probability-of-intercept (LPI) radar modulations is investigated. A software-engineering architecture that allows a full investigation of various preprocessing algorithms and classification techniques is applied to a database of important LPI radar waveform modulations, including frequency-modulation continuous waveform (FMCW), phase-shift keying (PSK), frequency-shift keying (FSK), and combined PSK and FSK. The architecture uses time-frequency detection techniques to identify the parameters of the modulation. These include the Wigner-Ville distribution, the Choi-Williams distribution, and quadrature mirror filtering. The autonomous time-frequency, image-cropping algorithm is followed by a feature-extraction algorithm based on principal components analysis. Classification networks include the multilayer perceptron, the radial-basis function, and the probabilistic neural networks. Lastly, using image-processing techniques on images obtained by the Wigner-Ville distribution and the Choi-Williams distribution, two autonomous extraction algorithms are investigated to derive the significant modulation parameters of polyphase-coded LPI radar waveform modulations.

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KEYWORDS: Autonomous Classification, Low Probability of Intercept, LPI, Principal Component Analysis, PCA, Time-Frequency, Multi Layer Perceptron, Radial Basis Function, Parameter Extraction, Radon Transform, 2-D FFT

TEMPERATURE STABILIZATION FOR NEGATIVE-BIAS TEMPERATURE INSTABILITY

Brian K. Harbison-Lieutenant Commander, United States Navy

B.S., United States Naval Academy, 1995

Master of Science in Electrical Engineering-September 2007

Advisors: Todd R. Weatherford, Department of Electrical and Computer Engineering

Andrew A. Parker, Department of Electrical and Computer Engineering

Second Reader: Sherif Michael, Department of Electrical and Computer Engineering

Previous research was conducted on a complementary metal-oxide semiconductor to determine the impact of a phenomenon known as negative-bias temperature instability (NBTI). NBTI affects the operational characteristics of these devices, with a stronger effect on p-channel devices. This instability is apparent when the semiconductor is “on” biased, and exacerbated under thermal stress. This data is useful in determining the projected failure rate of certain submicron technologies. The previous experiment used on-the-fly techniques at certain temperatures to measure the interface states in order to determine the susceptibility of the device under test to NBTI. In the previous research, thermal stress application was not exact. Temperature drift was observed over long-range test evaluations, and subsequent NBTI data was determined to be unsatisfactory. Temperature stabilization is necessary in order to maintain thermal stress at a constant value during NBTI testing. This paper explains the methods explored and adapted to stabilize temperature.

KEYWORDS: NBTI, On-the-Fly, Military Electronics, Stability, Control Feedback, Temperature Stabilization, IBASIC

SIGNAL DETECTION AND FRAME SYNCHRONIZATION OF MULTIPLE WIRELESS-NETWORKING WAVEFORMS

Keith C. Howland-Lieutenant Commander, United States Navy

B.A., Cornell University, 1992

Master of Science in Electrical Engineering-September 2007

Advisors: Murali Tummala, Department of Electrical and Computer Engineering

John C. McEachen, Department of Electrical and Computer Engineering

This thesis investigates the detection, classification, frame synchronization, and demodulation of wireless networking waveforms by a digital receiver. The approach is to develop detection thresholds for wireless networking signals based upon the probability density functions of the signal present or signal absent scenarios. A Neyman-Pearson test is applied to determine decision thresholds and the associated probabilities of detection. With a chosen threshold, MATLAB simulations are run utilizing models developed to generate and receive IEEE 802.11a, IEEE 802.16, and IEEE 802.11b signals in multipath channels characterized by Rayleigh fading. Algorithms are developed for frame synchronization for each of the three waveforms. The probability of signal detection, successful frame synchronization, and the bit error rates of the received packet header and data are calculated. The results show that, even in Rayleigh fading environments at low signal-to-noise levels, these three waveforms can be distinguished in a digital receiver. Further, the results show that significant signal information can be gathered on these wireless networking waveforms, even when the entire signal cannot be demodulated due to low signal-to-noise ratios.

KEYWORDS: Signal Detection, Frame Synchronization, Orthogonal Frequency Division Multiplexing, OFDM, IEEE 802.11a, IEEE 802.16

ELECTRICAL ENGINEERING

DETECTION AND LOCATION OF GLOBAL SYSTEM FOR MOBILE-COMMUNICATIONS SIGNALS USING SOFTWARE-DEFINED RADIO

**Ian P. Larsen-Lieutenant, United States Navy
B.S., United States Naval Academy, 2001**

Master of Science in Electrical Engineering-September 2007

Advisor: Frank E. Kragh, Department of Electrical and Computer Engineering

Second Reader: Ralph C. Robertson, Department of Electrical and Computer Engineering

This thesis presents an approach for generating, detecting, and decoding a global system for mobile communications (GSM) signal using software-defined radio and commodity computer hardware. Using software designed by the GNU free-software project as a base, standard GSM packets are transmitted and received over the air and their arrival times are detected. A method is provided to use software analysis of multiple receivers to locate an emitter based on the information received by the software radio. Results and accuracy, as well as limitations, are shown based on initial testing. Complete implementation source code is provided in the appendices.

KEYWORDS: Software Defined Radio, GSM, Geo-Location, Gaussian Minimum Shift Keying, FM Demodulation, Mobile Communication

AUTOMATIC WEB-BASED CALIBRATION OF NETWORK-CAPABLE SHIPBOARD SENSORS

**Charles K. Le-Lieutenant, United States Navy
B.S., University of Texas at Austin, 1998**

Master of Science in Electrical Engineering-September 2007

Advisor: Xiaoping Yun, Department of Electrical and Computer Engineering

Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

This thesis investigates the feasibility of developing an automatic, web-based, sensor-calibration system with four main objectives: to reduce the number of personnel required to calibrate shipboard sensors, to reduce the time required to complete the calibration process, to develop a platform-independent and user-friendly interface using the web browser, and to allow operators to calibrate the sensors remotely from thousands of miles away. This is achieved by using commercial, off-the-shelf products, developing in-house hardware, setting up a web server, and developing numerous software programs in Labview and Java languages to allow operators to remotely monitor and control the calibration process. All communication and control algorithms are handled by two computers. One serves as a web server, equipped with Java codes and web pages to interface with an operator. The other serves as a data collector. It collects data from all sensors via the network, and passes these data to the web server computer and then to the operator's web browser. It also runs a calibration algorithm on a selected sensor as requested by the user. The two computers communicate with one another via the ship's LAN using UDP packets.

KEYWORDS: Network-Based Calibration, Wireless LAN, UDP, Labview, Smart Sensors, Pressure Sensors, Tomcat Web Server, Java, Applet, Servlet

HIGH-SPEED, NUMERIC-FUNCTION GENERATOR USING PIECEWISE QUADRATIC APPROXIMATIONS

**Njuguna Macaria-Lieutenant, United States Navy
B.S., University of Colorado, 1998**

Master of Science in Electrical Engineering-September 2007

Advisor: Jon T. Butler, Department of Electrical and Computer Engineering

**Second Readers: Herschel H. Loomis, Department of Electrical and Computer Engineering
Christopher L. Frenzen, Department of Applied Mathematics**

The CORDIC algorithm is an accurate way to compute the value of a function like $\sin(x)$, for a given value of x . However, it is iterative and slow. In this thesis, it is shown that a wide class of arithmetic functions can be realized on the SRC-6, a reconfigurable computer, using polynomial approximations. The function

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is realized by partitioning its domain into segments and then approximating the function in each segment by a quadratic polynomial. This is not an iterative approach, and so it is faster than the CORDIC algorithm.

Two approximation methods are implemented. In one method, non-uniform segments are used. Here, larger segments can be used where the function is close to quadratic, while highly non-quadratic regions require smaller segments. This approach minimizes the number of segments. In the other method, uniform segments are used. Although more segments are needed than in the non-uniform method, the circuit is simpler.

It is shown that accuracies of up to 33 bits are possible. A pipelined circuit is built on the SRC-6 in two's complement and floating point. An efficient algorithm for segmenting the function, which is faster than previous methods, is also shown.

KEYWORDS: Numerical Function Generator, Piecewise Quadratic Approximation, Field Programmable Gate Array, FPGA, Reconfigurable Computer, VHSIC Hardware Description Language, Computer Arithmetic

VOICE-OVER-INTERNET-PROTOCOL TESTBED DESIGN FOR NON-INTRUSIVE, OBJECTIVE, VOICE-QUALITY ASSESSMENT

David L. Manka-Captain, United States Marine Corps

B.S., United States Naval Academy, 1998

Master of Science in Electrical Engineering-September 2007

Advisors: Murali Tummala, Department of Electrical and Computer Engineering

John C. McEachen, Department of Electrical and Computer Engineering

Voice over Internet Protocol (VoIP) is an emerging technology with the potential to assist the United States Marine Corps in solving communication challenges stemming from modern operational concepts. This thesis conducts a review of VoIP standards and develops an H.323-based testbed for the study of tactical wireless VoIP performance. Methods of collecting and presenting voice quality parameters in packet-based networks are explored. Incorporation of an Adtech SX/14 Data Channel Simulator provides user control of a SONET-simulated wireless channel. Experiments quantify the effect of channel injected error rate on received voice traffic. Plots are generated to illustrate the relationship between channel error rate, packet loss, and the listening quality mean opinion score. Experimental results are extended by incorporating E-model delay considerations. Commercial voice recognition software is successfully used to measure the impact of the channel on speech intelligibility. The experiments and analysis conducted provide a cost effective approach to non-intrusive, objective voice quality assessment.

KEYWORDS: Voice over Internet Protocol, VoIP, Voice Quality, MOS, E-Model, Wireless Communications

NEW PULSE SHAPES FOR ENHANCED SPECTRAL EFFICIENCY IN DIGITAL RADIO COMMUNICATIONS

Chee Wei Nga-Civilian, Republic of Singapore Defence Science and Technology Agency

B.E., Nanyang Technological University of Singapore, 1998

M.S., National University of Singapore, 2002

Master of Science in Electrical Engineering-September 2007

Advisor: Frank E. Kragh, Department of Electrical and Computer Engineering

Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

Linear modulation schemes, such as phase-shift keying and quadrature-amplitude modulation, are inherently spectrally efficient. This research seeks enhanced spectral efficiency by designing new spectrally efficient pulse shapes for such digital modulations. The pulses designed are of finite duration and exhibit zero intersymbol interference when received through an additive white Gaussian noise (AWGN) channel. It is shown that the resulting communications signals have optimal spectral roll-off while maintaining optimum bit error ratio performance when received via an AWGN channel. The bandwidths and power spectral densities of communications signals using these pulses are compared with traditional spectrally efficient communications signals.

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KEYWORDS: Nyquist Pulse, Spectral Efficiency, Intersymbol Interference, Additive White Gaussian Noise, AWGN

MODELING OF OPERATING-TEMPERATURE PERFORMANCE OF TRIPLE-JUNCTION SOLAR CELLS USING SILVACO'S ATLAS

**Michael H. Sanders-Lieutenant Commander, United States Navy
B.S., Carnegie Mellon University, 1996**

Master of Science in Electrical Engineering-September 2007

Advisor: Sherif Michael, Department of Electrical and Computer Engineering

Second Reader: Todd R. Weatherford, Department of Electrical and Computer Engineering

The inefficiency of solar cells due to high operating temperatures presents a growing issue for the spacecraft industry. Currently, the problem is solved by accepting the manufactured designs and compensating for losses with larger solar arrays. Building upon prior thesis work at the Naval Postgraduate School, this thesis utilizes Silvaco ATLAS software as a tool to simulate the performance of a typical InGaP/GaAs/Ge multi-junction solar cell at various temperatures. Additional optimization is performed on the base-thickness layers to represent that enhancement for the proper operating environment can be achieved. Results are shown for a multi-junction cell operating under Air Mass 0 at 300K, 325K, 350K, and 375K.

KEYWORDS: Silvaco, Atlas, Multi-Junction Solar Cell, Temperature, Photovoltaic, Simulation

SOFTWARE-DEFINED RADIO DESIGN FOR SYNCHRONIZATION OF 802.11A RECEIVER

**Juan Luis Sanfuentes-Lieutenant Commander, Chilean Navy
B.E.E., Naval Engineering School, 1997**

Master of Science in Electrical Engineering-September 2007

Advisor: Frank E. Kragh, Department of Electrical and Computer Engineering

Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

Constant improvements in techniques applied to different radio-communication system stages, including coding, modulation, synchronization, and security, make any implementation quickly obsolete. On the other hand, different communication standards used among military and public safety agencies make difficult the necessary interoperability. These reasons force users to replace equipment frequently, increasing cost and implementation time. Software-defined radios (SDRs), partly implemented in software, can solve these problems, making full use of programmable modules. This thesis presents an implementation of the necessary algorithms that solve the synchronization requirements of IEEE 802.11a WLAN receivers. This is a continuation of a previous thesis effort, where the post-synchronization steps of the receiver were addressed. The software utilized for this purpose is the open source SCA Implementation::Embedded (OSSIE), developed by Virginia Tech. Each algorithm is created as a different component, allowing reuse and modularity for the development of future waveforms.

KEYWORDS: Software Defined Radio, IEEE 802.11, LAN, Synchronization, OFDM, OSSIE, CORBA

ELECTRICAL ENGINEERING

VIBRATION ANALYSIS VIA WIRELESS NETWORK

David C. Wallis, III-Major, United States Marine Corps

B.S., United States Naval Academy, 1994

Master of Science in Electrical Engineering-September 2007

Advisor: Xiaoping Yun, Department of Electrical and Computer Engineering

Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

This thesis focuses on validating the feasibility of using remote sensors and a wireless network to monitor standard operating conditions on U.S. naval vessels. A pressure transducer, accelerometers, and MaxStream ZigBee devices are utilized to provide data to a remote GUI interface utilizing the wireless transmission medium. The thesis also includes a study of vibration analysis utilizing the Kullback-Lieber algorithm for spectral distance. This algorithm is programmed in LabView 8.0. The intent is to process the raw data obtained at the point of measurement through a fast Fourier transform. The processed data is then transmitted wirelessly to an end node where the Kullback-Lieber algorithm is utilized to obtain a spectral distance value. This value is then compared to a reference value to ascertain the operating condition of a particular piece of equipment. The wireless transmission standard utilized for this thesis is IEEE 802.15.4.

KEYWORDS: Vibration Analysis, ZigBee, Wireless Networks, Kullback-Lieber, Mesh, Wireless Sensor

MASTER OF SCIENCE IN ELECTRONIC WARFARE SYSTEMS ENGINEERING

SIMULATION OF NETWORK-ENABLED ELECTRONIC-WARFARE METRICS TO ASSESS THE VALUE OF NETWORKING IN A GENERAL INFORMATION AND RADAR TOPOLOGY

You-Quan Chen-Lieutenant, Republic of China (Taiwan)

B.S., National Defense University-Chung Cheng Institute of Technology, 2000

Master of Science in Electronic Warfare Systems Engineering-September 2007

Advisors: Phillip E. Pace, Department of Electrical and Computer Engineering

Ralph C. Robertson, Department of Electrical and Computer Engineering

This thesis explores information-network metrics, the concept of netted radar, and network theory in a network-centric warfare environment. It begins with a discussion of the relationship between the network space and the battlespace. MATLAB simulations are developed to demonstrate the concepts and quantify the network metrics discussed for important information and netted radar configurations. The effect of electronic attack is also addressed. Simulation results demonstrating the signal-to-noise ratio performance with and without network synchronization are shown, including the degradation due to electronic attack.

KEYWORDS: Network-Centric Warfare, NCW, Connectivity Measure, OODA, Netted Radar

DIRECTED-ENERGY WEAPONS: INVISIBLE AND INVINCIBLE

Bayram Mert Deveci-Captain, Turkish Army

B.S., Turkish Military Academy, 1997

Master of Science in Electronic Warfare Systems Engineering-September 2007

Advisor: Edward Fisher, Department of Information Sciences

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

A military weapon is any tool used to increase the destructive range or power of a nation. Simply, we can say that each era witnesses the deployment of new, powerful mass-destruction weaponry. What will this century's most powerful weapon be? Directed-energy weapons (DEW), which offer advantages over conventional weapons by providing attack at the speed of light, precise targeting, rapid engagement of multiple targets, adjustable damage capacity, low operational cost, reduced logistic support, a nearly unlimited magazine, and area coverage for offensive and defensive purposes, seem to be at the forefront of the next revolution in military weapons.

This thesis provides an understanding of the principles and techniques of DEW. In addition, key DEW programs in laser weapons and RF directed-energy weapons (high-power microwaves) are fully described. A comparison of these DEW types from a military utility perspective is provided. Last but not least, this study will assist in establishing a vision for how DEW could revolutionize military affairs in the Turkish Armed Forces of the future.

KEYWORDS: Directed-Energy Weapons, High-Power Microwave Weapons, RF Weapons, Laser, HEL, Ground-Based Laser, Airborne Laser, Space-Based Laser, Soft-Kill, Hard-Kill

ELECTRONIC WARFARE SYSTEMS ENGINEERING

MULTIPLE-ASSETS POSITION DETERMINATION IN A 3-DIMENSIONAL ENVIRONMENT USING THE APRS PROTOCOL

Evangelos Foutzitzis-Major, Hellenic Air Force
B.S., Hellenic Air Force Academy, 1992

Master of Science in Electronic Warfare Systems Engineering-September 2007
Advisor: Andrew A. Parker, Department of Electrical and Computer Engineering
Second Reader: James F. Ehlert, Department of Information Sciences

Increased situational awareness in the battlefield is one of the main objectives in today's operations and applies to all levels of commands. Several attempts have been made to use tracking devices for detecting and continuously updating the positional data of friendly assets on a map. Current applications like Falcon View fulfill their objective in presenting the location of targets of interest on a digital mapping environment. Falcon View is a geographic information system used extensively by the Department of Defense for mission-planning purposes. When the requirement is to track airborne assets, such as aircraft or unmanned aerial vehicles, none of the current applications can present the results in three-dimensions. Instead, they project the received tracks on the ground in two dimensions, creating a false or impaired perspective of the true tactical situation.

This thesis develops and tests a software application in a plug-in form integrated into the open-source NASA World Wind mapping engine. The application is designed to determine the tracks of both airborne and ground-moving assets in three dimensions. It also tests the concept in a real-world environment and verifies the impact it has on situational awareness at various command levels.

KEYWORDS: 3D, Tracking, APRS, NASA World Wind

WIRELESSLY NETWORKED DIGITAL-PHASED ARRAY: ANALYSIS AND DEVELOPMENT OF A PHASE-SYNCHRONIZATION CONCEPT

Micael Grahn-Lieutenant Colonel, Swedish Armed Forces (Army)
B.S., Swedish National Defense College, 2004

Master of Science in Electronic Warfare Systems Engineering-September 2007
Advisor: David C. Jenn, Department of Electrical and Computer Engineering
Second Reader: Bob Broadston, Department of Electrical and Computer Engineering

Ongoing research at the Naval Postgraduate School on a wirelessly networked, aperstructure, digital-phased array (WNADPA) has investigated the possibility of using a distributed opportunistic array for radar, where array elements are placed at any available area of the ship structure. This could give an array that is as large as the ship itself, with 360-degree coverage. It has advantages in the areas of survivability and adaptability, and the profile of the ship could be kept low for better maneuverability and smaller radar cross section.

The array elements are standalone transmit-receive (T/R) modules controlled over a wireless media, with no hardware connection other than the power supply. Phase and time synchronization are critical for the successful operation of the array. The focus of this thesis is on designing a phase synchronization concept, implementing it in existing T/R modules using commercial, off-the-shelf hardware, and performing validation measurements of the proposed phase synchronization process. The results verify that distribution and phase synchronization of a local oscillator signal over the free space channel are possible.

KEYWORDS: Phased Array, Phase Synchronization, Aperstructure, Radar, Modulator, Demodulator, Transmit/Receive Module, Digital Beamforming, Demonstration Array

ELECTRONIC WARFARE SYSTEMS ENGINEERING

AUTONOMOUS, NONLINEAR CLASSIFICATION OF LOW-PROBABILITY-OF-INTERCEPT RADAR-SIGNAL MODULATIONS

**Taylan O. Gulum-Lieutenant Junior Grade, Turkish Navy
B.S., Turkish Naval Academy, 2001**

Master of Science in Electronic Warfare Systems Engineering-September 2007

Master of Science in Electrical Engineering-September 2007

Advisors: Phillip E. Pace, Department of Electrical and Computer Engineering

Roberto Cristi, Department of Electrical and Computer Engineering

In this thesis, an autonomous feature-extraction algorithm for classification of low-probability-of-intercept (LPI) radar modulations is investigated. A software-engineering architecture that allows a full investigation of various preprocessing algorithms and classification techniques is applied to a database of important LPI radar waveform modulations, including frequency-modulation continuous waveform (FMCW), phase-shift keying (PSK), frequency-shift keying (FSK), and combined PSK and FSK. The architecture uses time-frequency detection techniques to identify the parameters of the modulation. These include the Wigner-Ville distribution, the Choi-Williams distribution, and quadrature mirror filtering. The autonomous time-frequency, image-cropping algorithm is followed by a feature-extraction algorithm based on principal components analysis. Classification networks include the multilayer perceptron, the radial-basis function, and the probabilistic neural networks. Lastly, using image-processing techniques on images obtained by the Wigner-Ville distribution and the Choi-Williams distribution, two autonomous extraction algorithms are investigated to derive the significant modulation parameters of polyphase-coded LPI radar waveform modulations.

KEYWORDS: Autonomous Classification, Low Probability of Intercept, LPI, Principal Component Analysis, PCA, Time-Frequency, Multi Layer Perceptron, Radial Basis Function, Parameter Extraction, Radon Transform, 2-D FFT

INFORMATION OPERATIONS IN PURSUIT OF TERRORISTS

Ulhas Kirpekar-Lieutenant Colonel, Indian Army

B.S., Jawahar Lal Nehru University-New Delhi, 1988

B.T., Jawahar Lal Nehru University-New Delhi, 1996

M.T., Indian Institute of Technology-Kanpur, 2000

M.S., Madras University-Chennai, 2003

Master of Science in Electronic Warfare Systems Engineering-September 2007

Advisors: John Arquilla, Department of Defense Analysis

Hy S. Rothstein, Department of Defense Analysis

Second Reader: Steven Iatrou, Department of Information Sciences

The global war on terrorism is now in its sixth year, and the battle with Islamist terrorists is being fought in both the physical and informational domains. This research examines the relationship between terrorism and information operations, keeping in view Martin Libicki's notion of information warfare as a mosaic of forms. This research begins with the basics of terrorism and information operations, and proceeds to highlight the use of information operations by terrorist organizations, in particular its use by Al Qaeda. In order to compare the complete spectrum of information operations being conducted by United States-led forces in this global war on terrorism, this research includes two detailed studies on the prosecution of information operations from the perspective of both the United States-led coalitions and the anti-coalition elements in Afghanistan and Iraq. The study concludes by highlighting the relevance of Libicki's constructs in the context of the global war on terrorism and proposes a macro strategy to pursue the Islamist terrorists in the information domain.

KEYWORDS: Information Operations, Information Warfare, Al Qaeda, Operation Enduring Freedom, Afghanistan, Operation Iraqi Freedom, Iraq, Global War on Terrorism, Martin Libicki

ELECTRONIC WARFARE SYSTEMS ENGINEERING

HF OVER-THE-HORIZON, RADAR-SYSTEM-PERFORMANCE ANALYSIS

Bin-Yi Liu-Lieutenant, Taiwan Navy

B.S., Chinese Naval Academy, 2000

Master of Science in Electronic Warfare Systems Engineering-September 2007

Advisors: Phillip E. Pace, Department of Electrical and Computer Engineering

Jeffrey B. Knorr, Department of Electrical and Computer Engineering

The basic concept of the structure and properties of the ionosphere are discussed to explain how the performance of the over-the-horizon radar (OTHR) system is affected. An overview of OTHR system characteristics and performance is presented, along with some applications currently used around the world, including their geographic location and historical background. The waveforms used for the OTHR systems include simple pulse, pulse Doppler, phased-coded pulse, frequency modulated continuous wave (FMCW), and frequency modulated interrupt continuous wave (FMICW). Other characteristics, such as target detection methods and the skywave OTHR range equation, are also discussed. A model of the maximum detection range for the Chinese FMCW OTH backscatter (OTH-B) radar is developed in MATLAB. An intercept-receiver maximum interception range is also analyzed. Simulation results indicate that the minimum required input signal-to-noise ratio (SNR) for a target with 100 m² cross section at 3,500 km footprint range -52.4dB at $f_c = 14.5$ MHz. In addition, a noncooperative intercept receiver requires a minimum input SNR of 94 dB for a square law detector and 97 dB for a linear detector for interception at a footprint range of 3,500 km at $f = 14.5$ MHz.

A model of the maximum detection range for the Chinese FMCW OTH backscatter (OTH-B) radar was developed in MATLAB. An intercept receiver maximum interception range is also analyzed. A ray tracing technique is also used in PROPLAB to present a more detailed analysis. The analysis includes the electron density profile, the maximum usable frequency, the critical frequency of the layers, the skip zone, and the signal quality. The simulations focused on the Chinese OTH-B radar system are to investigate the Chinese surveillance capabilities.

KEYWORDS: Over-the-Horizon, OTH, OTHR, OTH-B, Ionosphere, Jindalee, JORN, HF, HFSWR, Nostradamus, Valensole, OTH-SW, CONDO-R, MADRE, WARF, AN/FPS-95, AN/FPS-112, AN/FPS-118, AN/TPS-71, Waveform, Simple Pulse, Pulse Doppler, Phased-Coded Pulse, FMCW, FMICW, Radar Equation, PROPLAB, Ray Tracing, Signal Quality

WIRELESS NETWORKS FOR BEAMFORMING IN DISTRIBUTED, PHASED-ARRAY RADAR

Jose Saul Gomez Noris-Lieutenant Junior Grade, Mexican Navy

B.S., Mexican Naval Academy, 1998

Master of Science in Electronic Warfare Systems Engineering-September 2007

Advisor: David C. Jenn, Department of Electrical and Computer Engineering

Second Reader: Michael A. Morgan, Department of Electrical and Computer Engineering

The wirelessly networked, aperstructure, digital, phased-array radar (WNADPAR) applies three relatively new concepts: opportunism, aperstructure, and wirelessly networked, digital-architecture concepts. Using this approach, almost the full length of the ship becomes the aperture of the phased-array radar by placing the antenna elements at available open areas and having the power supply as the only wired connection.

This research addresses the wireless networking of the full-scale radar system. An analysis of the various existing and newly developed wireless technologies and guided-transmission media is conducted to determine a baseline approach for the full system implementation.

A two-element array demonstrator is wirelessly networked and tested to allow wireless communication between the central beamformer and controller and the T/R modules. Control and monitoring software that allows simultaneous transmission and reception in both T/R modules is developed in LabVIEW.

Finally, a number of tests and measurements are conducted to validate the operation of the two-element-array demonstrator while transmitting the control data wirelessly.

KEYWORDS: Opportunistic, Phased Array, Receiver, T/R Module, Transmitter, Beamformer, Array Demonstrator, Aperstructure, Wirelessly Networked Digital Architecture

MASTER OF SCIENCE IN ENGINEERING ACOUSTICS

MARITIME SURVEILLANCE USING A WIDEBAND HYDROPHONE

Jason K. Wilson-Lieutenant, United States Navy

B.S., University of Missouri-Columbia, 2000

Master of Science in Engineering Acoustics-September 2007

Advisors: Joseph Rice, Department of Physics

Daphne Kapolka, Department of Physics

Paul Hursky, DoD Contractor, HLS Research

Undersea acoustic modems acquire wideband acoustic time series through an electro-acoustic transducer and use on-board digital-signal processing for receiving acoustic communications. These component devices can potentially serve a dual use for passive sensing of radiated acoustic energy from maritime vessels. This thesis examines the characteristic Lloyd's mirror interference pattern present in the acoustic spectrogram of a passing surface target and applies two-path ray theory and waveguide invariant theory to an analysis of the phenomenon. The two theories are shown to be mathematically equivalent under certain conditions. In combination with the Doppler shift from a target tonal, these theories permit a calculation of target range and speed at the closest point of approach. Such analysis is applied to spectrograms obtained in a controlled experiment at the approaches to San Diego Bay. For targets passing within 185 meters of the receiver, the resulting Lloyd's mirror pattern permits calculation of the range to within 9%. Target speed obtained from the Doppler shift is within 4% of the ground-truth value.

KEYWORDS: Undersea Warfare, Acoustic Modem, Shallow Water Acoustic Detection, Doppler Shift, Lloyd's Mirror, Ray Theory, Waveguide Invariant, Multipath Propagation, Underwater Acoustics, Maritime Surveillance

MASTER OF SCIENCE IN HUMAN SYSTEMS INTEGRATION

THE ABBOTT-AND-COSTELLO EFFECT: WHO'S ON WHAT AND WHAT'S WHERE WHEN? A HUMAN-CENTERED METHOD TO INVESTIGATE NETWORK-CENTRIC WARFARE SYSTEMS

Derek W. Read-Captain, United States Air Force

B.S., Idaho State University, 1998

Master of Science in Human Systems Integration-September 2007

Advisor: Nita L. Miller, Department of Operations Research

Second Reader: Lawrence G. Shattuck, Department of Operations Research

Technological advancements, especially in communications systems, have led to a burgeoning interest in network-centric warfare (NCW), fundamentally changing how warfare is being conducted. NCW systems are being rushed to the field, offered as a solution for the “fog of war” and as a way to reduce manpower costs. To date, there are no empirical findings that support or refute these NCW system claims.

The goal of this thesis is to ascertain the utility of geographical recall and analysis of data in the environment (GRADE) as a method and process by which complex human-technological systems can be assessed. GRADE builds upon the dynamic model of situated cognition (DMSC). This study essentially determines if GRADE could be used in model validation in laboratory and field settings for evaluating NCW claims. Unfortunately, that research goal is not entirely realized due to constraints and limitations in the data-collection exercise.

The lessons learned from this research effort are discussed and recommendations are provided for future exercises and how to better populate the DMSC with data. Additional recommendations for changes to the processes and procedures for data collection are also provided.

KEYWORDS: Human Systems Integration, Network Centric Warfare, Dynamic Model of Situated Cognition, Geographical Recall and Analysis of Data in the Environment

MASTER OF SCIENCE IN INFORMATION OPERATIONS

PERCEPTION MANAGEMENT: A CORE INFORMATION-OPERATIONS CAPABILITY

Khyber Zaman-Lieutenant Commander, Pakistani Navy

B.S., Karachi University, 1996

Master of Science in Information Warfare Systems Engineering-September 2007

Master of Science in Information Operations-September 2007

Advisors: Robert O'Connell, Department of Defense Analysis

Steven Iatrou, Department of Information Sciences

This thesis postulates that in today's media environment, with adversaries skillfully using propaganda to skirt the nation's resolve, perception management is key to military success and should therefore be an information operations (IO) core capability vis-à-vis its current consideration in the U.S. doctrine as a related IO capability.

The Kargil episode of 1999 was a political victory for India, while, from the Pakistani perspective, it was a successful tactical operation—albeit one that was not accompanied by a coordinated politico-diplomatic plan—turned into a politico-diplomatic setback. Pakistan's tactical successes in Kargil were not translated into strategic gains due to the lack of clarity over policy and, hence, the absence of a perception-management offensive. On the contrary, India hyped the situation with the West, using its media as a key element of perception management to win substantial political support. Eventually, Pakistani forces had to withdraw in the face of immense international pressures.

When reviewing the Kargil conflict, a complete history of the injustices that Pakistan has been subjected to since the onset of independence in 1947 must also be considered. Pakistan's sense of historical grievance against India—fueled especially by exploitation of an internal crisis in Eastern Pakistan (now Bangladesh) in 1971, occupation of the Siachen glacier in 1984 (despite the 1972 Simla agreement), planning of a pre-emptive attack on Pakistan's nuclear facilities in the garb of the 1987 Brasstacks exercise, suppression of the Kashmiri people for decades, and a series of subsequent incursions and skirmishes along the northern line of control (LoC)—raised the concerns and fears of yet another Indian aggression in 1999 in the northern areas. Therefore, Pakistani forces took a “forward-defense posture across the LoC” at a time when the Kashmiri Mujahideen had occupied vacated Indian winter positions to settle scores with Indians and draw them away from Indian-occupied Kashmir.

As only the Indian disinformation about Kargil was publicized and myths were promoted, the real history of Kargil became obscured. It is a central aim of this thesis to present the Pakistani case and provide a balancing viewpoint through Pakistani eyes.

KEYWORDS: Perception Management, Information Operations, Core Capability, Media, Kargil Conflict

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

BUSINESS PROCESS REENGINEERING WITH INFORMATION TECHNOLOGY AT THE MARINE CORPS BASIC SCHOOL

**Brian J. Brauer-Captain, United States Marine Corps
B.S., University of Nebraska-Lincoln, 1999**

Master of Science in Information Technology Management-September 2007

Advisor: Albert Barreto, Department of Information Sciences

Second Reader: David F. Overton, Department of Information Sciences

This thesis analyzes the principles and concepts of the Marine Corps Basic School (TBS) at the operational level, and evaluates the current information-management systems used to track the progress of new officers. A web-enabled prototype for TBS is developed to enhance management and decision support for deliberate, time-sensitive planning utilized to optimize student performance. The first iteration of the prototype is tested by the TBS testing officer. Results of this research reveal potential benefits for student leadership and academic and tactical tracking. It also provides some insight into the benefits of a Marine Corps enterprise-wide decision-support system. This research will be used as a tool for requirements gathering as TBS assists in the development of the Marine Corps' enterprise training information-management system.

KEYWORDS: Information Management Systems, Web-Enabled, Decision Support System, Enterprise System

A HOLISTIC MANAGEMENT ARCHITECTURE FOR LARGE-SCALE ADAPTIVE NETWORKS

**Michael R. Clement-DoD Civilian
B.S., Seattle University, 2004
B.A., Seattle University, 2004**

Master of Science in Information Technology Management-September 2007

Advisor: Alexander Bordetsky, Department of Information Sciences

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

This thesis extends the traditional notion of network management as an indicator of resource availability and utilization into a systemic model of resource requirements, capabilities, and adaptable allocations from a services perspective. Central to this model is a mapping of user-information requirements onto measurable network attributes that can be used to evaluate levels of service. A monitoring infrastructure suitable to capturing and visualizing these attributes is also investigated. The outcome is a framework for understanding, measuring, and monitoring informational services in terms of their effects on a network. These results could be used to develop semi-automated and adaptive network monitoring and management suites that would support large-scale network centric operations.

KEYWORDS: Adaptive Networking, Holistic Network Management

INFORMATION TECHNOLOGY MANAGEMENT

THE COMBINED ENTERPRISE REGIONAL INFORMATION EXCHANGE SYSTEM: THE WAY AHEAD

**Douglas A. Cook-Captain, United States Marine Corps
B.A., North Carolina State University, 1998**

Master of Science in Information Technology Management-September 2007

**Patrick E. Lancaster, Jr.-Lieutenant, United States Navy
B.S., Southern Illinois University, 1997**

Master of Science in Information Technology Management-September 2007

**Robert R. Patto, Jr.- Lieutenant, United States Navy
B.S., The College of William and Mary, 1998**

Master of Science in Information Technology Management-September 2007

**Advisors: Karl D. Pfeiffer, Department of Information Sciences
Albert Barreto, Department of Information Sciences**

The Combined Enterprise Regional Information Exchange System (CENTRIXS) is a coordinated Department of Defense program established at the request of the combatant commands (COCOM) to support the global war on terrorism. CENTRIXS is a standing, global enterprise network allowing U.S. and coalition nations and their forces, in a seamless manner, to securely share operational and intelligence information in support of combined planning, unity of effort, and decision making in multinational operations.

This thesis describes CENTRIXS networks that support the needs of the COCOMs on a global basis. The document also addresses who is connected to whom, what kinds of information must be passed from one user to another, and the services provided to the users of CENTRIXS networks. A knowledge-value-added analysis is conducted to streamline the manning and usability of CENTRIXS nodes. Methods to efficiently and effectively go through the process of acquisition, installation, and accreditation of a CENTRIXS node are explored.

KEYWORDS: Defining CENTRIXS, Increasing the Value of CENTRIXS, Acquisition, Installation, Accreditation

THE USE OF COLLABORATIVE AND THREE-DIMENSIONAL IMAGING TECHNOLOGY TO ACHIEVE INCREASED VALUE AND EFFICIENCY IN THE COST-ESTIMATION PORTION OF THE SHIP MAINTENANCE-AND-MODERNIZATION (SHIPMAIN) ENVIRONMENT

**David H. Cornelius, Jr.-Lieutenant Commander, United States Navy
B.B.A., University of Memphis, 1992**

Master of Science in Information Technology Management-September 2007

**Advisor: Thomas J. Housel, Department of Information Sciences
Second Reader: Albert Barreto, Department of Information Sciences**

Maintenance and modernization efforts of the U.S. Navy fleet are essential to United States' ability to project power and deter adversaries from around the world. This maintenance and modernization requires substantial allocation of funds from an already thinly stretched budget. In order to facilitate the most cost-effective way to allocate funds, the Navy has invested substantial fiscal and human resources to standardize the processes used to accomplish maintenance, modernization, and repair of its fleet of ships. In order to realize the full benefit of the available technology, reliable and quantitative measures that capture and measure the full range of benefits provided by technology resources are essential. Knowledge-value-added (KVA) methodology is used in this thesis to identify and quantify the benefits that can be realized within the cost-estimation portion of the ship maintenance-and-modernization (SHIPMAIN) program.

A proof-of concept case is developed to analyze the current cost-estimation process with SHIPMAIN. After the completion of the baseline as-is process, the KVA methodology is applied to a notional scenario that uses 3D laser scanning and product-lifecycle management to reengineer the current cost-estimation process. The notional scenario demonstrates positive returns from the reengineered cost-estimation process, and the KVA methodology establishes evidence that suggests that operating costs will be reduced by over \$176 million and cost-estimation efficiency will increase.

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KEYWORDS: Knowledge Value Added, KVA, Ship Maintenance and Modernization, Return on Investment, ROI, Return on Knowledge, ROK, Information Technology, IT, Laser Scanners, Collaboration, Planning Yards, Navy Shipyards, PLM, Product Lifecycle Management, Lifecycle Management, SHIPMAIN

MODERN ADVANCES TO THE MODULAR FLYAWAY KIT TO SUPPORT MARITIME-INTERDICTION OPERATIONS

**Eric C. Cross-Captain, United States Marine Corps
M.S., University of Arizona, 2001**

Master of Science in Information Technology Management-September 2007

**Advisors: James F. Ehlert, Department of Information Sciences
Gurminder Singh, Department of Computer Science**

This thesis tests the performance of an end-to-end network solution designed to augment maritime-interdiction operations that support boarding parties and their near real-time communications with supporting agencies. The 802.16 point-to-point and point-to-multipoint orthogonal frequency divisional multiplexing (OFDM) is upgraded to reflect modern advances in 802.16. Additionally, there will be several enhancements to the peripherals associated with end-user innovations, including upgraded biometric devices, innovative camera solutions for near real-time viewing, laptop support, and airborne operations and communications devices for augmenting radio systems. Specifically, this thesis evaluates the enhanced effectiveness of implementing 802.16 networking equipment into the communications suite of several sea platforms. The test portions of this thesis include laboratory specifications, bench-test analysis, and field experimentation done in partnership with the Cooperative Operations and Applied Science and Technology Studies (COASTS).

COASTS is a combined Indonesian–Malaysian–Singaporean–Thai–American research and development effort to investigate commercial, off-the-shelf command, control, communications, computers and intelligence, surveillance, and reconnaissance (C4ISR) technologies to provide real-time situational awareness for multinational, tactical, and remote decision makers in a cooperative environment. The capstone field experiment is conducted annually in May and June. COASTS-07 is the third iteration in the series and builds on the successes and lessons learned from the 2005 and 2006 field experiments. In 2007, COASTS also employed some technologies into two major multinational Pacific Fleet exercises: 1) the U.S. Pacific Fleet exercise TALISMAN SABER 2007 with COMSEVENTHFLT in Australia during June 2007, and 2) COMLOG WESTPAC’s Southeast Asia Cooperation Against Terrorism (SEACAT) 2007 exercise in Singapore during August 2007.

KEYWORDS: 802.11b, 802.11g, Wi-Fi, SecNet-11, 802.16, WIMAX, MIMO, OFDM, COTS, Integrated Common Operational Picture, Maritime Interdiction Operations, WLAN, Bridging, Tactical Internet, Biometrics, Boarding, Backhaul, COASTS, FLAK, MFLAK

XML TACTICAL CHAT: THE WAY AHEAD FOR NAVY CHAT

**Daniel A. DeVos-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1995**

Master of Science in Information Technology Management-September 2007

**Advisors: Donald P. Brutzman, Department of Information Sciences
Donald R. McGregor, MOVES Institute**

The motivation for pursuing XML-based tactical chat includes the great potential of this technology and fixing limitations of current chat programs. XTC capabilities have the potential to completely upgrade and restructure all tactical military communications. The current tools for military chat include IRC, Yahoo, MSN, AIM, ICQ, and NKO. None of these provides the full functionality or interoperability needed in a joint environment. Moreover, if a nonproprietary chat protocol is developed, it can lead to a decision-support environment in which data, text, audio, and video can be logged, evaluated, and managed, all in a web environment where no additional specialized software or hardware is needed.

Chat technology challenges for the military fit into three areas: tactical, technical, and administrative. Tactically, there are many ways chat can be used, but effective practices are not yet defined in procedures

INFORMATION TECHNOLOGY MANAGEMENT

or doctrine. Joint forces use a myriad of chat programs that do not interoperate and are usually proprietary. Technically, many chat programs are barred by firewalls and lack a robust interface to allow logging and searching past chats. From an administrative perspective, plain-text chat has no structure. Scheduling and controlling who attends or converses remains undefined. Within the Department of Defense, there is no standard for how, when, and by whom chats ought to be conducted.

Possible approaches to these problems include adopting a proprietary chat system or customizing an open-source implementation. Proprietary solutions are costly, do not interoperate well, and are too inflexible for a technology that is evolving rapidly. Open-source software can provide a solution that is adaptable, extensible, quick to implement, straightforward to maintain, and relatively inexpensive.

KEYWORDS: XML, Tactical chat, XML, Jabber, XHTML, XTC, IRC

THE CASE FOR A KNOWLEDGE-BASED, DEPARTMENT OF DEFENSE SOFTWARE ENTERPRISE: AN EXPLORATORY STUDY USING SYSTEM DYNAMICS

Richard J. Dixon, Jr.-Lieutenant Commander, United States Navy

B.S., United States Naval Academy, 1997

Master of Science Information Technology-September 2007

Advisors: Tarek Abdel-Hamid, Graduate School of Business and Public Policy

Daniel Dolk, Department of Information Sciences

This research examines the Department of Defense's software-acquisition process utilizing Jay Forrester's system dynamics methodology. Well-known acquisition issues and policies are examined, with specific focus on oversight, process integration, process discipline, and knowledge management. These issues are examined for causality and dependent relationships. Additionally, a proof-of-concept systems-dynamics model is developed to simulate the system and test possible interventions for organizational structure and policy.

KEYWORDS: Management of Technology, Strategic Decision Making, Software Acquisition, System Dynamics Modeling, Product-Line Architecture, Learning Curve Theory

TRANSFORMING THE FORCE: A COMPARATIVE ANALYSIS OF THE DEPARTMENT OF DEFENSE'S ENTERPRISE RESOURCE-PLANNING SYSTEMS

Charles W. Hill-Captain, United States Marine Corps

B.A., Boston University, 1997

Master of Science in Information Technology Management-September 2007

Advisor: Glenn R. Cook, Department of Information Sciences

Second Reader: Walter Kendall, Department of Information Sciences

Automated information systems (AISs) are software systems that support administrative functions such as accounting, payroll, finance, personnel, inventory control, logistics, and equipment and maintenance scheduling. An enterprise resource-planning (ERP) system is a type of AIS that works to integrate all the different functional business areas of an organization. Since the 1990s, a large number of corporations have transitioned from legacy proprietary software to an ERP. The companies who have successfully made the transition have greatly benefited from the flow of information across the organization that is brought about by the ERP's ability to integrate the multidimensional data into a single common database. The current AIS environment of the DoD is marked by a lack of systems integration. Like industry, the DoD is looking to combat this environment with ERP systems. This thesis documents the history of ERP implementations in the DoD, highlights the different approaches each service is taking to complete their transitions, and compares the plans of the services to the plans that successful corporations executed in their transitions to an ERP. By comparing the plans of the services to industry's guidelines on how to correctly implement an ERP, this thesis provides new analysis to aid the DoD in this critical endeavor.

KEYWORDS: Enterprise Resource Planning, Business Systems Modernization, Defense Logistics Agency, Logistics Modernization Program, Global Combat Support System, United States Army, United States Navy, United States Air Force, United States Marine Corps

INFORMATION TECHNOLOGY MANAGEMENT

PERSONNEL IDENTITY MANAGEMENT AND THE EXPEDITIONARY STRIKE GROUP

Glen E. Neises-Captain, United States Marine Corps

B.S., The Citadel, 2000

Master of Science in Information Technology Management-September 2007

Advisors: Thomas J. Housel, Department of Information Sciences

Albert Barreto, Department of Information Sciences

Identity management (IM) plays a critical role in virtually every management process involving personnel. "Identity management" means the ability to uniquely and unambiguously identify people and entities and their interactions and interrelationships, and also the ability to track their mobility in a timely fashion. Currently, expeditionary strike group (ESG) personnel IM suffers from a lack of technology, systems integration, and training.

The purpose of this thesis is to identify best practices and technologies to help resolve ESG personnel IM problems. Chapter I defines IM and explains why IM is important for the Department of Defense. Chapter II provides an overview of DoD human-resource management and Defense Manpower Data Center information systems. Chapter III provides an introduction to the challenges associated with the ESG, personnel IM, and information technology (IT). Chapter IV provides an introduction to metrics, business process redesign, and knowledge-value added. Those concepts are used to derive an answer to the question, "What does the Noncombatant Evacuation Operation Tracking System do for ESG commanders?" Chapter V summarizes the challenges associated with ESG personnel IM and IT, recommends changes, and summarizes the main points of the thesis.

KEYWORDS: Identity Management, Expeditionary Strike Group, Non Combatant Evacuation Operation Tracking System, Defense Biometric Identification System, Knowledge Value Added, Business Process Redesign

COMMUNITIES OF PRACTICE: TOWARD LEVERAGING KNOWLEDGE IN THE MILITARY

Guillermo A. Palos-Major, United States Air Force

B.S., United States Air Force Academy, 1993

Master of Science in Information and Technology Management-September 2007

Advisors: Mark E. Nissen, Department of Information Sciences

Karl D. Pfeiffer, Department of Information Sciences

The Department of Defense has recently discovered the benefits of communities of practice as a knowledge-management program in strategic, tactical, and staff environments. Such communities have grown in popularity: 185,000 users growing at 5,000 per month in over 6,000 registered communities in the Air Force alone. However, their emergent manner and perspective is limited; an information-focused approach prevails, through which primary emphasis is placed on technology and document archives. This approach fails to address knowledge as a unique human feature. As a result, current implementations are unable to address intrinsic fundamental issues about knowledge that could improve the effectiveness of new and extant communities of practice. This thesis addresses the deficiency by investigating the characteristics of knowledge, knowledge management, and communities of practice, and proposing a socio-technical, knowledge-focused approach for military functional communities. Findings are applied principally to the Air Force manpower function and Navy-security cooperation activity, but results should also apply to other functions, organizations, military services, and Department of Defense entities trying to implement new communities of practice or enhance existing ones.

KEYWORDS: Communities of Practice, Knowledge Management, Knowledge, Learning, Organizational Performance

INFORMATION TECHNOLOGY MANAGEMENT

DESIGN OF EXPERIMENT AND SIMULATION EXECUTION ON A REMOTE HIGH-PERFORMANCE COMPUTING CLUSTER

**Adam J. Peters-Captain, United States Army
B.S., University of Pittsburgh, 1997**

Master of Science in Information Technology Management-September 2007

Advisor: Paul J. Sanchez, Department of Operations Research

Second Reader: Jon Alt, TRADOC Analysis Center-Monterey

This thesis focuses on creating an object-oriented software architecture around which tools can be created to increase the usability of stochastic simulations, such as IWARS and Pythagoras, on high-performance computing clusters. The objective of the architecture is to enable the user to design and execute simulation experiments using a platform-independent client and server to create a common interface for various simulations. The interface input is used to select the experimental factors of interest to the research analyst and then to create the scenario files for each simulation run with minimal human intervention. To develop the architecture, the current state of the art is explored and a proposed process flow is developed. This process flow is then vetted by operations researchers from several organizations. A prototype application is developed based on the software architecture. The prototype reveals great benefit in this type of tool.

KEYWORDS: Simulation, Design of Experiment, High Performance Computing Cluster, Ruby on Rails, Web-Enabled Database, Operations Research, Software Architecture

MILITARY APPLICATION OF NETWORKING BY TOUCH IN COLLABORATIVE PLANNING AND TACTICAL ENVIRONMENTS

**Brian T. Rideout-Major, United States Marine Corps
B.A., Ohio Wesleyan University, 1995**

Master of Science in Information Technology Management-September 2007

**James A. Strickland-Lieutenant, United States Navy
B.S., United States Naval Academy, 2000**

Master of Science in Information Technology Management-September 2007

Advisors: Alexander Bordetsky, Department of Information Sciences

David W. Netzer, Director, SOCOM Field Experimentation Program

Human-area networks (HAN) represent an emerging field of communications technology with the potential to offer significant advantages to military operations. This thesis explores and defines HANs and the various terminologies associated with HANs, and addresses how HANs relate to existing network topologies. This research addresses the notion of “touch” as an event and attempts to relate the various interpretations of “touch” networking to HANs, while describing a preliminary architecture through the use of multiple scenarios and use cases, quality attributes, and functional requirements. Additionally, this thesis explores the opportunities associated with one particular implementation of HAN, intrabody communications (IBC), and proposes an implementation plan for conceptual IBC devices. Ultimately, this thesis demonstrates the potential value of IBC and HANs in a joint tactical scenario. Recommendations are provided for iteratively evaluating the techniques, tactics, and procedures in an incremental manner that seamlessly evolves with technology advancements.

KEYWORDS: Human Area Network, HAN, Intrabody Communication, IBC, Personal Area Network, PAN, Body Area Network, BAN, Software Architecture Implementation

INFORMATION TECHNOLOGY MANAGEMENT

MESH NETWORKS WITHIN A DISTRIBUTED-OPERATIONS FRAMEWORK USING IP-BASED RADIOS

**Randall J. Simmons-Major, United States Marine Corps
B.A., Western International University 1989**

Master of Science in Information Technology Management-September 2007

**Christopher C. Curran-Major, United States Marine Corps
B.A., West Virginia University, 1996**

Master of Science in Information Technology Management-June 2008

**Advisors: Alexander Bordetsky, Department of Information Sciences
LtCol Carl Oros, USMC, Department of Information Sciences**

The U.S. Marine Corps employs radio sets to establish a tactical network in order to communicate in the area of operations. These radio sets include AN/PRC-150(C) HF, SINCGARS VHF, and AN/ARC-210 UHF radios. In every instance, these sets require individualized training and calibration to ensure that they all operate when needed. Further, these independent systems often have difficulty cross-communicating. This problem is the result of incorrect time hacks, outdated fills, or improper frequency IDs—the list goes on. The Marine Corps has dealt with this problem by establishing a tactical network, such as the Fire Support Coordination Center (FSCC) or the Direct Air Support Center (DASC), which acts as a liaison between these elements. This slows down the passing of information and even loses words, phrases, and (often) the meaning of what is being communicated. Emerging on the scene is the Global Information Grid, which brings with it a veritable cornucopia of information and a network of resources that would be unreachable by UHF/VHF/HF communications. To access this, the Department of Defense in general, and the Marine Corps in particular, need to adopt communications devices that speak the same language: IP-based radios are the only viable option.

KEYWORDS: IP, Global Information Grid, Network-Centric Warfare, Tactical Network, Mesh Network, Distributed Operations, USMC

ASSESSING SERVER-FAULT TOLERANCE AND DISASTER-RECOVERY IMPLEMENTATION IN THIN-CLIENT ARCHITECTURES

**Samuel L. Slaydon-Major, United States Marine Corps
B.A., McNeese State University, 1996**

Master of Science in Information Technology Management-September 2007

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

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

This thesis focuses on assessing server-fault tolerance and disaster-recovery procedures for thin clients being implemented in smart classrooms and computer laboratories aboard the Naval Postgraduate School campus. The successful discovery of fault-tolerance limits and a disaster-recovery plan not only benefits NPS, but also provides the same for other commands that have implemented or plan to employ thin clients as part of their information-technology (IT) infrastructure.

Since the backbone of thin-client/server-based computing (TCSBC) is the reliance on the server as the hub of processing power and data storage, it is imperative that some plan to restore the server be effected to save from the loss of valuable data. In the case of NPS, the absence of the main server not only contributes to data loss, but it deprives students of hours of invaluable classroom instruction. The fault-tolerance issues and disaster-recovery solutions addressed in this thesis may not be suitable in all thin-client architectures, but perhaps the knowledge gained through this research can aid some commands in avoiding a catastrophic server failure.

KEYWORDS: Thin Client, Thin Client/Server-Based Computing, Total Cost of Ownership, Windows Based Terminals, Wyse, Wyse Device Management Software

INFORMATION TECHNOLOGY MANAGEMENT

TESTING AND DEMONSTRATING SPEAKER-VERIFICATION TECHNOLOGY IN IRAQI ARABIC AS PART OF THE IRAQI ENROLLMENT-VIA-VOICE-AUTHENTICATION PROJECT IN SUPPORT OF THE GLOBAL WAR ON TERRORISM

Jeffrey W. Withee-Major, United States Marine Corps

B.A., The Citadel, 1996

Master of Science in Information Technology Management-September 2007

Edwin D. Pena-Captain, United States Marine Corps

B.A., University of Colorado, 2001

Master of Science in Information Technology Management-September 2007

Advisors: James F. Ehlert, Department of Information Sciences

Pat Sankar, Department of Information Sciences

This thesis documents the findings of an Iraqi-Arabic language test and a concept of operations for speaker-verification technology as part of the Iraqi banking system in support of the Iraqi Enrollment-via-Voice-Authentication Project (IEVAP). IEVAP is an Office of the Secretary of Defense-sponsored research project commissioned to study the feasibility of speaker-verification technology to support security requirements of the global war on terrorism. The intent of this project is to contribute to the future employment of speech technologies in a variety of coalition military operations by testing speaker verification and automated speech-recognition technology to improve conditions in the war-torn country of Iraq. In this phase of the IEVAP, the Naval Postgraduate School tested Nuance Inc.'s Iraqi-Arabic voice-authentication application and developed a supporting concept of operations for this technology in support of a new era in Iraqi banking.

KEYWORDS: Speaker Verification, Voice Authentication, Voice Verification, Voice Biometrics

EFFICACY OF IEEE 802.16-BASED RADIO, WIDE-AREA NETWORKS IN SUPPLEMENTING SATELLITE COMMUNICATIONS IN AN INTRA-BATTLE GROUP AND AMPHIBIOUS TACTICAL NETWORK

William E. Wren-Lieutenant Commander, United States Navy

B.S., Oregon State University, 1997

Master of Science in Information Technology Management-September 2007

Advisor: Rex Buddenberg, Department of Information Sciences

Second Reader: LtCol Carl Oros, USMC, Department of Information Sciences

The concept of network-centric warfare (NCW) promises to revolutionize the manner in which warfare and military operations are planned and executed. Many information systems are in development, or currently in production, which seize on the NCW initiative with the goal of enabling U.S. and coalition military forces to share information on a scale never before seen; however, application development has outpaced transmission media development. As information systems become more complex and the amount of information that must be exchanged between units on every level of the military hierarchy has increased, units on the tactical edge, who must rely on satellite communications or low-bandwidth radio communications, will increasingly find themselves outside the NCW environment looking in.

This research effort demonstrates the increasing communication needs of Naval units within a battle group and amphibious distributed-operations environment, and discusses the significant limitations that these units face with respect to bandwidth and how that affects their ability to efficiently transfer information. This research also proposes a tactical network based on IEEE standard 802.16 wireless technology as a means of creating a tactical network for use within the battle group, reducing the reliance on satellite communications to facilitate all the communications needs of the units. Based on previous research efforts and field experimentation conducted for this research effort, recommendations are made for improving the protocols contained in IEEE standard 802.16 to make them even more suitable for use in a tactical environment. In addition, research on support hardware for wireless communications based on IEEE standard 802.16 is recommended.

KEYWORDS: IEEE 802.16, NCW, Network Centric Warfare, Tactical Networking, Intra-Battle-Group Communications

MASTER OF SCIENCE IN INFORMATION WARFARE

AUTOMATED ALERTING FOR BLACK-HOLE ROUTING

Vinay Puri-Squadron Leader, Indian Air Force

B.E., Manipal Institute of Technology-Manipal, 1993

Master of Science in Information Warfare-September 2007

Master of Science in Computer Science-September 2007

Advisors: Geoffrey Xie, Department of Computer Science

J.D. Fulp, Department of Computer Science

Distributed denial-of-service (DDoS) attacks are the most common and easy-to-launch attacks against a computer or network. Once a DDoS attack is recognized, there are several methods available to mitigate its impact. One of the methods is to drop the attacker's traffic at the edge of the network via null routing—also called black-hole routing (BHR). BHR is more efficient than the creation and processing of access-control lists. Prior work has validated the effectiveness of BHR in mitigating DDoS attacks in a setting where the defense is activated manually. This research builds upon that work and develops a proof-of-concept, automated, BHR process that is integrated with Snort, an open-source intrusion-detection system (IDS), to facilitate a faster reaction to a DDoS attack. A real test bed consisting of Cisco routers is created to evaluate the performance of the developed system. Results demonstrate that the automation of BHR is both possible and desirable in mitigating DDoS attacks.

KEYWORDS: Automated Alerting for Black Hole Routing, Black Hole Routing, Intrusion Detection System, IDS, Automation of Black Hole Routing, DDoS Attacks, Network Security, ISP Network Security, Snort, Null Routing, Customer Triggered Black Hole Routing, Mitigating DDoS Attacks, BGP, iBGP

MASTER OF SCIENCE IN INFORMATION WARFARE SYSTEMS ENGINEERING

UNMANNED–AERIAL–VEHICLE MOUNTED, HIGH-SENSITIVITY RADIO-FREQUENCY RECEIVER TO DETECT IMPROVISED, EXPLOSIVE DEVICES

**Christopher M. Griffith-Captain, United States Marine Corps
B.S., University of Tennessee, 1996**

Master of Science in Information Warfare Systems Engineering-September 2007

Advisor: Lonnie A. Wilson, Department of Electrical and Computer Engineering

Second Reader: Ray A. Elliott, Department of Information Sciences

Improvised, explosive devices (IEDs) are increasing in complexity and lethality. A radio-frequency (RF) system is needed to detect the presence of RF IEDs. This thesis describes the evolution of a proven ground-based RF-detection system. It is designed to collect unintended radio-frequency emissions from the IED's RF triggers and receivers. Modification of the ground-based version allows placing this RF system into an airborne platform. Detection range and corresponding time to react to a possible threat are dramatically improved. Increased time provides greater protection for the front-line troops who are the primary targets of RF IEDs, hence reducing U.S. troop casualties. Field testing and technical feasibility demonstrations are conducted using a Naval Postgraduate School-owned TERN unmanned, aerial vehicle (UAV) at McMillan Airfield at Camp Roberts, California. The research conducted for this thesis deals primarily with the implementation and testing of this RF system onto UAVs. Several additional benefits make this RF system usable over a wide range of applications.

KEYWORDS: Improvised Explosive Devices, IEDs, Unmanned Aerial Vehicles, UAVs, Unintended RF Emissions, Remote Detection

USING KNOWLEDGE-VALUE ADDED FOR EVALUATING CRYPTOLOGICAL IT CAPABILITIES: TRIAL IMPLEMENTATION

**Ira D. Lambeth-Lieutenant, United States Navy
B.S., Louisiana State University, 1999**

Master of Science in Information Warfare Systems Engineering-September 2007

Hubert N. Clapp-Lieutenant, United States Navy

B.S., Joint Military Intelligence College, 2001

Master of Science in Information Warfare Systems Engineering-September 2007

Advisor: Thomas J. Housel, Department of Information Sciences

Second Reader: Richard D. Bergin, Department of Information Sciences

Program managers throughout the Department of Defense are faced with technology-portfolio management problems. Critical to these efforts is the need to track the performance of the technology on a routine, ongoing basis. This thesis focuses on solving this general problem in the specific context of the United States Navy's cryptologic carry-on program (CCOP). This study provides a demonstration of how a software suite that monitors process performance can be implemented to provide ongoing return on investment information about CCOP technology. This follow-on research and trial implementation demonstrate how the knowledge-value-added (KVA) methodology that is embedded in the performance monitoring software is used to formulate a framework for extracting and analyzing performance parameters and measures of effectiveness for each CCOP system. KVA is used to measure the effectiveness and efficiency of CCOP systems and the impact they have on the intelligence collection process (ICP) onboard the USS *Gonzales*. The analysis of the subprocess outputs involved in the ICP in common units of

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change, a price per unit of output, is generated to allocate both cost and revenue at the subprocess level. With this level of financial detail, a return on investment analysis can be conducted for each process.

KEYWORDS: ROI, Return on Investment, ROA, Return on Asset, IT ROI, IT Performance, IT Valuation, KVA, Knowledge Value Added, Public Sector Finance

THE VOLATILE SITUATION OF BALOCHISTAN—OPTIONS TO BRING IT INTO STREAMLINE

Abid Hussain Shah-Major, Pakistan Army
B.S., Pakistani Military Academy, 1992
B.E., National University of Science and Technology, 2002
M.S., Balochistani University, 2004
Master of Science in Information Warfare Systems Engineering-September 2007
Master of Science in Information Operations-September 2007
Advisors: Steven Iatrou, Department of Information Sciences
Robert O'Connell, Department of Defense Analysis

While most of the world's media remains focused on insurgent attacks on coalition forces, oil facilities, and Shia and Sunni sectarian attacks in Iraq, Pakistan is experiencing a rising tide of violence in the country's volatile Balochistan province, where the majority of the energy-starved country's natural-gas facilities are located. Pakistan, currently engaged in a drawn-out conflict against Al Qaeda and Taliban remnants in its northwest frontier province (NWFP), is slowly descending into conflict with anti-government forces in Balochistan province, raising the unsettling prospect of a rising second internal front against militants. A second internal front would drain resources from Pakistan's ability to maintain effective, smooth, and stable control over law and order in the country and its campaign against Al Qaeda and Taliban remnants in the NWFP and the federally administrated tribal areas (FATA).

Under the prevailing situation, conventional means to bring about peace and encourage political and economic stability seem to be elusive. In this thesis, an endeavor is made to cut deep into the root causes, historical perspective, and genesis of the socio-cultural setup in Balochistan, and to use the modern techniques and tools of IO/IW to recommend useful options for the Pakistani government to deal with this situation.

KEYWORDS: Pakistan, Balochistan, Sardars, Tumandars, Tribal System, Information Operations, Information Warfare, Psychological Warfare, Military Deception, Combat Camera, Regional Strategy, IO Tools, Conventional Warfare

INTEGRATION OF WIRELESS-NETWORK DISCOVERY- AND EXPLOIT CAPABILITIES WITHIN THE CONSTRAINTS OF THE JOINT THREAT-WARNING SYSTEM COMPONENT ARCHITECTURE AND FRAMEWORK

Charles D. Spera, Jr.-Lieutenant, United States Navy
B.S., United States Naval Academy, 2002
Master of Science in Information Warfare Systems Engineering-September 2007
Jonathan M. Hay-Lieutenant, United States Navy
B.S., University of Hawaii, 2001
Master of Science in Information Warfare Systems Engineering-September 2007
Advisor: John C. McEachen, Department of Electrical and Computer Engineering
Second Reader: LtCol Carl Oros, USMC, Department of Information Sciences

In this thesis, the integration of IEEE 802.11 wireless-network discovery, exploitation, and attack capabilities into the Joint Threat-Warning System (JTWS) Component Architecture and Framework (JCAF) is presented. JCAF is the foundation for the special operations command's (SOCOM) platform-independent, intelligence-gathering and information-processing functions. Although the capability to discover, exploit, and attack 802.11 networks already exists elsewhere, there is no common interface for all these functions. This thesis analyzes the feasibility of integrating these capabilities into the JCAF framework by examining the requirements that must be met for incorporation into JCAF. Additionally, this

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thesis considers design tradeoffs and justifies decisions made. Finally, JCAF is analyzed in terms of its suitability as an architecture for developing platform-independent, distributed systems.

KEYWORDS: 802.11, JTWS, JCAF, SPAWAR, SOCOM, Special Operations

PERCEPTION MANAGEMENT: A CORE INFORMATION OPERATIONS CAPABILITY

Khyber Zaman-Lieutenant Commander, Pakistan Navy

B.S., Karachi University, 1996

Master of Science in Information Warfare Systems Engineering-September 2007

Master of Science in Information Operations-September 2007

Advisors: Robert O'Connell, Department of Defense Analysis

Steven Iatrou, Department of Information Sciences

This thesis postulates that in today's media environment, with adversaries skillfully using propaganda to skirt the nation's resolve, Perception Management is key to military success and should therefore be an information operations (IO) core capability vis-à-vis its current consideration in the U.S. doctrine as a related IO capability.

The Kargil episode of 1999 was a political victory for India, while, from the Pakistani perspective, it was a successful tactical operation—albeit one that was not accompanied by a coordinated politico-diplomatic plan—turned into a politico-diplomatic setback. Pakistan's tactical successes in Kargil were not translated into strategic gains due to the lack of clarity over policy and, hence, the absence of a Perception Management offensive. On the contrary, India hyped the situation with the west, using its media as a key element of Perception Management to win substantial political support. Eventually, Pakistani forces had to withdraw in the face of immense international pressures.

When reviewing the Kargil conflict, a complete history of the injustices that Pakistan has been subjected to since the onset of independence in 1947 must also be considered. Pakistan's sense of historical grievance against India—fueled especially by exploitation of an internal crisis in Eastern Pakistan (now Bangladesh) in 1971, occupation of the Siachen glacier in 1984 (despite the 1972 Simla agreement), planning of a pre-emptive attack on Pakistan's nuclear facilities in the garb of the 1987 Brasstacks exercise, suppression of the Kashmiri people for decades, and a series of subsequent incursions and skirmishes along the northern Line of Control (LoC)—raised the concerns and fears of yet another Indian aggression in 1999 in the northern areas. Therefore, Pakistani forces took a “forward defense posture across the LoC” at a time when the Kashmiri Mujahideen had occupied vacated Indian winter positions to settle scores with Indians and draw them away from Indian-occupied Kashmir.

As only the Indian disinformation about Kargil was publicized and myths were promoted, the real history of Kargil became obscured. It is a central aim of this thesis to present the Pakistani case and provide a balancing viewpoint through Pakistani eyes.

KEYWORDS: Perception Management, Information Operations, Core Capability, Media, Kargil Conflict

MASTER OF SCIENCE IN LEADERSHIP AND HUMAN RESOURCE DEVELOPMENT

AN EXPLORATORY ASSESSMENT OF THE UNITED STATES NAVAL ACADEMY'S ETHICAL-DECISION-MAKING INSTRUMENT

**Wayne R. Beyer, Jr.-Major, United States Marine Corps
B.A., Northern Illinois University, 1994**

Master of Science in Leadership and Human Resource Development-September 2007

Advisor: Linda Mallory, United States Naval Academy

Second Reader: Brad Johnson, United States Naval Academy

This study examines the development of a survey called the Ethical-Decision-Making Instrument (EDMI). The study answers two questions regarding moral development at the Naval Academy. The first question involves determining if there is a difference in moral thinking between year groups at the Naval Academy. The second question involves determining whether men and women think differently in regards to moral reasoning and decision making. In answering the first question the study determines that a significant change in moral cognitive thought occurs in the brigade of midshipmen, primarily after the first year. In answering the second question, the study determines that differences in moral cognitive thought based on gender exist, but only slightly. The data also shows that a midshipmen's propensity to recognize when a moral issue exists actually decreases after their first year. Also, a midshipman's likelihood to indicate that they would take appropriate action in a morally challenging situation also decreases after the first year. The study concludes with recommendations for further research involving the dissection of the EDM I and its many possibilities.

KEYWORDS: Ethical Decision Making, Moral Reasoning, Moral Development

A STUDY OF RELIGIOUS FAITH AND THE ETHICAL-DECISION-MAKING PROCESS

**Kurt R. Parsons-Lieutenant, United States Navy
B.A., Jacksonville University, 1998**

Master of Science in Leadership and Human Resource Development-September 2007

Advisor: Brad Johnson, United States Naval Academy

Second Reader: Linda Mallory, United States Naval Academy

The purpose of this research is to determine if religious faith affects the moral-decision-making process of midshipmen at the United States Naval Academy. This is a quantitative analysis based on two surveys (N=319): the Ethical Decision Making Instrument (EDMI) and a faith survey. The author constructs a theoretical and statistical model to identify a dependent variable that shows intention in moral decision making. A thorough literature review is conducted to identify variables linked to moral decision making. A linear regression analysis using four faith components from the faith survey is then conducted. Results indicate that the faith component does not have an affect on the moral-decision-making process of midshipmen. Midshipmen view social consensus (or peer influence) as significant in every moral decision scenario. Self-interest and the consequence of actions also contribute to the moral decisions made. Finally, gender is significant in this process; men and women evaluate moral situations differently. This study summarizes these findings and provides recommendations to the United States Naval Academy.

KEYWORDS: Leadership, Military, Naval Academy, Decision Making, Morality, Religion, Ethics, Training, Officers, Students, USNA

MASTER OF SCIENCE IN MANAGEMENT

VOLUNTARY EDUCATION OF ENLISTED SERVICE MEMBERS: AN ANALYSIS OF PROGRAM EFFECTS ON RETENTION AND OTHER OUTCOME MEASURES

Douglas L. Barnard-Lieutenant Commander, United States Navy

B.S., Westminster College, 1993

Master of Science in Management-September 2007

Elizabeth F. Zardeskas-Lieutenant Commander, United States Navy

B.S., Radford University, 1990

Master of Science in Management-September 2007

Advisors: Stephen L. Mehay, Graduate School of Business and Public Policy

Elda Pema, Graduate School of Business and Public Policy

This thesis analyzes the Navy's tuition-assistance (TA) program. The thesis focuses on the effect of participation in TA on reenlistment and promotion outcomes for enlisted personnel. The statistical analysis is performed using data from: 1) Defense Manpower Data Center enlisted personnel files for cohorts, fiscal years (FY) 1991-2001; 2) Military Entrance Processing Command accession information on those same cohorts; and 3) TA usage data from FY95-FY01 from the Navy Center for Personal and Professional Development. The analysis finds that sailors who use TA have a higher probability of reenlistment and promotion than those who do not. The successful completion of at least one college course results in even higher probabilities of reenlistment and promotion. These findings confirm the positive relationship between investment in human capital and reenlistment (i.e., retention) found in two previous military and one civilian study. The thesis recommends that future research on this topic include data sufficient to adjust for potential selection bias in the statistical estimates.

KEYWORDS: Voluntary Education Program, VOLED, Tuition Assistance, TA, Reenlistment, Promotion, Human Capital, Enlisted Education Quick Poll

AN ANALYSIS OF HUMAN-RESOURCE OFFICERS IN SUPPORT OF MPT&E ENTERPRISE MANAGEMENT: A SUCCESSION-MANAGEMENT PLAN FOR HUMAN-CAPITAL MANAGERS

Derrick E. Blackston-Lieutenant Commander, United States Navy

B.A., Creighton University, 1997

Master of Science in Management-September 2007

Advisor: William D. Hatch, Graduate School of Business and Public Policy

Second Reader: Benjamin Roberts, Graduate School of Business and Public Policy

The purpose of this research is to examine the human-resource community's ability to effectively manage its human capital (active-duty officers) and to establish this as the foundation for value creation. In today's market, be it on Wall Street, Main Street, or Army-Navy Boulevard, value creation is dominated by human capital and other intangible assets. Ironically, these most important assets are the least understood, least prone to measurement, and hardest to manage. Thus, an analysis for improvement using a systems-control-theory model provides an important step forward in the Navy's ability to better manage its human capital. An assessment is conducted through interviews of community managers, experts, and participants, and a review of previous manpower studies. This research reveals critical control points whereby the HR-community manager (OCM) could leverage considerable change within the system to gain the desired effects of the human-resource succession-management plan. These control points are found through analysis of inputs, processes, and outputs pertaining to an HR officer's promotion, assignment, and education. This analysis shows that the HR-community manager could influence human-resource career

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progressions through the education process. The management of education–skill requirements and interaction with Naval Postgraduate School faculty will ensure alignment and acquisition of knowledge, skills, and abilities. These skills will support HRO and the warfighting enterprises to ensure a succession-management plan that reduces gaps and mismatches of human-resource billets.

KEYWORDS: Human Resource Officer, Succession Management, Workforce Planning, MPT&E System, Graduate Education, HR Management, Manpower, Personnel, Enterprise Management

ENLISTMENT DECISIONS OF THE MILLENNIAL GENERATION: AN ANALYSIS OF MICRO-LEVEL DATA

**Kevin M. Halfacre-Lieutenant, United States Navy
B.S., Jacksonville University, 1999**

Master of Science in Management-September 2007

Advisors: Stephen L. Mehay, Graduate School of Business and Public Policy

Elda Pema, Graduate School of Business and Public Policy

This thesis examines enlistment decisions of youth in the Millennial Generation based on individual-level data. Current recruiting policies are based upon studies that were conducted in the 1980s and 1990s. To update the factors that influence individual enlistment decisions of youth in the Millennial Generation, a nationwide representative survey of youth born between 1980 and 1984—the 1997 National Longitudinal Survey of Youth—is analyzed. The data set is used to compare enlistment decisions of previous generations and to update the potential background characteristics that affect the post–high-school decisions of American youth. In addition to using demographic data similar to previous studies, four additional predictors of enlistment are examined: high-school type; participation in high-school vocational, academic, and JROTC programs; educational classification; and legal issues. Results show that there are some differences in the factors that affect enlistment decisions across generations based upon demographic data, type of high-school programs, and legal background.

KEYWORDS: Navy, Enlistment, Recruiting, NLSY97

AN OPERATIONAL-MANPOWER ANALYSIS OF THE RQ-8 FIRE SCOUT, VERTICAL TAKE-OFF, UNMANNED AERIAL VEHICLE

**Matthew C. Stracker-Lieutenant Commander, United States Navy
B.A., Ohio State University, 1996**

Master of Science in Management-September 2007

Advisor: William D. Hatch, Graduate School of Business and Public Policy

Second Reader: Benjamin Roberts, Graduate School of Business and Public Policy

In August of 2001, the Secretary of the Navy announced that the Navy would expand work and experimentation in unmanned-vehicle systems. After the events of September 11th, this was accelerated with increased urgency in order to combat terrorism and asymmetric threats. The U.S. Navy is currently undergoing testing and evaluation of the Fire Scout vertical take-off, unmanned aerial vehicle (VTUAV) and its integration into the fleet.

An in-depth analysis of the Fire Scout’s manpower requirements is necessary as part of total force integration. Currently, the Navy only utilizes aviation ratings by requirement and assignment as unmanned-aerial-system operators, unlike the Army and Marine Corps. Currently, the littoral-combat-ship manpower requirements exceed the Navy’s target of 25 persons for the combined RQ-8B and SH-60 air detachment. Analysis shows that a possible remedy to this problem is to allow non-aviation ratings the opportunity to operate the Fire Scout. This change in policy and occupational standards would generate greater operational capability and personnel flexibility for this newly acquired air ship and surface platform.

Specifically, occupational research shows that the aviation-administrationman (AZ) rating is no more qualified to operate a Fire Scout VTUAV than the operations-specialist (OS) rating. In fact, it can be argued that an OS is better qualified according to occupational standards to operate the Fire Scout. Therefore, one of the recommendations of this research is to add operational specialist as a source rating to NECs 8363 and 8364 immediately.

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KEYWORDS: Unmanned Aerial Vehicles, UAV, Vertical Take-Off Unmanned Aerial Vehicle, VTUAV, Fire Scout, Littoral Combat Ship, LCS, Knowledge, Skills and Abilities, KSA, Manpower, Personnel, Manning, Requirements, UAV Operator, Occupational Standards

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

FINITE-ELEMENT-BASED STRUCTURAL-DAMAGE DETECTION USING ARTIFICIAL-BOUNDARY CONDITIONS

**Rafael A. Lagunes Arteaga-Lieutenant, Mexican Navy
B.S., Mexican Naval Academy, 1992**

Master of Science in Mechanical Engineering-September 2007

Advisor: Joshua H. Gordis, Department of Mechanical and Astronautical Engineering

Finite-element (FE) models can be used to discern the location and severity of damage in structures. This is frequently pursued by using the differences in measured and computed natural frequencies in conjunction with the sensitivities calculated using the FE model. Given that a modal test produced a limited number of natural frequencies for a structure, the concept of artificial-boundary conditions (ABCs) was developed, which yields additional natural frequency information for a structure. This is accomplished by artificially imposing additional boundary conditions to the measured data. In this thesis, the use of ABCs to produce an improved set of structural sensitivities is explored. It is shown that the selection of ABC sets is best guided by the strain energy distribution in the structure.

KEYWORDS: Artificial Boundary Conditions, Finite Element Model, Natural Frequencies, Sensitivity Based Updating, Strain and Kinetic Energies

SENSITIVITY AND TRADE-OFF ANALYSIS OF WAVE-MAKING RESISTANCE AND STABILITY OF SMALL-WATERPLANE-AREA TRIMARANS

**Brian R. Boudreau-Lieutenant, United States Navy
B.S., Auburn University, 2003**

Master of Science in Mechanical Engineering-September 2007

Advisor: Fotis Papoulias, Department of Mechanical and Astronautical Engineering

Recent concept-ship designs have called for a vessel capable of lifting and transporting multiple medium-displacement combatant boats (approximately 40 to 100 tons) at high speeds over thousands of nautical miles. One such design placed two small waterplane area (SWATH) side hulls significantly aft of the center hull transom to facilitate a heavy duty hoist system. This thesis determines the optimal longitudinal and lateral positioning of small waterplane area side hulls, and the number of and associated position of struts that would be used in a large displacement small waterplane area trimaran design. The analysis explores 18 different small waterplane area side hull configurations to verify, through a series of computational fluid dynamics calculations, the total resistance and wake characteristics of the overall hull designs. A mathematical analysis of the wave making, frictional, and pressure resistance of each of the hull configurations is developed using the Rankine panel method from the surface wave and flow analysis software package called SWAN2. Static stability and geometry data is generated for the concept design using computer aided design and Rhinomarine hydrostatic-analysis software. A systematic analysis of the results is conducted in order to determine the optimal side hull; separation, longitudinal position, and number of struts for best resistance and static stability, which can then be used in a systems engineering process for further study on the feasibility of using a small-waterplane-area trimaran for a concept design.

KEYWORDS: Trimaran, Wave Resistance, Small Waterplane Area, SWATH, Optimization, SWAN2, Mothership

MECHANICAL ENGINEERING

AGING EFFECTS ON MICROSTRUCTURE AND CREEP IN SN-3.8AG-0.7CU

Orlando Cornejo-Lieutenant Commander, Chilean Navy

B.S., Chilean Polytechnic Academy, 1993

Master of Science in Mechanical Engineering-September 2007

Advisor: Indranath Dutta, Department of Mechanical and Astronautical Engineering

Solder joints provide mechanical and electrical interconnections between electronic devices and packaging substrates in electronics applications. The different coefficients of thermal expansion (CTE) between substrate, silicon device, and solder imposes strains on the solder joint. Creep constitutes the primary deformation mechanism, limiting the low cycle-fatigue life of a solder joint. The trend toward miniaturization, higher service temperatures, and higher current densities, and the transition to lead-free solders (which possess higher melting points than leaded solders) aggravates the situation. Therefore, knowledge of properties and performances is needed to predict the lifetime of solders in order to successfully assure applications in electronic assemblies. This study focuses on the change of microstructure due aging in bulk and ball joints, and a preliminary analysis of the primary creep behavior of Sn-3.8Ag-0.7Cu. Differences in microstructure evolution between bulk and small joints are highlighted.

KEYWORDS: Lead-Free, Solders, SAC-387, Microstructure

MASTER OF SCIENCE IN METEOROLOGY

PERFORMANCE OF HYBRID EULERIAN-LAGRANGIAN, SEMI-IMPLICIT TIME- INTEGRATORS FOR NON-HYDROSTATIC, MESOSCALE, ATMOSPHERIC MODELING

**Thomas J. De Luca-Second Lieutenant, United States Air Force
B.A., Cornell University, 2004**

Master of Science in Meteorology-September 2007

Master of Science in Applied Mathematics-September 2007

**Advisors: Francis X. Giraldo, Department of Applied Mathematics
CDR Rebecca E. Stone, USN, Department of Oceanography**

In this thesis, the performance and accuracy of explicit, semi-implicit, and Hybrid Eulerian-Lagrangian semi-implicit (HELSE) time-integration methods used in atmospheric modeling are examined. Four test cases are analyzed: a density current, an inertial gravity wave, a rising thermal bubble, and a hydrostatic mountain wave. Strict attention is paid to computational time, stability criteria, and accuracy. The project aims to show increased efficiency using the HELSE method over fully semi-implicit methods, which, in turn, should be better than the split-explicit methods currently used in mesoscale models such as WRF, COAMPS, and the German LM model. This increase in efficiency allows for valuable computational resources to be used for other purposes, such as improved data assimilation, increased spatial resolution, or more detailed physics.

KEYWORDS: HELSE, Semi-Implicit, Time-Integration, Atmospheric Modeling, NWP

SENSOR-MODEL REQUIREMENTS FOR TAWS/IRTSS OPERATION

**Rachel Hughes-Second Lieutenant, United States Air Force
B.S., Houghton College, 2003**

Master of Science in Meteorology-September 2007

**Advisors: Andreas Goroeh, Naval Research Laboratory-Monterey
Kenneth Davidson, Department of Meteorology**

Possible improvements to the minimum resolvable temperature difference (MRTD) entered into TAWS are considered. FLIR92 is modified to include atmospheric turbulence, which depends on height in the atmosphere. Resultant MRTDs are compared to the operational FLIR92 MRTD predictions excluding atmospheric turbulence. The difference in the MRTD is only apparent in the higher frequency regime and is less than 0.05% of the MRTD values for a typical test case. MRTD is calculated by FLIR92 and NVThermIP over desert and marine locations. The resultant MRTDs are entered into TAWS to compare maximum detection range. NVThermIP yields a larger maximum detection range by up to 1.5% over the desert and 2% over water.

KEYWORDS: TAWS, FLIR92, NVThermIP, Atmospheric Turbulence, MRTD

METEOROLOGY

A SMART CLIMATOLOGY OF EVAPORATION-DUCT HEIGHT AND SURFACE RADAR PROPAGATION IN THE INDIAN OCEAN

Katherine L. Twigg-Lieutenant, Royal Navy
M.S., University of Durham, 1997

Master of Science in Meteorology-September 2007

Advisors: James T. Murphree, Department of Meteorology
Paul A. Frederickson, Department of Meteorology

Surface electromagnetic propagation over the ocean is highly sensitive to near-surface atmospheric variability, particularly the height of the evaporation duct. Seasonal variation in near-surface meteorological factors and sea surface temperatures impact the evaporation-duct height (EDH). Present U.S. Navy EDH climatology is based on sparse ship observations over a relatively short period and an outdated evaporation-duct (ED) model. This EDH climatology does not utilize smart, or modern, climatology datasets or methods and provides only long-term mean (LTM) values of EDH. Existing civilian, dynamically balanced reanalysis data for 1970 to 2006 and a state-of-the-art ED model are used to produce a spatially and temporally refined EDH climatology for the Indian Ocean (IO) and nearby seas. Comparisons of the present U.S. Navy EDH climatology with our climatology show a number of differences. These differences, and the differences in the methods used to generate the two climatologies, indicate that the EDH climatology generated in this research provides a more accurate depiction of EDH.

The EDH climatology produced provides LTM EDH values, but the data and methods used to create this climatology also allow examination of the impacts of climate variations on EDH. Climate variations can have major impacts on the upper ocean and overlying lower troposphere. These impacts can lead to major fluctuations in the factors that determine EDH, and can thereby alter the propagation of EM signals through the atmosphere. The IO and nearby seas are strongly affected by a number of climate variations (e.g., El Niño-La Niña (ENLN), Indian Ocean Zonal Mode (IOZM)). These climate variations are known to lead to large anomalies in sea surface temperature, air temperature, winds, humidity, and other variables in the IO; however, the associated impacts on EDH and EM propagation have not been identified. To assess these impacts, reanalysis data composited by season and climate variation are processed using: 1) the Naval Postgraduate School (NPS) ED model to assess the impacts of the climate variations on EDH; and 2) the Advanced Refraction Effects Prediction System (AREPS) to assess the impacts of the variations on radar propagation. Results show significant variations in EDH and AREPS ranges associated with the climate variations that affect the IO and nearby regions. These climate variations are predictable on weekly and longer time scales. In addition, for several seasons, EDH is significantly correlated with the climate variation when EDH lags by zero, one, and two months. Thus, there appears to be potential for climate scale forecasting of EDH and radar propagation at weekly to monthly lead times.

For areas of operational interest, correlation analyses of EDH with its associated factors are conducted to further the understanding of the processes that cause spatial and temporal variations of EDH. These correlation results provide insights into the spatial and temporal sensitivity of EDH to the factors. Thus, they provide guidance on how to focus research, development, and operational efforts aimed at improving analyses and forecasts of EDH.

The EDH climatology created in this study is used to generate climatological sensor performance surfaces for radar propagation. These surfaces are maps of climatological surface radar propagation over the IO and nearby seas under different climatological conditions (e.g., different months, locations, climate variations, and regimes). The performance surfaces are prototypes of operational climatological products, and examples of the improved climatological products that can be developed using smart climatology data and methods.

These results indicate that climatological support for military planners could be substantially improved by using a smart climatology approach (i.e., applying state-of-the-art climate datasets, analysis, and forecasting methods).

KEYWORDS: Climatology, Smart Climatology, Evaporation Duct Height, Radar Propagation, Radar Detection Range, Sensor Performance, Performance Surface, Indian Ocean, Climate Variations, El Niño, La Niña, Indian Ocean Zonal Mode, North Atlantic Oscillation, U.S. Navy, Royal Navy

MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

ENHANCEMENT OF THE DAYTIME MODIS-BASED ICING POTENTIAL USING NOGAPS AND COAMPS MODEL DATA

**Richard L. Davidson, Jr.-Lieutenant, United States Navy
B.S., The Citadel, 2001**

Master of Science in Meteorology and Physical Oceanography-September 2007

**Advisor: Philip A. Durkee, Department of Meteorology
Second Reader: Kurt Nielsen, Department of Meteorology**

In this thesis, NOGAPS and COAMPS model data are fused with the Alexander (2005) algorithm to determine its usefulness in enhancing satellite-based aircraft-icing analysis. This is a follow on to Cooper (2006) research where MM5 and ETA were used. Using historical NOGAPS and COAMPS data (T, Td, and RH) accessed from the GODAE server, several storms from 2004 are fused with available MODIS imagery from the same storms to produce an enhanced icing product. Pilot reports (PIREPS) are used as a validation tool to determine where icing was taking place during the storms analyzed. A comparison is made between the MODIS-based icing potential and the model-based icing potential. The two icing potentials are fused together to produce an enhanced icing product. Statistical analysis using ROC curves is performed on the various combinations to determine which product combination gives the best results. Two different available Tmap (Alexander and CIP) are used and have mixed results. Contrary to what Cooper (2006) found, where weighting RH and the Alexander Tmap produced the best results, this study finds that equal weighting of T and RH and the CIP Tmap produce the same or better results than weighting RH. This study also finds that NOGAPS combined with the MODIS algorithm provide the best icing potential results.

KEYWORDS: MODIS, Icing, UAV, NOGAPS, COAMPS, ROC, PIREPS, Multispectral Satellite Analysis

THE EFFECT OF OCEANOGRAPHIC CIRCULATION IN MONTEREY BAY ON PLANKTON ECOLOGY: AN ANALYSIS OF THE NAVY COASTAL OCEAN MODEL

**Adria R. McClain-Lieutenant, United States Navy
B.S., University of California-San Diego, 1999
M.A., American Military University, 2005**

Master of Science in Meteorology and Physical Oceanography-September 2007

**Advisor: Jeffrey D. Paduan, Department of Oceanography
Second Reader: Curtis A. Collins, Department of Oceanography**

Blue whales migrate to Monterey Bay, California, between June and November to feed on dense euphausiid schools that form near the offshore edge of the submarine canyon. The seasonal arrival of the whales may be linked to predictable krill abundance. There are two hypotheses concerning euphausiid accumulation: 1) krill accumulate in areas where current flow is consistently weak, and 2) krill accumulate in areas of high primary production. This study examines output from the high-resolution Navy Coastal Ocean Model (NCOM) and correlates the circulation features predicted by the model with observed biological distributions. The model output indicates that the Monterey Bay submarine canyon is a region of weak current flow and low current variability. Model current fields show that nutrient-rich water from a nearby upwelling center flows into the bay, making it conducive to primary productivity. Knowledge of how physical oceanographic factors affect marine food webs will facilitate the prediction of areas where marine mammals are likely to be present and will enable the designation of marine sanctuaries.

METEOROLOGY AND PHYSICAL OCEANOGRAPHY

KEYWORDS: Monterey Bay, Blue Whales, Marine Mammals, Trophic Links, Krill, Zooplankton, Phytoplankton, Plankton Ecology, Navy Coastal Ocean Model

DIRECT NUMERICAL SIMULATIONS OF THE DIFFUSIVE CONVECTION AND ASSESSMENT OF ITS IMPACT ON ARTIC CLIMATE CHANGE

Ivo J. Prikasky-Lieutenant Commander, United States Navy

B.A., Binghamton University, 1995

Master of Science in Meteorology and Physical Oceanography-September 2007

Advisor: Timour Radko, Department of Oceanography

Second Reader: William Shaw, Department of Oceanography

This thesis focuses on the numerical modeling of the oceanic double-diffusive convection, an important small-scale mixing process that is driven by the two orders of magnitude's difference in diffusivities of heat and salt in seawater. This study explores the diffusive regime of double diffusion, which is realized when cold and fresh water overlies warm and salty water. The aim of this research is to quantify the double-diffusive transport in both smooth gradients and thermohaline staircases, and to develop clear insight into the origin of the staircases and specify conditions for their formation. Based on numerical process modeling, it is determined that the evolutionary pattern of staircases is controlled by the merging events in which weak interfaces gradually erode and ultimately disappear. To illustrate dynamics of these events, a theoretical framework—merging theorem—is developed. It is numerically confirmed that the merging theorem predicts the time scale of merging events within the order of magnitude. The validity of the lab derived $4/3$ flux law is tested and it is determined that its form is consistent with the numerical results, but the amplitude requires adjustment. The computed fluxes from numerical experiments are comparable to the diffusive fluxes inferred from the Beaufort Gyre observations (Wilson, 2007), and an order of magnitude greater than the fluxes from earlier laboratory-based experiments. Although a large discrepancy in the values of diffusive fluxes exists in the earlier laboratory and field studies, the present analysis suggests that the diffusive fluxes could play an important factor in the Arctic heat budget; hence, future study in this field is recommended. This study contributes to a better understanding of global climate change, which presents a new challenge to national security. The Navy has to be concerned with the impact of climate change on naval operations, specifically in the Arctic, where the melting polar ice cap may soon provide a gateway across the north, resulting in the opening of shipping lanes and borders.

KEYWORDS: Double-Diffusion, Diffusive Convection, Flux, Thermohaline Staircase, Merging

UNDERSTANDING RECENT VARIABILITY IN THE ARCTIC SEA ICE COVER – SYNTHESIS OF MODEL RESULTS AND OBSERVATIONS

John Whelan-Lieutenant Commander, United States Navy

B.S., Rensselaer Polytechnic Institute, 1992

Master of Science in Meteorology and Physical Oceanography-September 2007

Advisor: Wieslaw Maslowski, Department of Oceanography

Second Reader: William Shaw, Department of Oceanography

This thesis provides a continuation of the analysis of the diminishing sea-ice trend in the Arctic Ocean by examining results from the Naval Postgraduate School's 1/12 degree pan-Arctic coupled ice-ocean model. While many previous studies have analyzed changes in ice extent and concentration, this research focuses on ice thickness as it gives a better representation of ice volume variability.

The skill of the model is examined by comparing its ice thickness output to actual sea-ice thickness data gathered during the last three decades. The model comparison is made against the most recently released collection of Arctic ice-draft measurements conducted by U.S. Navy submarines between 1979 and 2000.

The NPS model indicates an accelerated thinning trend in Arctic sea ice during the last decade. The validation of model output with submarine upward-looking sonar data supports this result. This lends credence to the postulation that the Arctic is likely to be ice-free during the summer in the near future. From the naval perspective, the diminishing Arctic sea ice will have significant implications for both the physical and operational environment in which the Navy currently operates.

METEOROLOGY AND PHYSICAL OCEANOGRAPHY

KEYWORDS: Polar Oceanography, Arctic Ice Pack, Ice Thickness Distribution, Arctic Ocean Modeling, NPS Pan-Arctic Coupled Ice-Ocean Model, Submarine Upward-Looking Sonar, ULS, Climate Change

STRUCTURE AND DYNAMICS OF THE THERMOHALINE STAIRCASES IN THE BEAUFORT GYRE

**Ana L. Wilson-Lieutenant, United States Navy
B.S., United States Naval Academy, 2000**

Master of Science in Meteorology and Physical Oceanography-September 2007

Advisor: Timour Radko, Department of Oceanography

Second Reader: John Colosi, Department of Oceanography

This study explores the dynamics of diffusive convection that occurs when cold, fresh water overlies warm, salty water. Diffusive convection is generally observed in high-latitude regions, particularly in the Arctic Ocean, between the base of the mixed layer and the top of the Atlantic water. The primary convective regime in this region is characterized by the spontaneous formation of well mixed layers separated by thin, high-gradient interfaces known as thermohaline staircases.

Data analysis and analytical considerations are used to estimate the vertical heat/salt mixing rates and their dependencies on large-scale environmental parameters. Ice-tethered profiler data from the Beaufort Gyre are analyzed to determine the origin of the thermohaline staircases and the mechanism for selection of the preferred layer thickness. Based on the analysis of Beaufort staircases, it is suggested that the layer thickness, as well as the vertical heat/salt fluxes, is controlled by the patterns of merging events in which relatively small steps are systematically eliminated. Significant concerns are raised with regard to the direct extrapolation of laboratory-derived flux laws to ocean conditions—a conventional approach to the analysis of the Arctic staircases. An alternative and more accurate method of analysis is proposed, involving recalibration of the laboratory-derived flux laws for oceanic conditions.

Extrapolated diffusive convective fluxes are in the range of $1-6 \text{ Wm}^{-2}$, which is comparable to the magnitude of fluxes currently unaccounted for in the Arctic heat budget. It is proposed that the parameterizations of the diffusive fluxes in thermohaline staircases (developed in this thesis) can be used to enhance understanding of Arctic climate changes and predictive capabilities of large-scale numerical models. Preliminary findings are indicative of the importance of diffusive convection for sound propagation in the Arctic region – a problem of great interest for various Naval research applications in the area.

KEYWORDS: Double-Diffusion, Diffusive Convection, Thermohaline Staircases

MASTER OF SCIENCE IN MODELING, VIRTUAL ENVIRONMENTS, AND SIMULATION

EFFECTIVENESS EVALUATION OF FORCE-PROTECTION TRAINING USING COMPUTER-BASED INSTRUCTION AND X3D SIMULATION

Wilfredo Cruzbaez-Lieutenant, United States Navy

B.A., Norfolk State University, 2001

Master of Science in Modeling, Virtual Environments, and Simulation-September 2007

Advisors: Donald P. Brutzman, Department of Information Sciences

Anthony Ciavarelli, MOVES Institute

Due to growing operational constraints accelerated by the global war on terrorism, the United States Navy is looking for alternative methods of training to maintain its force in a high status of readiness. Updates in technology over the last decade have prompted Navy officials to take the initiative to update training technologies. Computer-based instruction provides alternative means of training so that the training of war-fighters can be accomplished efficiently and effectively, saving the Navy time and resources while maintaining a high state of readiness. The goal of this thesis is to combine the principles of instructional-design systems (ISD) technology and advanced simulation in order to produce a multimedia training capability for Navy and Marine Corps officers.

Specifically, this thesis applies ISD principles to engineer and improve the Anti-Terrorism Force Protection (AT/FP) Officer Course Level II (ATO Level II Course) lessons for use by Navy and Marine Corps officers. The SavageStudio scenario generation application, originally designed for assessment of force protection measures in a port environment, is used to allow students to develop simulation lessons for this course.

The final product of this thesis is a training course consisting of two lessons combining computer-based training and simulation (providing interactive lessons and exercises) and two media-delivery comparison studies with results for the anti-terrorism force protection lessons. The first study compares the media effectiveness of computer-based training versus classroom instruction. The second assesses the effectiveness of computer-based training and the use of simulation for AT/FP.

KEYWORDS: Discrete Event Simulation, Simkit, Diskit, Viskit, RHIB, ISD, Java, XML, Distributed Interactive Simulation, DIS

EXTENDING DEPARTMENT OF DEFENSE MODELING AND SIMULATION WITH WEB 2.0, AJAX, AND X3D

Michael A. Farias-Lieutenant, United States Navy

B.S., United States Naval Academy, 2002

Master of Science in Modeling, Virtual Environments, and Simulation-September 2007

Advisor: Donald P. Brutzman, Department of Information Sciences

Second Reader: Don McGregor, MOVES Institute

The Department of Defense has much to gain from open-source Web 2.0 and Ajax applications. The Java language has come a long way in providing real-world case studies and scalable solutions for the enterprises that are currently in production on sites such as eBay.com (<http://www.ebay.com>) and MLB.com (<http://www.mlb.com>). The most popular Ajax application in production is Google Maps (<http://maps.google.com>), which serves as a good example of the power of the technology. Open-source technology has matured greatly in the past three years and is now mature enough for deployment within DoD systems. In the past, management within the DoD has been reluctant to consider enterprise-level

MODELING, VIRTUAL ENVIRONMENTS, AND SIMULATION

open-source technologies as a solution for fear they might receive little to no support. In fact, the open-source business model is entirely based on first developing a broad user base and then providing support as a service for their clients.

DoD modeling and simulation can create dynamic and compelling content that is ready for the challenges of the 21st century and completely integrated with the Global Information Grid (GIG) concept. This paper presents a short history of model view controller architectures (MVC) and describes various pros and cons of each framework (Struts, Spring, Java Server Faces), which are critical for the deployment of a modern Java web application. Ajax and various frameworks are also discussed (Dojo, Google Web Toolkit (GWT), ZK, and Echo2). The paper touches on Ajax3D technologies and the use of Rez to generate simple 3D models of entire cities. This thesis includes a discussion of possible extended functionality of the Rez concept to create a terrain system like Google Earth in X3D.

KEYWORDS: Asynchronous JavaScript and XML, Ajax, Web 2.0, Mashups, Extensible X3D Graphics, X3D, Extensible X3D Earth, X3DEarth, Rez, Extensible Markup Language, XML, Extensible Markup Language Style Sheet, XSLT, Java, Open Source, Server Side Architecture, Model View Controller, MVC, Keyhole Markup Language, KML, Terrain, Collada, MOVES, SAVAGE

TRAINING METHODS AND TACTICAL DECISION-MAKING SIMULATIONS

Charles N. Fitzpatrick, III-Major, United States Marine Corps

B.E.D., Texas A&M University, 1990

Master of Science in Modeling, Virtual Environments, and Simulation-September 2007

Ümit Ayvaz-Captain, Turkish Army

B.S., Turkish Military Academy, 1997

Master of Science in Modeling, Virtual Environments, and Simulation-September 2007

Advisors: Amela Sadagic, MOVES Institute

Anthony Ciavarelli, MOVES Institute

Introducing simulation training to ground officers for the first time, within an existing proven curriculum, presents a number of challenges and questions. The proper amount of simulation time to evaluate and train skill sets and how to introduce simulation into an existing curriculum are mostly unknown. Two studies have been completed at the Naval Postgraduate School (NPS). The first study examined the length of time and the most appropriate method for introducing simulation training to a user. The second study compared the use of the Close Combat Marines (CCM) Tactical Decision-Making Simulation (TDS) with the traditional method of training decision-making called the Tactical Decision-Making Game (TDG). The TDS and TDG were used in a between-subjects experimental design to examine the viability of each with regard to their ability to evaluate several important military traits. It is found that both the TDG and the TDS methods are useful in evaluating a participant's leadership characteristics and decision-making ability. However, only the TDS is capable of evaluating situational-awareness. Results also address a novel way in which these two approaches could be combined to amplify each other's potential in training of ground officers and military personnel in general.

KEYWORDS: Tactical Decision-Making Simulation, Tactical Decision-Making Game, Leadership, Decision-Making, Situational Awareness, Close Combat Marine

MASTER OF SCIENCE IN OPERATIONS RESEARCH

PREDICTING THE NUMBER OF POTENTIAL MILITARY RECRUITS OVER THE NEXT TEN YEARS WITH APPLICATION TO RECRUITER PLACEMENT

**Donald L. Britton-Lieutenant, United States Navy
B.S., University of Tennessee, 1999**

Master of Science in Operation Research-September 2007

Advisor: Samuel E. Buttrey, Department of Operations Research

Second Reader: CDR David Schiffman, USN, Department of Operations Research

The object of this thesis is to evaluate Navy recruiter placements, as resource allocation directly affects organizational efficiency and mission success. In order to produce a model to assist decision makers, this study analyzes: 1) demographic characteristics of past military applicants, 2) recruiter assignment histories, 3) station ZIP codes, and 4) predicted populations within each ZIP code. ZIP-code-level analysis is performed on more than four million records provided by the Defense Manpower Data Center. The records consist of all military applicants (those who applied for military service with the intention of enlisting) and accessions (those who reported to basic training) from October 1998 - September 2006. Records contained home-of-record ZIP code and demographic information, including age, race, gender, and education. Woods and Poole population data, provided by the Navy Recruiting Command, is then merged in order to incorporate the 990 possible combinations of demographic characteristics for each ZIP code of the national population from 2000-2020. Computation of service-specific propensities (that is, expected numbers of military applicants) shows that the Navy has been successful in its attempt to effectively place recruiters in order to exploit the available target market. A series of comparison tables is developed to aid decision makers.

KEYWORDS: ZIP Code, Demographics, Recruiter Assignment, Age, Race, Education, Gender, Population Prediction

COST ESTIMATION OF POST-PRODUCTION SOFTWARE SUPPORT IN GROUND COMBAT SYSTEMS

**Christopher J. Cannon-Captain, United States Marine Corps
B.S., Carnegie Mellon University, 1998**

Master of Science in Operations Research-September 2007

Advisors: Daniel A. Nussbaum, Department of Operations Research

Gregory K. Mislick, LtCol, USMC (Ret.), Department of Operations Research

Weapon systems and programs are becoming increasingly more dependent on software as a critical technology for the success of the programs. Along with this dependence on performance, the costs associated with software are becoming an increasing share of the life cycle costs of these weapon systems and programs. Lifecycle software costs are divided into development and maintenance. This thesis furthers the understanding of the full lifecycle costs associated with software in weapon systems. In addition to specific results on ground combat systems presented, the thesis provides insight into maintaining other large, software-dependent systems. Recommendations on further research in the field are presented.

KEYWORDS: Post Production Software Support, Cost Estimation, Future Combat System, FCS, Empirical Distribution, 3-Parameter Gamma Distribution, System Evaluation and Estimation of Resources-Software Estimation Model, SEER-SEM

OPERATIONS RESEARCH

IMPLEMENTATION OF THE QUANTIFIED JUDGMENT MODEL TO EXAMINE THE IMPACT OF HUMAN FACTORS ON MARINE CORPS DISTRIBUTED OPERATIONS

**Matthew S. Desmond-Captain, United States Marine Corps
B.S., United States Naval Academy, 1999**

Master of Science in Operations Research-September 2007

Advisor: Nita L. Miller, Department of Operations Research

Second Reader: Lawrence G. Shattuck, Department of Operations Research

The distributed-operations (DO) concept is designed to answer the challenge of covert, highly-adaptable enemies operating with a dispersed command structure. The human variance that is part of military combat presents a critical challenge to the United States Marine Corps in the implementation of the DO concept. In addition to all current capabilities, a DO Marine unit would have the additional capability of operating in smaller, more autonomous units, and would have greater authority to take actions in a given situation. The domains of doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) and human-systems integration (HSI) are areas where augmentation of current Marine Corps policy could enable DO as a capability. This thesis presents a modified form of Dupuy's quantified-judgment model (QJM) (1987) called the predictive force-ratio model. It is programmed in Microsoft Excel and first develops a score for a given unit based on physical characteristics pertaining to fire power, then adjusts that score through the use of factor weightings. The model is intended for use by a subject-matter expert in estimating the gains that can be achieved in combat power through improvement in a force's human capabilities.

KEYWORDS: Distributed Operations, Quantified Judgment Model, Lanchester Equations, DOTMLPF, Marine Corps Warfighting Lab, Human Systems Integration

NAVY MISSION PLANNER

**Kevin C. Dugan-Major, United States Marine Corps
B.A., George Washington University, 1993**

Master of Science in Operations Research-September 2007

Advisor: W. Matthew Carlyle, Department of Operations Research

Second Reader: Jeffrey E. Kline, CAPT, USN (Ret.), Department of Operations Research

The United States Navy continually deals with the challenges involved with the assignment of limited resources to address numerous and dispersed critical missions. The Navy's continued pursuit of decision aids to answer this problem and the ongoing critical maritime operations in the western Pacific and Arabian seas demonstrate the importance of this issue. How do Navy staff assign surface and subsurface combatants to areas and missions? The available ships may be inbound or outbound to the maritime theater, they may already be assigned to other missions in different regions, or they may require transit and off-station time before they can cover a particular mission. In planning major operations there are usually more missions than can be covered by available Navy combatants; therefore, it is likely that no ship will be assigned to low-priority missions, and deciding which higher-priority missions to cover at any time involves complicated tradeoffs. This planning problem is compounded by the fact that multiple alternatives are required by Fleet Admirals and Joint Force Maritime Component Commanders (JFMCC) who want to maximize the effectiveness of their maritime forces while avoiding excessive risk and identifying gaps in mission coverage. This thesis develops a decision-support tool, the Navy Mission Planner (NMP), which rapidly selects employment schedules for Navy combatants to meet the requirements above. The authors illustrate how NMP identifies optimal coverage of maritime missions in a theater with a notional, unclassified Korean peninsula scenario with 11 ships, 65 missions, and 24 user-defined maritime regions, on a desktop personal computer. NMP gives decision makers the ability to adjust courses of action by manipulating the time horizon, optimality criterion, mission values, mission dependencies, and ships available, and provides valuable insight into which missions will and, more importantly, will not be covered for any set of mission priorities.

KEYWORDS: Set Partitioning, Integer Programming, Navy Asset-Mission Pairing, Maritime Headquarters, Maritime Operations Center, Mathematical Programming, Optimization, Decision Aid, JFMCC, Employment Schedules

OPERATIONS RESEARCH

A COMPARISON BETWEEN THE NAVY STANDARD WORKWEEK AND ACTUAL WORK AND REST PATTERNS OF U.S. NAVY SAILORS

**Leonard E. Haynes-Lieutenant, United States Navy
B.S., University of South Carolina, 1995**

Master of Science in Operations Research-September 2007

Advisor: Nita L. Miller, Department of Operations Research

Second Reader: CDR David Schiffman, USN, Department of Operations Research

The demands placed upon the United States Navy are greater now than ever before. As ships become more versatile, sailors must become proficient in many warfare areas while also maintaining operational readiness. The primary manning tool used by the United States Navy to determine manpower requirements is the Navy standard workweek. This research seeks to determine if the Navy standard workweek accurately reflects the activities of deployed sailors and to determine their work and rest patterns. Each sailor completed surveys detailing tasks in which they were engaged. Survey data were compared to the Navy standard workweek. Individual Sailors aboard USS *Chung-Hoon* (DDG-93) wore wrist activity monitors to collect actigraphy data. Actigraphy data were analyzed using the fatigue-avoidance scheduling tool (FAST), which uses the sleep, activity, fatigue, and task effectiveness (SAFTE) model, to predict the waking effectiveness level of each sailor. Results show that the Navy standard workweek does not accurately reflect the daily activities of sailors. More importantly, based on FAST results, most sailors had predicted effectiveness levels lower than the predicted effectiveness level of the Navy standard workweek model. It is recommended that the Navy standard workweek be revised to more accurately reflect requirements of sailors in different departments.

KEYWORDS: Navy Standard Workweek, FAST, SAFTE, Shiftwork, Circadian Rhythm, Sleep Debt, Fatigue Management, Actigraphy Aboard, Operational Manning Requirements

OPTIMIZATION OF THE SUPPLY-DISTRIBUTION NETWORK

**Ryan R. Heisinger-Captain, United States Marine Corps
B.S., Linfield College, 2000**

Master of Science in Operations Research-September 2007

Advisor: David L. Alderson, Department of Operations Research

Second Reader: W. Matthew Carlyle, Department of Operations Research

The Marine Corps does not currently have a process or system to distribute supplies in support of combat operations in an optimal manner. The problem of re-supplying a forward-deployed U.S. Marine Corps artillery battalion is considered in this research. Specifically, a supply distribution network of roads between the battalion supply area, the firing batteries, and the headquarters battery is modeled. The objective is to develop a decision support tool to help a logistics officer build efficient supply convoys that deliver all demanded supplies to the requesting units in the shortest convoy route.

The supply distribution network consists of a set of locations connected by roads of known length. A small number of these nodes are logistics nodes that either supply or demand the commodities in the model, while the majority of the nodes are transshipment nodes. Dijkstra's algorithm is used to calculate the associated shortest travel distance between each pair of logistics nodes and then enumerate all possible tours through the logistics nodes. From this list of potential convoy routes, the best combination of vehicles and supplies to assign to each in a manner that satisfies operational constraints and meets the mission objectives is determined.

The decision the logistics officer has to make is to determine the convoy(s) that will deliver the demanded supplies in the shortest convoy route with the number of available vehicles to support the convoy. This model provides insight to the logistics officer about how to build convoys to distribute supplies optimally within the network.

KEYWORDS: Optimization, Network, Convoy Operations, Supply Distribution Network

OPERATIONS RESEARCH

THE EFFECT OF MORAL WAIVERS ON THE SUCCESS OF NAVY RECRUITS

Richard A. Huth-Lieutenant, United States Navy

B.S., Vanderbilt University, 1998

Master of Science in Operations Research-September 2007

Advisor: Samuel E. Buttrey, Department of Operations Research

Second Reader: CDR David Schiffman, USN, Department of Operations Research

This study examines the Navy's enlisted screening process and identifies success predictors through the analysis of moral waiver and attrition data for a two-year cohort (calendar years 2003 and 2004) compiled from three sources: 1) Personnel Recruiting for Immediate and Delayed Enlistments (PRIDE), 2) the Military Entrance Processing Command (MEPCOM) Integrated Reporting System (MIRS), and 3) Navy recruiting district (NRD) Nashville, Tennessee. Data comparisons are performed to measure the quality of existing waiver data. Historical success rates are then compared against moral waiver status, and logistic regression models are constructed to predict: 1) the long-term success of applicants from the beginning of the delayed entry program (DEP) through first term, and 2) the success of sailors from the time they enter active duty. The data comparisons show that MIRS recorded more waivers than PRIDE and that Nashville recorded more waivers than either MIRS or PRIDE. Results also show that those with moral waivers were actually more successful at completing DEP than those who enlisted without moral waivers. However, it is found that those who required moral waivers were not as successful in the long term and were significantly more likely to be moral-related losses from active duty than those without moral waivers. Regression analysis shows that moral waivers are negative predictors of long-term success.

KEYWORDS: Moral Waivers, Civil Waivers, Attrition, Success, Recruiting, Waiver Codes, Delayed Entry Program, DEP

OPTIMAL AIRCRAFT ROUTING IN A CONSTRAINED, PATH-DEPENDENT ENVIRONMENT

Norbert J. Karczewski, III-Major, United States Marine Corps

B.S., United States Naval Academy, 1993

Master of Science in Applied Mathematics-September 2007

Master of Science in Operations Research-September 2007

Advisors: Johannes O. Royset, Department of Operations Research

Raluca M. Gera, Department of Applied Mathematics

Second Reader: Craig W. Rasmussen, Department of Applied Mathematics

A method of automatically generating a route of flight for an aircraft (or group of aircraft flying in formation) from an origin to a destination in the presence of threats is presented. The threats encountered at a point of the route are a function of the route used to arrive there. The route is constrained by limits on one or more resources, such as fuel and time, expended over the course of the route. A C++ program is used to implement the method for two scenarios. In the first scenario, optimal routes for a path-dependent radar threat environment are generated. These results are then compared with routes generated for a path-independent radar threat. In a second scenario, a route is generated for a three-dimensional airspace over terrain in the presence of two constraints and multiple threats that vary dependent upon the route taken. The computing time required to generate a route is sufficiently short for use of the method in mission planning tools. Recommendations for future research and model improvement conclude the thesis.

KEYWORDS: Flight Planning, Routing, Aircraft, Network Models, Shortest Path, Optimization, Radar Threats, Path-Dependence, Lagrangian Relaxation

OPERATIONS RESEARCH

DETERMINING SURFACE-COMBATANT CHARACTERISTIC REQUIREMENTS THROUGH A MISSION-EFFECTIVENESS-ANALYSIS FRAMEWORK

Jeffrey A. Koleser-DoD Civilian

B.S.E., University of Michigan, 1980

Master of Science in Operations Research-September 2007

Advisor: Kyle Lin, Department of Operations Research

Second Reader: Jeffrey E. Kline, CAPT, USN (Ret.), Department of Operations Research

Ship-performance characteristics, such as max sustained speed, acceleration, and maneuverability, are generally predetermined as a platform requirement based on precedents. However, these predetermined performance characteristics have far reaching impacts on the size, logistics, manning, and cost of the ship platform. Instead of designing to pre-define platform performance requirements, ship performance characteristics should be determined based on fulfilling mission objectives.

This research evaluates viability to effectively determine if ship-characteristic requirements can be quantified by using the Naval Sea Systems Command's naval-battle engagement model (NABEM)—an agent-based simulation tool. In particular, two tactical situations are studied by varying three platform characteristics—maximum speed, acceleration, and turning diameter—and the authors determine how these platform characteristics affect mission performance.

KEYWORDS: Mission Effectiveness, NABEM, Ship Characteristics, Response Surface Model

A LITTORAL COMBAT MODEL FOR LAND-SEA MISSILE ENGAGEMENTS

Casey M. Mahon-Lieutenant, United States Navy

B.A., Norwich University, 2001

Master of Science in Operations Research-September 2007

Advisor: Thomas W. Lucas, Department of Operations Research

Second Reader: Wayne P. Hughes, Jr., Department of Operations Research

This thesis develops a littoral combat model of interactions between Naval ships at sea and anti-ship cruise missile batteries on land. The littoral combat model seeks to answer the question, is a modern naval force capable of effectively operating in the dangerous littoral environment? The model is derived from a combination of Hughes' salvo model and Lanchester's equations. Cases are developed using either direct fire or area-fire weaponry by the sea-based force. Land forces deliver aimed fire with missiles, which the ships defend against. A number of embellishments are utilized to provide an in-depth analysis of the interaction. Application of the model with two representative scenarios shows: 1) that attacking effectively first remains an important advantage, and 2) that accurate direct-fire weapons used by the sea-based force against the batteries ashore will often overcome Admiral Nelson's warning that "A ship's a fool to fight a fort." However, naval area fire (e.g., naval gunnery) is a key weakness in these inherently complicated littoral engagements, unless used in large volume and backed by sufficient defensive power in the sea-based force.

KEYWORDS: Littoral Combat, Amphibious Warfare, Power Projection, Area Denial, ASCM, Anti Ship Cruise Missile, Hughes' Salvo Model, Lanchester Differential Equations, Naval Surface Warfare

OPERATIONS RESEARCH

RELATIONSHIPS BETWEEN GLOBAL WARMING AND TROPICAL CYCLONE ACTIVITY IN THE WESTERN NORTH PACIFIC

David W. Meyer-Lieutenant Commander, United States Navy
B.S., Ohio State University, 1987

M.S., Naval Postgraduate School, 1994

Master of Science in Operations Research-September 2007

Advisor: Tom Murphree, Department of Meteorology

Advisor: Lyn R. Whitaker, Department of Operations Research

Second Reader: Samuel E. Buttrey, Department of Operations Research

In this work, the relationships between global warming and tropical cyclone (TC) activity in the western North Pacific (WNP) are investigated. The hypothesis is that global warming impacts on TC activity occur through induced changes in the large-scale environmental factors (LSEF) known to be important in determining the formation and intensity of TCs. The LSEFs focused on are sea surface temperature (SST) exceeding 26°C, weak vertical shear in horizontal winds, large positive absolute vorticity at low levels, mean upward motion, and high mid-level humidity.

Data is separated into weekly averages for 50x50 regions. Using a least-squares fit, global warming signals in both the SST and vertical wind shear data across the WNP are identified. These signals vary significantly on a 50x50 scale. Regression is used to determine the LSEFs/TC formation probability relationship. Linear regression is performed to determine the LSEF/ACE relationship. Through the two regression models, it is determined that each of the LSEFs is important for both TC formation and ACE. Independent data from that used in the regression modeling is used to validate the models.

Results support the hypothesis, and indicate that global warming has increased TC numbers and intensities in the WNP via the LSEFs.

KEYWORDS: Tropical Cyclones, Hurricanes, Typhoons, Climate, Pacific, Atlantic

ROBUSTNESS: A BETTER MEASURE OF ALGORITHMIC PERFORMANCE

Roger D. Musselman-Lieutenant Commander, United States Navy

B.S., Rensselaer Polytechnic Institute, 1994

Master of Science in Operations Research-September 2007

Advisor: Paul J. Sanchez, Department of Operations Research

Second Reader: Susan M. Sanchez, Department of Operations Research

Algorithms are an essential part of operations-research (OR) methodology. Therefore, efficiency of the algorithms must be a consideration. However, traditional approaches to assessing algorithmic efficiency do not always capture the real-world trade offs involved. This thesis explores the use of a new measure of algorithmic efficiency and robustness and contrasts it with the traditional “big-O” analysis. Sorting algorithms are used to illustrate the trade offs.

The use of Dr. Genichi Taguchi’s robust-design techniques allows us to take into account the impact of factors that would be uncontrollable in the real world by measuring how those factors affect the consistency of the results. These factors, which are treated separately by big-O analysis, are incorporated as an integral part of robust analysis. The hypothesis is that robustness is potentially a more useful description of algorithmic performance than the more traditional big-O analysis.

Results of experimentation support this hypothesis. Where big-O analysis only considers average performance, robustness integrates average performance and consistency of performance. Most importantly, the robust analysis performed yields results that are consistent with actual usage—practitioners prefer quicksort over heapsort, despite the fact that under big-O analysis heapsort dominates quicksort.

KEYWORDS: Robust Design, Taguchi Method, Sorting Algorithms, Quicksort, Heap Sort

OPERATIONS RESEARCH

OPTIMIZED ROUTING OF UNMANNED, AERIAL SYSTEMS FOR THE INTERDICTION OF IMPROVISED, EXPLOSIVE DEVICES

**Daniel N. Reber-Major, United States Marine Corps
B.S., Arizona State University, 1996**

Master of Science in Operations Research-September 2007

Advisor: Johannes O. Royset, Department of Operations Research

Second Reader: Robert F. Dell, Department of Operations Research

As of September 2007, improvised, explosive devices (IEDs) account for 43% of U.S. casualties in Iraq—the largest single cause of death. One reason for their high rate of effectiveness is that they are extremely difficult to detect. This research develops a tool for selecting routes that will best employ unmanned, aerial systems (UAS) for the purpose of detecting IED or related activity. This tool is referred to as the IED search-optimization model (ISOM). ISOM, which uses prediction-model results as an underpinning, accounts for factors such as winds, sensor sweep-width, and aircraft de-confliction. This problem is formulated as an integer program and optimally solved to select the best routes. Initial evaluation of ISOM, through field experiments with actual UAS, suggests that the tool produces realistic routes that can be flown in the expected amount of time. Furthermore, these routes result in a 42% increase in the likelihood of achieving a detection opportunity over searching nodes in a random manner. ISOM could be implemented as a “reach-back” capability with an analyst providing daily routes for tactical operators.

KEYWORDS: IEDs, IED Detection, IED Interdiction, Vehicle Routing Problem, Integer Program

RELIABILITY ANALYSIS AND MODELING OF THE U.S. MARINE CORPS' MEDIUM TACTICAL, WHEELED VEHICLE IN OPERATION IRAQI FREEDOM

**Matthew B. Reuter-Major, United States Marine Corps
B.S., United States Naval Academy, 1993**

M.E., University of Colorado at Boulder, 2003

Master of Science in Operations Research-September 2007

Advisor: Robert A. Koyak, Department of Operations Research

Second Reader: Daniel A. Nussbaum, Department of Operations Research

This thesis describes an analysis of the reliability of the medium tactical-vehicle replacement (MTVR) cargo variant in Operation Iraqi Freedom (OIF), from 1 March 2004 to 31 March 2007. More than 870 MTVRs were fielded by the Marine Corps for OIF, of which 456 provided data for analysis. Analysis and modeling of this repairable system's failure modes are conducted at the MTVR variant, major unit, armored status, and subsystem levels to develop an understanding of the vehicle's usage and performance under field conditions. Reliability is measured by the frequency of occurrence of unscheduled maintenance events, with the number of days that a vehicle is not available due to these events (“deadlined days”) used as a measure of severity. The challenges of using field maintenance and supply data are handled using various methods, including data verification, failure event aggregation, and odometer reading imputation. Nonparametric and parametric statistical methods are utilized, with system and subsystem failure mode recurrence data, to measure reliability throughout the period of observation and amidst the installation of system modifying vehicle armor kits. Reliability metrics are quantified to capture the effects of usage and armoring, taking into account that the MTVR is a repairable system.

KEYWORDS: Marine Corps, Medium Tactical Vehicle Replacement, MTVR, Motor Transportation, Reliability, Reliability Analysis, Reliability Modeling, Operation Iraqi Freedom, OIF, Operational Availability, USMC

OPERATIONS RESEARCH

OPTIMIZING THE U.S. MARINE CORPS' SELECTIVE REENLISTMENT BONUS PROGRAM FOR CAREER FORCE RETENTION

**Kent A. Robbins, Jr.-Captain, United States Marine Corps
B.S., United States Naval Academy, 2001**

Master of Science in Operations Research-September 2007

Advisor: R. Kevin Wood, Department of Operations Research

Second Reader: Ronald D. Fricker, Jr., Department of Operations Research

The Marine Corps uses its selective reenlisted bonus (SRB) program to influence Marines to reenlist for a designated term into certain military occupational specialties (MOSs) in order to reach planned manpower goals. The bonus amount is determined by selecting an SRB multiplier for each combination of MOS and zone (MOSZ). ("Zone" corresponds to length of service.) A higher multiplier means a larger bonus and leads to a higher percentage of Marines reenlisting. That percentage, predicted by an existing forecasting model, is assumed exact here.

The SRB multiplier model assigns multipliers to minimize a sum of weighted squared deviations from MOSZ targets subject to a budget constraint. This model is implemented as a generalized assignment problem, and solved approximately on a personal computer using Lagrangian relaxation and a secondary heuristic. (The algorithm is programmed in Visual Basic for Applications and has an Excel interface.)

Data for fiscal year 2004 shows 491 bonus-eligible MOSZs. With up to eleven possible multiplier values, this yields a model with 5,401 0-1 variables and 491 constraints. A solution within 0.0018% of optimality is reached in 1.4 seconds on 1.58 GHz personal computer. Standard integer-programming software verifies the correctness of the solution.

KEYWORDS: Selective Reenlistment Bonus, Multiplier, Generalized Assignment Problem, Lagrangian Relaxation

A MULTIVARIATE ANALYSIS OF LOST WORK-TIME DUE TO ON-THE-JOB INJURIES AT MARINE CORPS COMMANDS

**Timothy J. Robinson-Captain, United States Marine Corps
B.S., Virginia Polytechnic Institute and State University, 2000**

Master of Science in Operations Research-September 2007

Advisor: Lyn R. Whitaker, Department of Operations Research

Second Reader: Sergio Posadas, Department of Operations Research

Yearly, the Department of the Navy pays about \$245 million in workers' compensation and related medical benefits under the Federal Employee Compensation Act. (Bowes, 2003) Based on data from the Defense Manpower Data Center and the Defense Finance and Accounting Service, the Office of the Secretary of Defense stated that since fiscal year 2002, the number of lost workdays (LWD) the U.S. Marine Corps (USMC) has accumulated per hundred civilian employees has been higher than the rate for the U.S. Army, the U.S. Navy (USN), and the U.S. Air Force.

This thesis investigates the LWD rate of the USN and the USMC. However, more detailed analysis is completed on the USMC. The goal is to identify factors that lead to a high LWD rate and to determine which employees are more likely to accrue LWD.

This study consists of the use of generalized linear models, classification trees, and descriptive statistics to explore historic datasets to determine which factors influenced an employee's tendency to accrue a LWD the most.

It is found that fire fighters, mechanics, and police, followed by equipment operators under the GS10 pay grade, are at greatest risk of accruing at least one LWD per year.

KEYWORDS: Lost Workday, Multivariate Linear Regression, Generalized Additive Models, Classification and Regression Trees

OPERATIONS RESEARCH

TRI-LEVEL OPTIMIZATION MODELS TO DEFEND CRITICAL INFRASTRUCTURE

Pablo Alvarez San Martin-Lieutenant Commander, Spanish Navy

B.S., Spanish Naval Academy, 1993

Master of Science in Operations Research-September 2007

Advisor: Kevin Wood, Department of Operations Research

Second Reader: Javier Salmeron, Department of Operations Research

This thesis develops and solves a tri-level optimization model to plan the optimal defense of an infrastructure from intelligent attack. It is assumed that a “defender” will first use limited defensive resources to protect the system’s components; then, an intelligent adversary (“attacker”) will use limited offensive resources to attack unprotected components in order to inflict maximum damage to the system. The defender guides system operation with an optimization model, so increased operating cost equates to damage. This leads to a tri-level defender-attacker-defender model (DAD), where the second defender means “defender as system operator.”

The general DAD is NP-hard and requires decomposition to solve. Four decomposition algorithms are developed: direct, nested, reformulation-based, and reordering-based. The reordering-based algorithm computes an optimistic bound by reordering the stages of the DAD, and the reformulation-based algorithm uses sub-problems that resemble standard capacity-interdiction models. Computational tests on generic instances of “defending the shortest path” (DSP) show the nested and reformulation-based algorithms to be twice faster than the first (on average).

A hypothetical instance of DSP provides a concrete illustration: a Spanish marine unit, in an emergency deployment, must defend its base-to-port route against potential terrorist attacks.

KEYWORDS: Critical Infrastructure Systems, Tri-Level Models, Mixed-Integer Linear Program, Homeland Security

MASTER OF SCIENCE IN PHYSICAL OCEANOGRAPHY

LAGRANGIAN OBSERVATIONS OF RIP CURRENTS

Jonathan D. Morrison-Lieutenant, United States Navy

B.S., University of California-Berkeley, 2001

Master of Science in Physical Oceanography-September 2007

Advisor: Jamie H. MacMahan, Department of Oceanography

Second Reader: Timothy P. Stanton, Department of Oceanography

A comprehensive field rip-current experiment (RCEX) was conducted from 14 April to 18 May 2007 in Sand City, California, on Monterey Bay. Lagrangian observations were made with inexpensive (\$150), handheld, differential, global-positioning systems (DGPS) mounted on surf-zone drifters. The inexpensive DGPS requires post-processing to achieve $O(0.4\text{m})$ position accuracy and $O(0.01\text{m/s})$ velocity accuracy. Thirty drifters were constructed and deployed in well-developed rip currents to map the circulation patterns for the first time in the field at a high spatial resolution. Drifter observations obtained during three-hour periods on seven different days under varying wave and tidal conditions describe eddies with a rotational period of 4.7min, confined to the surf zone and coupled to the rip morphology. On average, three drifters per hour exited the surf zone. Dependent upon wave conditions, one or two eddies existed between 90m-spaced rip channels, creating a seaward flow in the channels and shoreward flow over the shoals. Cross-shore volumetric flow rates for an alongshore transect through the eddy centers balance to a difference of less than 10% of the gross flow discharge. Velocity measurements obtained from drifter data are evaluated with velocities obtained from stationary, in-situ instruments.

KEYWORDS: Rip Currents, Lagrangian Observations, Surf Zone, Drifters, Near Shore Circulation

MASTER OF SCIENCE IN SPACE SYSTEMS OPERATIONS

A MODEST PROPOSAL FOR PREVENTING SPACE OPERATIONS FROM BEING A BURDEN TO THE NAVY AND MAKING THE SPACE CADRE BENEFICIAL TO THE COMMUNITY

**Paul V. Bandini-Lieutenant Commander, United States Navy
B.S., Texas A&M University, 1996**

Master of Science in Space Systems Operations-September 2007

**Andrew R. Dittmer-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1997**

Master of Science in Space Systems Operations-September 2007

**Advisors: Charles M. Racoosin, Space Systems Academic Group
William J. Welch, Department of Information Sciences**

U.S. Navy efforts in implementing Department of Defense policy guidance for the effective integration of space capabilities and effects consist of a variety of multi-pronged and disjointed efforts. Lack of clear direction in analysis and identification of current and future requirements for space-related capabilities presents a hazard to implementation of the tenants of Sea Power 21 and Navy participation in future conflicts.

This work proposes an alternative construct for the organization and utilization of Navy space resources against the backdrop of requirements levied by the 2001 U.S. Commission to Assess National Security Space Management and Organizations and resulting Department of Defense Directive 5101.2, DoD Executive Agent for Space.

In order to accomplish its mission, the Navy must establish a clear focus of effort, consolidate and formalize space-related human capital, and divest itself of space-specific undertakings not related to core functions. This thesis establishes arguments to propose that the United States Navy relinquish development, acquisition, and satellite operations tasks to another service or agency, and invest in appropriately leveraging space assets through the professionalization and promotion of a robust, educated, experienced, and capable Navy space cadre.

KEYWORDS: Executive Agent for Space, Navy Space Cadre, Human Capital Strategy, Sea Power 21, Naval Network Warfare Command, NETWARCOM, Navy Space Operations Command, NAVSOC, Network Information Operations and Space Center, NIOSC, Naval Research Laboratory, NRL, Naval Center for Space Technology, NCST, Carrier Strike Group, CSG

THE USE OF COMMERCIAL REMOTE SENSING IN PREDICTING HELICOPTER BROWNOUT CONDITIONS

**Anthony W. Davis, Jr.-Lieutenant, United States Navy
B.S., Morehouse College, 2001**

Master of Science in Space Systems Operations-September 2007

Advisor: Richard C. Olsen, Department of Physics

Second Reader: David Trask, Measurement and Signals Intelligence (MASINT) Chair

Observations of potential helicopter landing zones are analyzed to determine suitability with respect to helicopter brownout. Imagery from civil and commercial satellites is used. VNIR and LWIR imagery of Yuma Proving Grounds taken by the ASTER sensor are analyzed. NDVI calculations from the VNIR data are used to define bare earth and vegetated areas. Some correlation is found in LWIR signatures, but the 60-m GSD for those bands limits utility. QuickBird MSI taken over Iraq is also analyzed for vegetation; results could not be ground truthed.

SPACE SYSTEMS OPERATIONS

KEYWORDS: ASTER, QuickBird, NDVI, VNIR, LWIR

SMALLER SATELLITE OPERATIONS NEAR GEOSTATIONARY ORBIT

Matthew T. Erdner-Lieutenant, United States Navy

B.S., Norwich University, 2001

Master of Science in Space Systems Operations-September 2007

Advisor: Charles M. Racoosin, Space Systems Academic Group

Second Reader: William J. Welch, Department of Information Sciences

With the ongoing miniaturization of components, the utility of smaller satellites is increasing. Many believe that in the near future small satellites will be able to perform all functions that larger satellites currently perform. It has been suggested that these satellites will be less expensive, thus offering a lower risk to the consumer in case they fail before their mission design life. This paper looks at the ability to build and operate smaller satellites with current technology to perform covert space control and space situational awareness missions near geostationary orbit. The investigation determines whether space qualified commercial, off-the-shelf (COTS) components and current technology could be used to build covert smaller satellites. The largest satellite is sized to be undetectable from earth-based sensors. Subsequent CubeSat sizes are selected to determine how small a satellite could be built with COTS components and current technology to perform the assigned missions. A comparative analysis is then performed to determine how these satellites could be cost-effectively launched to orbit. A cost estimate is performed to determine the entire life cycle cost for each satellite size, excluding launch and integration segments. Using that information, the best satellite size is determined.

KEYWORDS: Small Satellite, CubeSat, Optical Survey, Geostationary, Geosynchronous, Space Situational Awareness, SSA, Space Control, Satellite Took Kit, Modular Add-On Launch, Ride-Along Launch, Mothership, Erdner, NPS

IDENTIFYING ROADS AND TRAILS HIDDEN UNDER CANOPY USING LIDAR

Fermin Espinoza-Lieutenant Commander, United States Navy

B.B.A., University of Texas, 1995

Master of Science in Space Systems Operations-September 2007

Robb E. Owens-Major, United States Air Force

B.S., Creighton University, 1994

M.S., Troy State University, 1999

Master of Science in Space Systems Operations-September 2007

Advisor: Richard C. Olsen, Department of Physics

LIDAR data collected from four geographic regions are studied to determine the feasibility of reliably identifying roads and trails hidden under dense jungle and forest canopies. The four analyzed regions include the Elkhorn Slough in central California (2005); Kahuku Training Area on the north side of Oahu Island in Hawaii (2005); La Selva Biological Station near Puerto Viejo de Sarapiquí, Costa Rica (1997); and Cougar Mountain Park in Bellevue, Washington (2001). Using the commercial product, Quick Terrain Modeler, 3-D interactive analysis is conducted to identify roads and trails hidden under canopy. Results are compared to overhead panchromatic imagery and verified by significant ground truth. Trails with widths of 2.5 meters and narrower are found with overall accuracies up to 85%.

KEYWORDS: Lidar, Ladar, Laser Radar, Foliage Penetration, FOPEN, Poke-Through, Terrain Analysis, Trails, La Selva Biological Station, Elkhorn Slough, Kahuku, Cougar Mountain Park, IPB

SPACE SYSTEMS OPERATIONS

TACTICAL SPACE: BEYOND LINE OF SIGHT ALTERNATIVES FOR THE ARMY AND MARINE CORPS GROUND TACTICAL WARFIGHTER

Anthony G. Knight-Major, United States Marine Corps

B.S., Lock Haven University, 1993

Master of Science in Space Systems Operations-September 2007

Aaron B. Luck-Major, United States Army

B.S., United States Military Academy, 1996

Master of Science in Space Systems Operations-September 2007

Advisor: William J. Welch, Department of Information Sciences

Second Reader: CAPT Alan Scott, Space Systems Academic Group

United States Army and Marine Corps ground tactical warfighters find themselves conducting operations across greater distances and with more autonomy from their higher commands than ever before. As their areas of operations become larger in modern conflicts, and distributed operations become more the norm, deficits in the tactical warfighter's ability to conduct beyond-line-of-sight (BLOS) communications, intelligence, surveillance, and reconnaissance (ISR), blue-force tracking and situational awareness (BFT/SA), and position, navigation, and timing (PNT) become more noticeable and dangerous. The capabilities existing in the tactical space this warfighter operates within, and from where he is supported, cannot meet his needs now, nor will they likely meet his needs in the future.

While upgrades and expansion of current satellite and unmanned aerial system (UAS) architectures will expand these BLOS capabilities, it is not likely they will increase sufficiently to reduce the deficit in support. A new regime, the High Altitude Area of Interest (HAAI), also known as near space, provides potential capabilities specifically tailored to the tactical warfighter.

This thesis reviews the BLOS requirements of the tactical warfighter, identifies the current and future deficits in each area, and identifies emerging areas of support. Recommendations are provided on further development of integrated architectures spanning multiple regions, to provide efficient, persistent, and sufficient BLOS capabilities to the tactical warfighter.

KEYWORDS: Lossless U.S. Army, USA, USMC, Marine Corps, High Altitude, HAP, HALE, HAAI, Near Space, UAV, UAS, BLOS, Communications, Intelligence, Surveillance, and Reconnaissance, ISR, Blue Force Tracking and Situational Awareness, BFT/SA, BFS, Position, Navigation, and Timing, PNT, Tactical Warfighter, Tactical Space, Space, Aerial Network Layer

GROUND SEGMENT PREPARATION FOR NPSAT1

Luke E. Koerschner-Major, United States Army

B.S., North Carolina State University, 1990

Master of Science in Space Systems Operations-September 2007

Advisor: James A. Horning, Space Systems Academic Group

Second Reader: David Rigmaiden, Space Systems Academic Group

Most satellites rely on a ground-control station to command their payloads and through which to download data from their payloads. The Naval Postgraduate School's satellite (NPSAT1) is no exception. The spacecraft's payloads, which include the coherent electromagnetic radio tomography (CERTO), Langmuir probe, configurable, fault-tolerant processor (CFTP), and the visible-wavelength imager (VISIM), all generate data that require collection on the ground through a radio frequency downlink. Telemetry from NPSAT1's unique attitude control system, which uses only MEMS angular rate sensors, magnetic coils, a magnetometer, and a GPS, could aid in the development of improved or more economical attitude control systems. The goal of this thesis is to ready the ground-control segment for operation for collection of data from and command of NPSAT1 immediately after launch.

Included is a description of the spacecraft to ground calculation, bidirectional, link budget and the operation and testing of the ground antenna pointing control system. Future space systems students and faculty will use the ground control segment to harvest data and reap knowledge from the experiments that will orbit inside NPSAT1. What better way to test the pointing of the antenna than to use it to track the Midshipman Space Technology Applications research program's first satellite (MidSTAR1).

KEYWORDS: Ground Segment, NPSAT1, MidSTAR1

SPACE SYSTEMS OPERATIONS

CHARACTERIZATION OF GRAPHITE LITHIUM-ION CELLS

Steven D. Moseley-Major, United States Army

B.S., Rocky Mountain College, 1994

Master of Science in Space Systems Operations-September 2007

Advisor: James A. Horning, Space Systems Academic Group

Second Reader: Ronald L. Phelps, Space Systems Academic Group

This thesis explores the characterization of graphite lithium-ion cells. A control procedure is performed to ensure any capacity loss or gain seen in tests is not the result of cell cycling. Vibration testing of the cells, on all three axes to simulate the spacecraft launch environment, shows a slight increase in capacity after vibration. Cell capacity is measured at two current rates at a variety of temperatures to obtain a family of curves to allow for a prediction of cell capacity at a given temperature. Voltage drift is explored and determined to not be a factor when matching cells for a battery. Using data from hard carbon lithium-ion cells, data for capacity loss over time, while in storage, is examined. It is determined that for an 18-month time period, these cells lost less than 2% of their capacity while in storage. Cells are then cycled in simulated low earth orbit power cycling to determine capacity loss while on orbit. Using a 0.25 Amp charge rate, the graphite cells retain 93% of their initial starting capacity by the 2,000th cycle. Finally, cells undergo accelerated low earth orbit testing to validate the accelerated testing theory. This thesis concludes that accelerated testing is not a good representation of how cells will perform under real-time conditions.

KEYWORDS: Graphite Lithium-Ion Cells

CHARACTERIZATION, OPTIMIZATION, AND TEST OF THE NPSAT1 MICRO-ELECTRO-MECHANICAL-SYSTEM 3-AXIS RATE-SENSOR SUITE FOR USE IN SMALL-SATELLITE ATTITUDE CONTROL

Thomas S. Pugsley-Major, United States Army

B.S., Illinois Institute of Technology, 1997

M.B.A., Touro University International, 2004

Master of Science in Space Systems Operations-September 2007

Advisor: James H. Newman, Space Systems Academic Group

Second Reader: Daniel J. Sakoda, Space Systems Academic Group

The NPSAT1 project is a Naval Postgraduate School educational small satellite combining student education in satellite systems and operations, institutional research, and sponsored experiments with the objective of testing technologies for applications in space flight. The micro-electro-mechanical system (MEMS) rate sensor is one of these experimental technologies. Packaging three of these MEMS sensors together makes a 3-axis rate-sensor suite. The MEMS experiment was originally conceived of as a low-cost, low-mass augmentation to the magnetometer for use by the attitude-control system (ACS). The experiment is to test the sensor suite's ability to measure NPSAT1 rates, comparing these rates to those determined by using a magnetometer and a global positioning system. Operationally, the goal is to perform a space-flight demonstration of the MEMS sensor.

This thesis includes two phases of research and development. First, the MEMS 3-axis rate sensor suite is fully tested and characterized. Experimental testing proves the sensor suite's effectiveness as a low-cost, low-mass augmentation to the magnetometer for satellite rate determination, as well as its ability to measure very low rates. Second, the original design and operations are adapted to maximize the accuracy and utility of the sensor suite. Finally, a complete flight-like subsystem is built and tested.

KEYWORDS: MEMS, 3-Axis Rate Sensor, Rate Sensor, Attitude Control, Spacecraft, Micro-Electromechanical, NPSAT1, Low Rate, ACS Subsystem

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

IMPACTS AND CONSEQUENCES OF NON-STANDARD COMMERCIAL, OFF-THE-SHELF C4I SYSTEM ACQUISITION UPON ASSOCIATED PROGRAMS OF RECORD

Ted W.L. Huskey-Senior Systems Engineer

Science Applications International Corporation

B.S., United States Naval Academy, 1986

M.S., Naval Postgraduate School, 1993

Master of Science in Systems Engineering-September 2007

Advisor: David F. Matthews, Graduate School of Business and Public Policy

**Second Reader: Ken McCloud, Program Executive Officer, Command, Control, Communications,
Computers, Information (C4I), (Ret.)**

Commercial, off-the-shelf (COTS) command, control, communications, computers, and information (C4I) equipment is acquired outside of standard acquisition practices. Analysis of the circumstance under which and the consequences of non-standard C4I acquisition and fielding of COTS C4I equipment, and the impact upon similar capability programs of record, is conducted using a case study of the Navy's acquisition of the air-defense system integrator (ADSI). Additionally, analysis of practices, methodologies, and philosophies that could be implemented to prevent future occurrences is performed.

Despite years of reform, the Department of Defense acquisition system does not field capabilities quickly enough to meet warfighter requirements. DoD acquisition cannot keep pace with the rate of C4I technology growth and is encumbered by layers of procedural bureaucracy. Subsequently, existing programs of record were negatively impacted by the resulting non-standard acquisitions.

More reform is neither necessary nor the panacea. Adequate processes and programs exist to expedite fielding of new capabilities. Optimization of existing processes and programs, combined with greater warfighter involvement, are necessary to prevent future occurrences of non-standard acquisition.

Adherence to and execution of existing rules and regulations, combined with reduction/elimination of detrimental bureaucracy, will significantly reduce future occurrences of non-standard COTS C4I equipment acquisition and speed the fielding of new C4I capabilities.

KEYWORDS: Tactical Data Links, Link 16, C4I, COTS, NDI, NGC2P, GWOT, JRAC, ATD, RCIP, ADSI

BUILT-IN TEST EQUIPMENT FOR INTEGRATED WEAPONS SYSTEMS: ACHIEVING UTILITY AND USER ACCEPTANCE

Nicholas P. Previsich-DoD Civilian

B.A., Excelsior College, 2003

M.A., University of Phoenix, 2005

Master of Science in Systems Engineering-September 2007

Advisor: John S. Osmundson, Department of Systems Engineering

Second Reader: Gary O. Langford, Department of Systems Engineering

The objective of this work is to determine whether a direct statistical or stochastic relationship between the following systemic characteristics of dedicated built-in test equipment (BITE) could be derived and quantified: annual maintenance costs, user acceptance, operational availability, and "complexity" (defined as total number of sensor interfaces per system). Three systems of ascending degrees of complexity from the USAF F-15A/BC/D, O/A-10A, and C-5A/B/C are analyzed, and based upon raw data acquired from field operating units and fleet-wide maintenance-data collection, a model is constructed to derive constraints on a postulated "best-fit" interdependence between these four characteristics. The chief finding

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is that BITE reliability and minimal intrinsic system-maintenance burden are the prime determinants of user acceptance, and therefore system success. A corollary finding is that the number of data interfaces (or sensors) is mathematically irrelevant to user acceptance, suggesting that condition-based monitoring schemas are feasible provided that BITE system-level reliability is maximized with a minimal maintenance burden placed on the user community. Sensor redundancy to achieve this goal is the suggested method. This model may be used as an objective criterion for evaluating future BITE system procurement proposals, a critical concern for the emerging predictive/condition-based maintenance paradigms currently favored by the Department of Defense, NASA, and other federal and commercial agencies.

KEYWORDS: BIT, BITE, CBM, Avionics, Electronics, Condition-Based Maintenance, MADAR, TEMS, ASP, Built-In Test, A-10, C-5, F-15, CAMS, REMIS, Fault Protection, Fault Detection, Fault Isolation, Air Vehicle, Space Vehicle, Aircraft, Spacecraft, Ship, Vessel, Submarine, Ground Mobile, Built-In Test, Human Machine Interface, HMI

MASTER OF SCIENCE IN SYSTEMS ENGINEERING MANAGEMENT

IMPROVING NAVAL SHIPBUILDING PROJECT EFFICIENCY THROUGH REWORK REDUCTION

**Deborah L. Clark-Civilian, Northrop Grumman Corporation
B.S., University of Southern Mississippi, 2004**

**Donna M. Howell-Civilian, Northrop Grumman Corporation
B.S., University of Southern Mississippi, 2004**

**Charles E. Wilson-Civilian, Northrop Grumman Corporation
B.S., United States Naval Academy, 1986**

Master of Science in Systems Engineering Management-2007

**Advisors: John S. Osmundson, Department of Systems Engineering
Henry B. Cook, DoD Contractor**

The rising cost of U.S. Naval ships and the rate of change in technology require a thorough analysis of current shipbuilding practices. The Navy wants the latest and greatest technology while keeping overall cost low. Some technologies are obsolete before completion of the ship's design and construction. A design locked in at critical design review (CDR) undergoes multiple modifications prior to ship's delivery. Design changes drive up cost. The goal is to provide the warfighter battlespace dominance while keeping cost low enough to allow a consistent purchase of additional ships.

To accomplish this goal, both industry and the Navy must be aware of what is driving design changes and willing to revise existing practices. The objectives of this thesis are to identify the major sources of rework and to suggest modifications and improvements to existing practices. A review of Department of Defense acquisition and the shipbuilding process identifies design changes resulting from requirements volatility, inconsistent execution of defense acquisition, and the rigidity of the design and construction process as major sources of rework. Recommendations include improving change management, optimizing the schedule for resilience, and the use of a modular open systems approach to reduce rework.

KEYWORDS: Design Changes, Rework, Shipbuilding, Out of Sequence

DATA-CENTRIC INTEGRATION AND ANALYSIS OF INFORMATION-TECHNOLOGY ARCHITECTURES

**Kristin Giammarco-DB-03, United States Army
B.E., Stevens Institute of Technology, 1999**

Master of Science in Systems Engineering Management-September 2007

**Advisors: Gary O. Langford, Department of Systems Engineering
John S. Osmundson, Department of Systems Engineering**

The premise of this thesis is that integrated architectures have increased usefulness to the users of the systems they describe when they can be interactively and dynamically updated and used in conjunction with systems-engineering analyses to enable systems optimization. In order to explore this premise, three research topics are presented. The first topic discusses needs and uses for integrated architectures indicated throughout Department of Defense policies, directives, instructions, and guides. The second topic presents a systems-engineering analysis process and discusses the relevancy of integrated architectures to these analyses. Building on the previous two topics, the third discusses federation, governance, and net-centric concepts that can be used to significantly improve DoD enterprise-architecture development, integration, and analysis; with specific recommendations for the Army architecture integration process. A key recommendation is the implementation of a collaborative environment for net-centric architecture

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integration and analysis, to provide a rich and agile data foundation for systems engineering and system of systems engineering analyses, which are required to optimize the DoD enterprise architecture as a whole. Other conclusions, recommendations, and areas for future work are also presented.

KEYWORDS: Systems Engineering Analysis, DoD Enterprise Architecture, System of Systems, Integrated Architecture, DoDAF, Architecture Federation, Governance Architecture, Net-Centric Environment, Modeling and Simulation, Architecture Agility, Authoritative Reference Data

SYSTEM-OF-SYSTEMS TECHNOLOGY-READINESS ASSESSMENT

WindyJoy S. Majumdar-DoD Civilian

B.S., University of Tennessee, 1984

Master of Science in Systems Engineering Management-September 2007

Advisor: John S. Osmundson, Department of Systems Engineering

Second Reader: Jay Mandelbaum, DoD Contractor

The Chairman of the Joint Chiefs of Staff established Joint Capabilities Integration and Development System processes for acquisition of joint capabilities, which are achieved through network-centric applications, services, enterprise systems, Family of Systems (FoS), and System of Systems (SoS). In many cases, advanced technologies must be matured simultaneously by multiple systems to support the degree of interoperability and/or integration required. Current Department of Defense (DoD) guidance with respect to technology development and assessment is focused on acquisition of a system that operates relatively independently within a collection of other independent systems.

An approach to technology development and technology readiness assessment of advanced technologies that support network-centric systems is required for successful development and fielding of network centric warfighting capabilities. Fundamental activities of technology maturation and assessments are the definition of a relevant environment and the ability to identify the critical technologies that provide for interoperable or interdependent functions. This paper proposes definitions for System of Systems and Family of Systems, degrees/levels of interoperability, and SoS Technology Readiness Assessment requirements and guidelines. SoS acquisition strategies are proposed to support program synchronization and SoS engineering activities, which are key to successful development of net-centric service and joint capabilities.

KEYWORDS: System of Systems, Technology Readiness Assessment, Family of Systems, Technology Readiness Level

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY

ATTRIBUTES OF SUCCESS IN A CHALLENGING INFORMATION PROCESSING ENVIRONMENT

**David E. Faherty, III-Ensign, United States Navy
B.S., United States Naval Academy, 2006**

**Master of Science in Systems Technology-September 2007
Advisors: Karl D. Pfeiffer, Department of Information Sciences
Tara Leweling, Department of Information Sciences**

By using graph-theoretic techniques to compare the information processing behaviors of three groups of mid-level working professionals as each undertakes a series of four complex, interdependent, computer-mediated decision-making exercises, this thesis explores the relationship between network centrality and individual performance and the relationship between network density and group performance. The results of this exploration, though mostly inconclusive, call into question both intuition and social network analysis literature. It was predicted that centrality in a network correlates positively with high performance among individuals, but statistical analysis of data collected during controlled experimentation reveals an almost negligible relationship. It was also hypothesized that high density groups would outperform low density groups, but density and performance are found to correlate in exactly the opposite direction: as density increases, group performance decreases.

As an explanation, this thesis proposes that as network density increases actors require more time to process and respond to incoming information. In as much as central actors possess a greater number of edges (i.e., communication linkages to others), this thesis also argues that centrality in a network has costs as well as benefits. Further experimentation is needed to test the validity of these conjectures and bring better understanding to organization theory, social network analysis, and information processing networks.

KEYWORDS: ELICIT, Social Network Analysis, Performance, Organization Theory, Centrality, Density

OPTIMUM ANTENNA CONFIGURATION FOR MAXIMIZING ACCESS POINT RANGE OF AN IEEE 802.11 WIRELESS MESH NETWORK IN SUPPORT OF MULTI-MISSION OPERATIONS RELATIVE TO HASTILY FORMED SCALABLE DEPLOYMENTS

**Robert L. Lounsbury, Jr.-Captain, United States Air Force
B.S., University of Maryland University College, 2002**

**Master of Science in Systems Technology-September 2007
Advisor: James F. Ehlert, Department of Electrical and Computer Engineering
Second Reader: Karl D. Pfeiffer, Department of Information Sciences**

In this thesis, research is conducted with an applied science approach to determine the optimum antenna configuration for maximizing access point range in an Institute of Electrical and Electronic Engineers (IEEE) 802.11 wireless mesh network. Antenna theory provides a theoretical basis upon which real-world application put several antenna configurations to the test. The required ability for the Cooperative Operations and Applied Science and Technology Studies (COASTS) research group's network to connect in varied environments, including ground to ground, ground to air, and air to air applications, requires more than a simple radio-frequency link-budget calculation. Difficulty in connecting to a tethered, helium-filled balloon aerial platform drove the need to thoroughly test various antenna polarizations. IxChariot network throughput testing software is used to gauge antenna performance. Results of this research show that for fixed, ground to ground applications, the WiFi-Plus Multi-polar 13dBi Sector antenna

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configuration, providing 19.4 Mbps actual throughput at 0.75 miles (max test range of 1.06 miles at 4.5 Mbps), in the IEEE 802.11g standard, is superior. For the ground to air application, the WiFi-Plus Multi-polar 13dBi Sector antenna as the fixed ground antenna and the WiFi-Plus Multi-polar 5dBi affixed on the aerial platform, also in the IEEE 802.11g standard, provides the most reliable connection (throughput data was not able to be obtained). To aide future research, azimuth and elevation plots of the multi-polar antennas are produced through the use of the Naval Postgraduate School's Antenna Laboratory. The multi-polar antennas clearly outperform the vertically polarized antennas tested and are believed to be the optimum choice for the varied needs of the COASTS network.

KEYWORDS: COASTS, Wifi, Wireless, Wireless Mesh Network, Multi-Polar Antenna, Throughput, Access Point, IEEE 802.11, IEEE 802.11g, IEEE 802.11a, Link Budget

MASTER OF ARTS

**National Security Affairs
Security Studies**

MASTER OF ARTS IN NATIONAL SECURITY AFFAIRS

PURSUING THE BOTTOM LINE: HOW THE MIDDLE EAST WILL BE AFFECTED BY AN AGING AMERICA

**Stephen E. Bergey-Major, United States Air Force
A.B., University of Georgia, 1994
M.B.A., Colorado State University, 1999
M.A., Tufts University, 2006**

Master of Arts in National Security Affairs-September 2007

Advisor: Robert E. Looney, Department of National Security Affairs

Second Reader: Richard Doyle, Graduate School of Business and Public Policy

The Middle East plays a vital role in the world economy. Resource rich, it provides much of the energy that advanced industrialized societies need to keep their economies growing. Challenges in the region lie on the horizon, however, and are beginning to take shape today. These challenges, if left unresolved, could create more regional instability and could have far-reaching consequences. The United States faces its own challenges in the coming years. Demographic trends and budgetary concerns call into question the ability of the United States to lead in the coming decades.

This thesis examines the confluence of issues facing Middle Eastern countries today, while also linking demographic trends currently underway in the United States with the country's ability to fulfill its on-going role in the Middle East. In so doing, it assesses the impact of an aging America on the federal budget and the ramifications of this impact on not only the U.S. Department of Defense, but also the entire Middle Eastern region.

KEYWORDS: Iran, Globalization, Youth Bulge, Federal Budget, Defense Spending, Social Security, Medicare, Medicaid, Entitlements, Demographics, Discretionary Spending, Non-Discretionary Spending, United States, Foreign Military Finance, Economic Support Funds, Security Assistance, Total Fertility Rate

INTERSTATE COMMUNICATIONS IN THE TWENTY-FIRST CENTURY: CAN YOU HEAR ME NOW?

**Anthony Bessone-Lieutenant Commander, United States Navy
Master of Arts in National Security Affairs-September 2007**

Advisors: James A. Russell, Department of National Security Affairs

Peter R. Lavoy, Department of National Security Affairs

This thesis examines the utility of interstate bargaining frameworks, as described by Thomas Schelling and Robert Jervis, in regard to determining the effectiveness of the signaling process between sovereign states. Are coercion and compellence, as described by Thomas Schelling, an effective means of determining a state's intent? Or, is the alternative interstate communications system involving perception and misperception, as described by Robert Jervis, flawed? According to Schelling, coercion convinces a person to involuntarily behave in a certain way through pressure or force; while compellence attempts, through action or commitment to action, to induce an opponent's response if they do not comply with the former's wishes. Jervis on the other hand, asserts that intrastate communications are, for all intents and purposes, ineffective, ranging from difficult if not impossible to attain due to the ambiguities of participating states' actions. Specifically, this thesis examines a case study involving Iran's nuclear program and how it is or is not influenced by Israel and the United States, and identifies which theoretical framework, if any, best explains a nation's intent in the international arena.

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KEYWORDS: Ahmadinejad, Bargaining Frameworks, Coercion, Compellance, Interstate Communication, IAEA, Iran, Israel, Jervis, Nuclear, NPT, Schelling, Signaling, U.S.

AN ANALYSIS OF HIZBULLAH'S USE OF MEDIA

Diane S. Cua-Lieutenant, United States Navy

B.S., University of California-San Diego, 1999

Master of Arts in National Security Affairs-September 2007

Advisor: Anne Marie Baylouny, Department of National Security Affairs

Second Reader: Abbas Kadhim, Department of National Security Affairs

In recent years Lebanon's Hizbullah, the Party of God, has been steadily increasing its influence domestically and in Middle East politics regionally. Despite widely accepted understandings of Hizbullah as a movement, the organization has evolved to strategically respond to changes in the surrounding political context, specifically through the use of their own media, a satellite television station with region reach. Using elements of social movement theory (SMT), this paper analyzes whether Hizbullah's messages through the media have remained the same or changed in relation to political events occurring domestically and regionally during three time periods: from the parliamentary elections in 1992 to the Israeli withdrawal in 2000, from the post-Israeli withdrawal to the July 2006 war, and from the post-July war to the present. Alternatively, this framework is compared against theories that Islamist movements are unique and not responsive to the dynamics of social movements.

KEYWORDS: Terrorism, Hizbullah, Al-Manar, Social Movements

THE FRACTURING OF CHINA? ETHNIC SEPARATISM AND POLITICAL VIOLENCE IN THE XINJIANG UYGHUR AUTONOMOUS REGION

Bradley D. Hitchcock-Captain, United States Marine Corps

B.S., Southern Illinois University-Carbondale, 2000

Master of Arts in National Security Affairs-September 2007

Advisors: Aurel Croissant, Institute of Political Science, Ruprecht-Karls-University Heidelberg

Christopher Twomey, Department of National Security Affairs

In the wake of the September 11th terrorist attacks on New York and Washington, D.C., China began to tout its own terrorist problem in the predominantly Muslim populated province of Xinjiang. Claims that the province's separatists and extremists threaten China's national security seem contrary to literature focusing on the region's ethnic minorities. Yet Xinjiang has historically been a restive, rebellious province, and has only in recent years come fully under Beijing's sphere of control. Throughout the 1990s, sporadic political violence occurred in Xinjiang, and as the geopolitical situation in Central Asia changed, Beijing's claim that Muslims were a threat to its national security became a legitimate question. An evaluation of those elements that produce an environment ripe for mass organized political violence of such a scale as to threaten China's sovereignty will provide a useful understanding of the current state of affairs within Xinjiang. This thesis concludes that while each element exists and has existed in varying degrees since Chinese rule of the region began, all of the elements have not been simultaneously at a level to produce the level of violence that would threaten China's sovereignty.

KEYWORDS: Political Violence, Xinjiang Uyghur Autonomous Region, Chinese Government Minority Policy, Relative Deprivation, Rational Choice

NATIONAL SECURITY AFFAIRS

THE GLOBAL REACH OF CHINA'S SOFT POWER – CHINA'S RISE AND AMERICA'S DECLINE?

**James H. Hoey-Lieutenant, United States Navy
B.S., United States Naval Academy, 2001**

Master of Arts in National Security Affairs-September 2007

**Advisors: Anshu N. Chatterjee, Department of National Security Affairs
Edward A. Olsen, Department of National Security Affairs**

Over the past decade China has downplayed its hard power, instead focusing on a strategy to build its “soft power.” Emerging from a shell of defensive diplomacy dating back decades, China suddenly has engaged the world, wooing friends with a subtle, softer approach to make gains as America’s popularity has plummeted. In Africa, newly popular China is winning oil and gas deals; in Latin America, China is signing strategic partnerships; in the Philippines, Chinese films are making inroads against American movies; and in southern Thailand, the U.S. consulate building in Songkhla is now the Chinese consulate. Clearly this charm offensive utilizing soft power has potentially forced the United States into a situation in which another country’s appeal outstrips its own. As China’s soft power encompasses a global reach, U.S. policymakers need to understand how China exerts soft power, whether China’s soft power is dangerous to developing nations, and whether elements of China’s charm offensive seek hard power objectives that threaten U.S. interests.

As America faces a decline in its soft power, it will have to reverse course through the promotion of classic American values, public diplomacy, and a great culture to prevent the worst-case scenario; China using its soft power to push countries to choose between close ties to Washington or closer ties to Beijing. In the meantime, Washington must not foolishly ignore the gains China is making in the balance of soft power around the world, and seek to properly balance its soft and hard power, a sign of a country’s maturity and confidence, which China still struggles with.

KEYWORDS: The United States of America, China, Soft Power, Africa, Latin America, Southeast Asia, Hard Power, Culture, Values, Public Diplomacy, Foreign Policy, Peaceful Rise, Peaceful Development, Isolation, Energy, Oil, Taiwan, Great Power, Governance, Quality Control, Transparency, Noninterference Policy, Resources, American Soft Power, U.S. Information Agency, Voice of America, U.S. Foreign Policy

MULTI ATTRIBUTE DECISION ANALYSIS IN PUBLIC HEALTH – ANALYZING EFFECTIVENESS OF ALTERNATE MODES OF DISPENSING

**Sinan Khan-Epidemiology Analyst, Los Angeles County-Department of Public Health
B.S., California State University-Fullerton, 2003**

M.P.H., University of Southern California, 2005

Master of Arts in National Security Affairs (Homeland Security and Defense)-September 2007

**Advisors: Anke Richter, Defense Resources Management Institute
Lauren F. Wollman, DoD Contractor**

Local emergency planners are creating mass prophylaxis plans to prophylax entire populations within forty-eight hours in order to reduce mortality after a bioterrorist attack. The Points of Dispensing (POD) used in prophylaxis are central to an area’s mass prophylaxis plans, but they are insufficient because of their staffing and security constraints. Several alternate modes of dispensing that have similar attributes and are considered best practices are presently being implemented in local health departments. The purpose of this thesis is to develop models to evaluate alternate modes of dispensing using multi-attribute value function, an approach that supports multi-attribute decision-making by taking into account the trade-offs a decision-maker is willing to make between attributes. Two models are created for Los Angeles County (LAC). The models show that in LAC, the door-to-door option, pharmacy option, civil service option, and Kaiser Permanente option work best. The study finds that alternate modes of dispensing can be useful in filling the gaps in the POD-based approach by increasing critical resources or lowering the pressure on existing resources.

KEYWORDS: Strategic National Stockpile, SNS, Cities Readiness Initiative, CRI, Points of Dispensing, POD, Alternate Modes of Dispensing, Pre-Positioning, Business PODs, Special Needs Population, University PODs, Hotel PODs, Kaiser Permanente, Door to Door Dispensing, USPS, Drive Thru PODs,

NATIONAL SECURITY AFFAIRS

Pharmacy, Multi Attribute Decision, Multi Criteria Decision, Objectives Hierarchy, Individual Value Function, Relative Importance, Weights

CHINA'S RISE: REGIONAL STABILIZER OR U.S. ADVERSARY?

Rufus A. Lensey-Lieutenant, United States Navy

B.S., Norfolk State University, 1998

Master of Arts in National Security Affairs-September 2007

Advisor: Alice L. Miller, Department of National Security Affairs

Second Reader: Edward A. Olsen, Department of National Security Affairs

China's reform and modernization have led to extraordinary economic growth. Statistical data reveal that the economy's dynamism foreshadows a prominent military in the future. This unfolding development has led to both negative and positive views of China in the international community. Will China's rise threaten U.S. interests and lead to China becoming an adversary? Or, will it serve as a regional stabilizer and help solve problems in Asia? Competing theoretical frameworks offer a means to analyze the validity of the two perspectives on the significance of China's rise. Historical case studies involving Germany, Japan, Russia, Great Britain, and the United States provide an opportunity for a comparative analysis of the rise of China.

The future outlook need not be negative. China's leadership is in transition. Democracy and greater economic interdependence are possible outcomes. In light of China's military potential, it will be increasingly important to see not only how China relates to the outside world, but also how China evolves politically. Assessing the implications of China's military modernization is necessary for the understanding of its critically important trend in world affairs. China's desire to be a major regional power and a more powerful presence on the global stage, in military as well as political and economic terms, means that U.S. decision makers will need to design policies founded on a comprehensive analysis of the implications of the rise of China.

KEYWORDS: China, Economic, Development, Military, Adversary, Stabilizer, Theoretical, Frameworks, Transition, Interdependence

THE FALKLANDS WAR: UNDERSTANDING THE POWER OF CONTEXT IN SHAPING ARGENTINE STRATEGIC DECISIONS

Scott C. Nietzel-Lieutenant, United States Navy

B.A., Columbia College, 2000

Master of Arts in National Security Affairs-September 2007

Advisor: Jeanne Giraldo, Department of National Security Affairs

Second Reader: Mark Berger, Department of Defense Analysis

This thesis uses a historical case study approach to examine the impact of context on shaping decision making during the conduct of war. The case analyzed is the war between Argentina and Great Britain for control of the Falkland Islands in 1982. This thesis examines the relative strength of the belligerents' positions using the concepts of force, time, and space from current operational warfare doctrine, and shows that British victory in the conflict was by no means a foregone conclusion. Next, an exploration of the Argentine conduct of the war highlights and discusses in detail mistakes and errors in judgment that had direct impacts on battlefield results. These decisions are then traced to the context in which they were made. It is this context, specifically the power of limited war culture and to a lesser extent the strength of the military polity as a constituency, which explains the Argentine defeat in the Falklands.

KEYWORDS: Falklands War, Malvinas, Argentina, Great Britain, Limited War Culture, Inter-Service Rivalry, Military Polity as Constituency

NATIONAL SECURITY AFFAIRS

GAINING CONTROL OF IRAQ'S SHADOW ECONOMY

David S. Ramirez-Lieutenant, United States Navy

B.S., Excelsior College, 2001

Master of Arts in National Security Affairs-September 2007

Advisor: Robert E. Looney, Department of National Security Affairs

Second Reader: Abbas Kadhim, Department of National Security Affairs

Four and a half years after freeing Iraqi citizens from a ruthless dictatorship, the country is still mired in poverty, corruption, and insurgent violence. These conditions fuel a sprawling, decades-old shadow economy manipulated by elements of organized crime, militias, and insurgents to fund attacks on Coalition forces, infrastructure, and innocent Iraqi civilians. The shadow economy is also used extensively by the poor and women for subsistence living. The combined effect for Iraqi citizens is that they have to survive in a country with inadequate institutions and poor governance. The extensive shadow economy diverts funds from legitimate uses by the government, such as taxes, funds for reconstruction projects, social protection, social insurance, etc. Numerous agencies are deeply committed to helping the Iraqi government rebuild and formalize the shadow economy. The challenges involved in formalizing a shadow economy in the midst of war and the strategies undertaken are examined in this thesis. Similar efforts to restore peace and stability in Afghanistan, with its burgeoning opium trade, are analyzed, searching for successful approaches with applicability in Iraq.

KEYWORDS: Iraq, Shadow Economy, Informal Economy

PROVINCIAL RECONSTRUCTION TEAMS: IMPROVING EFFECTIVENESS

Cameron S. Sellers-Major, United States Army Reserve

B.A., Wheaton College, 1990

Master of Science in Defense Analysis-September 2007

Master of Arts in National Security Affairs (Stabilization and Reconstruction)-September 2007

Advisors: Karen Guttieri, Cebrowski Institute

Anna Simons, Department of Defense Analysis

Provincial Reconstruction Teams (PRT) are currently prominent constructs for stabilization and reconstruction in Afghanistan and Iraq. PRTs are composed of civil-military teams, including elements from coalition partners and the host-nation, and involve multiple military services and civilian agencies. Their missions are to extend the legitimacy of the central government throughout the country and to use civil military operations to counter anti-government forces. PRTs are prominent, but controversial. Nongovernmental organizations (NGO) complain that the U.S. military blurs the lines between humanitarian assistance and military operations. Other critics have called PRTs interagency failures because the U.S. Department of State, the Department of Defense, and other government agencies have not contributed the personnel, resources, or training required to make PRTs operationally functional. The result is a lack of both integration and effectiveness. The purpose of this thesis is to determine how to make PRTs more effective in the future. While host-nation participation is necessary for success, this thesis focuses only on the controversies involving NGOs and interagency communities. These include humanitarian space, general attributes, and the effectiveness of PRTs. The policy prescription for future PRTs is found in the concept of a Civil Military Operations Center (CMOC), which is described in the U.S. Army's *FM 3-05.40, Civil Affairs Operations*. The core tasks of a CMOC, especially those of civil information management, are designed to accomplish a variety of missions relating to post-conflict reconstruction. They would serve well as foundational components of a PRT. Also, because of the interagency nature of PRTs, commanders of these teams must have the right character and skill sets to operate in this complex environment.

KEYWORDS: Provincial Reconstruction Teams, Army Civil Affairs, Civil Military Operations Center, Civil Military Operations, Civil Affairs Operations, Measures of Effectiveness, Nongovernmental Organizations, International Organizations, Interagency, Iraq, Afghanistan, Operation Enduring Freedom, Operation Iraqi Freedom, North Atlantic Treaty Organization, International Security Assistance Force, Civil Information Management, Military Selection Process, Boundary Spanner, Bureaucracy

NATIONAL SECURITY AFFAIRS

THE ROLE OF POLITICAL AND ECONOMIC FACTORS IN THAILAND'S LAST TWO COUPS D' ETAT

**Roger R. Vrooman-Major, United States Air Force
B.S., Troy State University, 1993**

M.S., Southern Methodist University, 1999

Master of Arts in National Security Affairs-September 2007

Advisor: Michael Malley, Department of National Security Affairs

Second Reader: Robert E. Looney, Department of National Security Affairs

Thailand has experienced numerous coups. The last two Thai coups (1991 and 2006) were against popularly elected prime ministers. This thesis proposes and tests six hypotheses as the basis for each coup. The six hypotheses are split evenly between three political and three economic hypotheses. After a case study of each coup, the similarities and differences between the two coups are examined. In the case of this thesis, the trend of political factors causing political instability is supported. Although economic factors fluctuated (or in the case of income inequality, remained relatively constant), the three economic factors are not found to contribute to Thailand's political instability. Therefore, no combination of any of the six hypotheses tested is substantial enough to be labeled as the cause of either coup.

KEYWORDS: Coup, Coup D'etat, Thai Politics, Thai Economics, Thai Political Parties

MASTER OF ARTS IN SECURITY STUDIES

COMPLIANCE WITH COMMUNITY MITIGATION AND INTERVENTIONS IN PANDEMIC INFLUENZA: A COMMUNITY POLICING STRATEGY

Timothy P. Alben, Sr.-Major, Massachusetts State Police

B.S., Westfield State College, 1984

M.S., Western New England College, 2001

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisor: Robert Bach, DoD Contractor

Second Reader: Anke Richter, Defense Resources Management Institute

A number of response plans and strategies have been published concerning preparation for an oncoming pandemic influenza. The majority of federal guidance and state planning with respect to pandemic preparation focuses excessively on the availability and distribution of effective vaccine and antiviral remedies — pharmaceutical solutions. Effective vaccines, presently unavailable, will not be in production and available for application for at least eight months after the onset of an identified pandemic. Community mitigations and interventions (such as school closures, event cancellations, limited travel, quarantine, and work at home plans) are traditional responses to slowing the spread of a virus. In order to effectively implement these time-tested strategies, voluntary community compliance with interventions becomes exceedingly important. The recent global experience with SARS and current mathematical modeling of virus spread characteristics support community mitigation efforts. The community policing model, having evolved over the last twenty years, provides a pre-existing framework to engage the public in grassroots pandemic education, awareness, planning, and problem solving partnerships. The Incident Command System provides a structure for a collaborative, multi-agency approach to successfully implement a community awareness and compliance initiative. Community mitigations will save lives.

KEYWORDS: Community Policing, Pandemic Influenza, Community Mitigation, Intervention, Quarantine, Law Enforcement, Public Health

LEVERAGING CITIZENS AND CULTIVATING VIGILANCE FOR FORCE MULTIPLICATION IN THE MARITIME DOMAIN

Michael Andre Billeaudeau-Lieutenant Commander, United States Coast Guard

B.A., California State University-Fullerton, 1993

M.A., University of Washington, 2003

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisor: Richard D. Bergin, Department of Information Sciences

Second Reader: Christopher J. Bellavita, DoD Contractor

This thesis examines a Coast Guard-led networked community (Citizen's Action Network – CAN) by exploring the network's potential to augment the Coast Guard in managing its prodigious maritime domain risks. Through an expansive literature review, a survey, and a set of semi-structured interviews, a proposed set of community-based structural components are identified and tested for strength and significant relationships using ANOVA, Regression, and Student's T statistical testing methods. Findings suggest that component parts of CAN fit into a business-oriented, networked, management model called a Community of Practice (COP), with vigilance emerging as a sustainable, predictable, and highly desirable post-9/11 networked community behavior. CAN's demographics are also examined to determine trends, such as above-average military veteran membership, which may support future targeted volunteer recruiting. Finally, various Coast Guard-initiated CAN communication methods are tested for significant impact;

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volunteers receiving phone calls correlate to higher levels of trust in the Coast Guard, while those receiving written communications maintain a heightened sense of access to the Coast Guard. These findings underscore the yet-untapped potential to groom grassroots vigilance, build trust in government, and create a culture of prevention by sharing national challenges — ultimately putting the “home” back in homeland security.

KEYWORDS: Citizen, Vigilance, Network, Community, Collaboration, Corroboration, Security, Terror, Virtual, War on Terror, Volunteer, Trust, Social Identity, Social Networking, Community of Practice, Social Capital, Affect, Community Engagement, Mutual Understanding, Coast Guard, Maritime Domain Awareness, Ports, Waterways, Royal Canadian Mounted Police

PRISON RADICALIZATION: THE NEW EXTREMIST TRAINING GROUNDS?

McKinley D. Coffin, Jr.-Captain, Volusia County, Florida, Sheriff's Office

B.A., Warner Southern College, 1998

M.S., National University, 2005

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisor: David Brannan, Center for Homeland Defense and Security

Second Reader: Lauren F. Wollman, Center for Homeland Defense and Security

As a nation with the largest prison population in the world, the United States has all the ingredients for criminals, extremists, and religious radicals to collaborate in producing a new breed of homegrown terrorist. Although there are documented cases where homegrown prison converts have conducted or provided material support for terrorist operations both domestically and internationally, the phenomenon is still a relatively new concern for U.S. homeland security. This thesis uses survey and interview methodologies to assess the opinions of correctional officers and experts as to the extent of the problem, as well as to identify gaps in intelligence, training, and strategy. Results suggest that prisons are fertile recruiting grounds for disaffected inmates who may be influenced by charismatic extremists acting under the guise of religion or politics. However, the results also point to a disconnect between corrections and other homeland security disciplines that prevents the creation of a robust information sharing environment. This study's conclusions indicate that a comprehensive and effective strategy cannot be developed without first acknowledging that the problem exists, understanding the rudimentary contributing factors, and initiating discussion on a multi-faceted approach to counter the radical influence.

KEYWORDS: Prison, Radicalization, Extremists, Corrections, Information Sharing Environment, Intelligence

COUNTERING THE LINGERING THREAT OF THE ABU SAYYAF GROUP

Stephen C. Cohn-Major, United States Marine Corps

B.A., University of Texas at San Antonio, 1990

M.A., Naval Postgraduate School, 2006

Master of Arts in Security Studies (Homeland Defense and Security)-September 2007

Advisor: Maria Rasmussen, Department of National Security Affairs

Second Reader: Jacob Shapiro, Department of National Security Affairs

This thesis argues that the most effective strategy for eradicating the U.S.-designated Foreign Terrorist Organization, the Abu Sayyaf Group (ASG), is to bolster current peace talks between the Republic of the Philippines and the Moro Islamic Liberation Front (MILF). The MILF has been providing support and sanctuary to the ASG, which has hindered U.S.-Philippine counter-terror operations. This thesis explains why a shift in U.S.-Philippine strategy is required by examining the historical circumstances that led to the creation of the ASG; the supporting-supported relationship between the MILF and ASG; and lastly, the effectiveness of the U.S.-Philippine response to the ASG from 2001-2007. Successful peace talks between the Government of the Philippines (GRP) and the MILF will lead not only to a loss of critical MILF support to the ASG, but will also allow the AFP to hunt down and eradicate the remaining ASG in areas that had previously been untenable. Successful execution of this strategy will bolster regional stability in

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Southeast Asia by defeating one of the targets of the Global War on Terror, as well as diminishing one of the places of refuge utilized by other international terrorist organizations.

KEYWORDS: Philippines, Muslim Secessionists, MILF, MNLF, ASG, RSM, ARMM, Terrorism, International Relations, Regional Stability, Peace Process

THE EFFECT OF ASSESSMENT PROCESSES ON MEASURING HOMELAND SECURITY CAPABILITY

John A. Donnelly, Sr.-Captain, District of Columbia Fire and Emergency Medical Services

B.S., University of the District of Columbia, 2005

Master of Arts in Security Studies-September 2007

Advisor: Robert Bach, Department of National Security Affairs

Second Reader: Amy Donahue, University of Connecticut

The National Preparedness Goal directs that preparedness efforts for major events should be developed through a capability-based planning process. The ability to perform a valid and reliable capability assessment is necessary to guide proper allocation of resources in the capability-based planning process. Capability assessment is also necessary to validate and measure the impact of investments. This thesis examines a self-assessment methodology that may be used to perform capability assessment. The thesis employs a comparative case study methodology to examine process options that might be utilized to determine which process provides the most opportunity for data collection while fostering a collaborative environment that will provide opportunities for sharing knowledge among assessment group members. A review of the case studies suggests that the subject matter experts employed in the analysis may not have the requisite knowledge to perform the assessment. This suggested finding implies problems with capability based planning efforts. The thesis provides recommendations for future strategies to perform homeland security capability assessments.

KEYWORDS: Capability Assessment, HSPD 8, Subject Matter Experts, Collaboration

CROSS-SECTOR COLLABORATION AMONG CRITICAL INFRASTRUCTURE UTILITIES: A CASE STUDY FOR ASSESSING RELATIONAL CAPACITY

Brian A. Draper-Administrator, City of Mesa, Utility Department

B.A.S., Arizona State University, 2003

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisors: Gail Fann Thomas, Graduate School of Business and Public Policy

Susan P. Hocevar, Graduate School of Business and Public Policy

This nation relies on the network of critical infrastructures to maintain economic superiority, public health, and military strength. Under this premise, the federal government established the National Infrastructure Protection Plan (NIPP) to leverage national and regional preparedness. Hurricane Katrina demonstrated that, collectively, the infrastructure sectors are not prepared to respond to local and regional disasters using national strategies and resources. There remains a lack of capability to assess an organization's capacity to collaborate. To better understand the enablers and barriers to collaboration within a region's infrastructure system, this study reports on the findings from interviews of 13 middle and 10 top managers of the utility organizations in and around Mesa, Arizona. In addition to interviews, the managers in this case study completed a survey on collaborative capacity, which provides a lens for examining the factors that enable and impede cross-sector collaboration in the City of Mesa and the interdependent sectors. Finally, the managers were requested to provide individual interpretations of the survey data and recommendations for improvement on the "Response Form." Incorporating this feedback will be critical for starting the momentum for change.

KEYWORDS: Collaborative Capacity Audit, National Infrastructure Protection Plan, Critical Infrastructure, Cross-Sector Collaboration, Diagnostic Instrument

SECURITY STUDIES

UNLEASHING OUR UNTAPPED DOMESTIC COLLECTION IS THE KEY TO PREVENTION

Nestor Duarte-Assistant Special Agent in Charge, Federal Bureau of Investigation

B.A., Wake Forest University, 1985

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisors: Robert L. Simeral, Department of National Security Affairs

James J. Wirtz, Department of National Security Affairs

Human intelligence from informants, criminals, good samaritans, and cooperative individuals is the key to neutralizing major terrorist plots. The need for domestic intelligence collection in the United States is supported by a review of the national strategies and data collected from statements of Federal Bureau of Investigation and Department of Homeland Security officials. Unfortunately, scholarly articles and commentaries point to an inadequate human intelligence program five years after the events of September 11, 2001.

This thesis presents a community-based exploitation strategy for the expansion of domestic collection through the leveraging of state and local law enforcement and public and private collection. The strategy would take advantage of the significant untapped resources available to state and local law enforcement and public and private entities by encouraging sharing and discouraging hoarding. The technology would do the heavy lifting by sifting through vast amounts of available information to find a key piece of data. Technology can assist analysts by allowing them to exploit the semantic process of the Global Justice Extensible Markup Language (XML), a computer language. Together, this exploitation strategy and technology will become part of new homeland security doctrine that could unleash the full potential of domestic collection and provide the missing pieces of the intelligence puzzle.

KEYWORDS: Domestic Intelligence, Intelligence Collection, Human Intelligence, HUMINT, Fusion Centers, State and Local Law Enforcement Intelligence, Data Platforms, Global Justice XML

COMMUNITY EXPECTATIONS: MATCHING GOVERNMENT CAPABILITIES TO THE EXPECTATIONS OF THE PUBLIC

Jeffrey A. Friedland-Director, St. Clair County Homeland Security-Emergency Management

B.B.L., Baker College, 1996

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisors: Glen Woodbury, Center for Homeland Defense and Security

Robert Bach, Center for Homeland Defense and Security

Major events potentially affect all types of essential services in both government and private sectors. These are services that residents expect to be delivered, are required by other services to function, and are critical to the life safety of residents. If those services collapse, there will be a threat to life and limb. Failure to properly ensure continuity of essential governmental and private services in the wake of a natural disaster or terrorist attack could result in societal chaos.

A community expects the response and outcome of any event to be the same, failing to realize the interdependencies required for continuation of necessary services. Contributing factors to interdependency effects are stove-pipe planning and ineffective information sharing. A stove-pipe or vertical sector based system creates an environment of isolation within a community rather than a cohesive interacting system.

As public and private expectations are identified, two relevant issues are required to address the capabilities needed to enhance essential services: horizontal planning and resilience. Governmental structures provide the platform for horizontal planning and cooperation, which is essential to civil protection. A community-based system is the mechanism for improving coordination and communication into and out from the government.

KEYWORDS: Expectations, Essential Services, Resiliency, Interdependencies, Continuity

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THE PREPAREDNESS WEB: REGIONAL COLLABORATIVE NETWORKS FOR HOMELAND SECURITY PREPAREDNESS

**Christopher C. Holbrook-Battalion Chief, Sacramento Metropolitan Fire District, California
B.S.A., California State University, 1991**

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

**Advisors: Gail Fann Thomas, Graduate School of Business and Public Policy
Susan P. Hocevar, Graduate School of Business and Public Policy**

This case study is offered with the purpose of informing the initiation of regional collaborative efforts nationwide. This research effort examines a network of networks, called here a Preparedness Web, utilized to meet locally-identified, regional homeland security preparedness needs. How and why these networks were established is documented to allow other regions to draw parallels to their own situations. A measurement of the systems' collaborative capacity is identified to validate the systems' functionality. Recommendations are offered for other regions considering collaborative efforts based upon a retrospective examination of the system originators' strategic intent. To the extent to which this effort can be used to illustrate successful collaboration on a national basis, a replicable "ground up" process designed to entice more agencies to undertake or enhance their own regional collaborative preparedness efforts is presented.

KEYWORDS: Networks, Collaboration, Regionalization, Homeland Security Preparedness

A COUNTRY DIVIDED: THE IMPACTS OF FRAGMENTED COMMUNITIES ON IRAQ'S GOVERNMENT

**Andrew P. Hubbard-Captain, United States Army
B.S., United States Military Academy, 2002**

Master of Arts in Security Studies (Defense Decision-Making and Planning)-September 2007

**Advisor: Abbas Kadhim, Department of National Security Affairs
Second Reader: Vali Nasr, Department of National Security Affairs**

This thesis seeks to answer the question "What effect do Iraq's fragmented communities have on the government's ability to consolidate control in the country?" To answer this question, this thesis examines three underlying factors, essentially on three levels of analysis (individual, communal, and state): first, why Iraqis are more loyal to their communities than to the central government; second, how the political militias in Iraq affect the security situation in the country (both adversely and positively); and lastly, how Iraqi politics impact the government's ability to consolidate control over the country. Although seemingly obvious, this thesis brings to light the role that militias play in everyday life and how deeply entrenched into Iraqi society they have become, and explains why they cannot be simply wished away, as some U.S. policymakers would like to believe. The thesis concludes with a discussion of 1) the likelihood of U.S. success with the "surge" and an analysis of its impact on Iraq's Sunni and Shi'a militias; 2) some U.S. policy recommendations; and 3) some thoughts on democratization as a U.S. grand strategy.

KEYWORDS: Iraq, Militia, Mahdi Army, JAM, Sadr, "Surge," Sectarian

CAN YOU LEAD ME NOW: LEADING IN THE COMPLEX WORLD OF HOMELAND SECURITY

**Nola M. Joyce-Senior Executive Director, Metropolitan Police Department
M.A., Southern Illinois University-Edwardsville, 1983**

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

**Advisors: Christopher J. Bellavita, Center for Homeland Defense and Security
Robert Bach, Center for Homeland Defense and Security**

This thesis focuses on a theory of leading and the activities and processes used to move a bureaucratic, public agency to a higher level of fitness in the contexts of dynamic equilibrium and the edge of chaos. The primary claim is that leading and all of its components – thinking and sensemaking, storytelling and

demonstrating the right ideas, and organizing action and shaping collective movement – are required for an organization to address the complex, coordinating problems of homeland security.

This research is exploratory using the methodology of grounded theory. An in-depth analysis of a single case is used to test a theory of leading in complexity. Descriptive examples are provided of the activities identified in the process of leading.

Findings support the theory of leading and offer some suggestions for leading the work of homeland security. The analysis demonstrates that leading is a process that weaves in a non-linear way from thinking to sensemaking to demonstrating the “right ideas” and identities to organizing collective movement and back around to thinking. It is a process without ends and a process that shows how to accomplish organizational change in the realm of complexity and chaos.

KEYWORDS: Leadership, leading, Chaos Theory, Grounded Theory

FEDERAL-TRIBAL GOVERNMENT COLLABORATION IN HOMELAND SECURITY

Monica R. Kueny-Commander, United States Public Health Service

B.S., St. Louis University, 1991

M.P.H., Uniformed Service University of the Health Sciences, 2003

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisor: Robert Bach, Center for Homeland Defense and Security

Second Reader: Christopher J. Bellavita, Center for Homeland Defense and Security

Each day, more than fifteen hundred illegal immigrants enter the United States through the tribal lands of the Tohono O’odham Nation, and more than twenty-five other tribes also have land on or near the international borders or shorelines of the United States. Beyond borders, tribal lands cover fifty-six million acres of trust lands, which include a wide variety of national critical infrastructure that often provide the backbone of non-tribal regional infrastructure. Although federal-tribal relationships have long been rooted in a unique relationship defined by the sovereignty of each government, the Homeland Security Act of 2002 defines tribal governments as local governments. The shift virtually ignores decades of treaties and U.S. Supreme Court rulings that established the special relationship between tribes and the federal government. Despite the recent addition of the word “tribal” to many Department of Homeland Security documents, this action fails to outline the mechanisms for collaboration with tribal governments in homeland security programs that adequately reflect and build upon the sovereign status of tribal governments. This research reviews aspects of social trust required for collaboration, explores successful federal-tribal collaboration efforts, and suggests legislative and policy changes that may provide mechanisms necessary for effective federal-tribal collaboration in homeland security.

KEYWORDS: Social Trust, Collaboration, Sovereignty, Tribal Government, Federal

A NEW ROLE FOR LOCAL POLICE IN RADIOLOGICAL SECURITY

Thomas F. Lee, Jr.-Deputy Superintendent, Boston Police Department

B.S., Western New England College, 1991

M.S., Boston University Metropolitan College, 1994

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisors: Robert L. Simeral, Department of National Security Affairs

David Brannan, Center for Homeland Defense and Security

Since the 9/11 attacks, the possibility of another attack on America using radiological weapons has been a subject of much discussion both in the press, in national security and homeland security circles, and in academic literature. While much of the federal government’s focus has been on preventing radiological material from being smuggled into the United States, this thesis examines the possibility of terrorists using materials that are readily available in medical, research, and industrial locations. A dirty bomb or radiological dispersal device could have a devastating impact on the economy and greatly raise public fears.

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Local police agencies have previously not had a formal role in radiological security. This thesis explores policy initiatives, based on community policing principles conducted at the local police level, which will enhance security at locations where radiological materials are kept.

KEYWORDS: Radioactive Security, Community Policing, Radioactive Materials, Radiological Dispersal Device, Terrorism, Source Material Security, Local Law Enforcement, Radiation Control Program

A NEW DEPARTMENT OF DEFENSE FRAMEWORK FOR EFFICIENT DEFENSE SUPPORT OF CIVIL AUTHORITIES

**Rodney D. Liberato-Major, United States Air Force
B.S., United States Air Force Academy, 1994**

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisor: Robert Bach, DoD Contractor

Second Reader: Stanley Supinski, DoD Contractor

The terrorist attacks of September 11, 2001, triggered a new focus on Department of Defense (DoD) capabilities support to civilian authorities during emergencies. Hurricane Katrina added to this national attention on the role the Department of Defense (DoD) should play in responding to emergencies. Despite this recognition of the significance of military involvement, little has been done to organize a military framework that can effectively respond to a no-notice domestic incident. This thesis analyzes the current context in which DoD capabilities are approved and utilized in a national crisis to examine two core issues: 1) under what circumstances can DoD capabilities be better leveraged in response to a catastrophic domestic event, and 2) what are the strategic implications for DoD if they assume a more proactive role in domestic events? Two situational vignettes carved out of the National Planning Scenarios are used to demonstrate that the DoD validation and approval process for civil support operations is slowed by current DoD policy. The study culminates by advocating that the DoD reorganize its force structure to most efficiently support a military response to a domestic event. A new Civil Support Expeditionary Force framework for Defense Support of Civil Authorities is recommended.

KEYWORDS: National Response Plan, Defense Support of Civil Authorities, USNORTHCOM, Request for Assistance, Request for Forces, Emergency Support Functions, Pre-Scripted Mission Assignments, Civil Support

DYSFUNCTION JUNCTION: INTELLIGENCE, PEACEKEEPING, AND THE UNITED NATIONS

**Steven E. Maceda-Major, United States Air Force
B.S., United States Air Force Academy, 1995**

M.S., Joint Military Intelligence College, 1996

Master of Arts in Security Studies (Security Stabilization and Reconstruction)-September 2007

Advisor: Kenneth Dombroski, Department of National Security Affairs

Second Reader: Timothy J. Doorey, Department of National Security Affairs

United Nations (UN) peace operations continue to play a vital role in international security, with 15 missions underway in 2007. The UN, however, lacks the institutional intelligence capacity to provide guidance, high-level assessments, and tactical/operational intelligence support for the over 100,000 peacekeepers around the world. The UN's lack of focused capabilities is particularly surprising in the post-9/11 world and after the 2003 bombing of its headquarters in Iraq. Since the UN's first foray into peacekeeping in 1948, member states, fearful of violations of their sovereignty, have blocked previous reform attempts. This has forced UN operations to rely on ad hoc measures to meet their intelligence requirements, while the Secretary General and Security Council are at the mercy of member state intelligence agencies for their information. Despite this handicap, some improvements have been made, particularly at the mission level. Further, open source intelligence (OSINT) holds great promise for addressing many of the UN's intelligence requirements. This study concludes that the UN would be well-

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served by adopting the existing NATO model for OSINT production, enabling the organization to effectively collate and analyze the vast information stores at its fingertips.

KEYWORDS: Intelligence, Peacekeeping, United Nations, UN, Peace Operations, OSINT, JMAC

INTELLIGENCE SHARING IN COUNTERPROLIFERATION

Kevin J. Moyer-Captain, United States Army

B.S., University of Memphis, 1998

M.A., Webster University, 2001

Master of Arts in Strategic Studies (Defense Decision-Making and Planning)-September 2007

Advisor: Jeffrey Knopf, Department of National Security Affairs

Second Reader: Timothy J. Doorey, Department of National Security Affairs

Determining the role information sharing should play in operations has plagued policymakers since the United States' days of isolationism. Such sharing has the potential to either help or hinder any type of operation. This thesis looks at that role specifically with regard to counterproliferation operations. The purpose is to determine if the spread of weapons of mass destruction (WMD) material and related technology can be prevented by improving working relationships with allies via intelligence sharing. Moreover, if increasing intelligence sharing creates a more effective collective security action, then why is the United States very selective with whom and what it shares? Specifically, what are the risks and how can they be minimized? This thesis looks at three distinct cases where intelligence sharing has either helped or hindered counterproliferation operations in order to determine the relationship between the level and nature of sharing and the probability of success. The premise of this thesis is that increased information sharing among allies causes more effective security cooperation and is therefore necessary for combating the spread of WMD. Therefore, identifying and overcoming challenges in information sharing is imperative in preventing the spread of WMD.

KEYWORDS: Information Sharing, Intelligence, Counterproliferation, Proliferation, Interdiction, BBC China, So San, Iraq, Weapons of Mass Destruction, Libya, North Korea, Yemen, Trust, Barriers, Challenges, Risks

NATIONAL IMPERATIVE TO ESTABLISH A DOMESTIC MEDICAL INTELLIGENCE CENTER

Nitin Natarajan-Bioterrorism Coordinator, District of Columbia Department of Health

B.S., State University of New York-Empire State College, 2004

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisors: Robert L. Simeral, Department of National Security Affairs

Anke Richter, Defense Resources Management Institute

The United States does not have a centralized organization tasked with the oversight or implementation of a domestic medical intelligence program. Organizations throughout the nation have adopted a variety of definitions and operating procedures related to medical intelligence; however, they are inconsistent. Additionally, most jurisdictions limit medical intelligence to epidemiological surveillance.

This thesis proposes the structure, governmental organization, data sets, and reporting for a domestic medical intelligence center. This center will require close partnership with other federal agencies and state, local, tribal, and territorial (SLTT) governments. In addition, this thesis analyzes medical intelligence operations within the Armed Forces Medical Intelligence Center, the Department of Homeland Security Office of Health Affairs, the Metropolitan Washington Fusion Center, and the Los Angeles Terrorism Early Warning Group.

As this thesis shows, the development of a domestic medical intelligence center, covering a wide range of data sets, will allow for the effective collection, integration, analysis, and dissemination of both tactical and strategic actionable intelligence for federal and SLTT governments and private sector partners. These actions will assist in addressing this significant gap and increasing the nation's level of preparedness, thereby improving our nation's response to large-scale incidents, both naturally occurring and man-made.

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KEYWORDS: Intelligence, Public Health, Medical Intelligence, Domestic Medical Intelligence, Fusion Center, Information Sharing, Data Collection

RISK MANAGEMENT AS STRATEGIC CHANGE IN NATIONAL HOMELAND SECURITY POLICY

John P. Paczkowski-Civilian, Port Authority of New York and New Jersey

B.S., New Jersey Institute of Technology, 1975

M.S., New Jersey Institute of Technology, 1983

M.A., Columbia University, 1994

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisor: Robert Bach, DoD Contractor

Second Reader: Thomas Mackin, DoD Contractor

Secretary Michael Chertoff has said that the core principle that animates the Department of Homeland Security (DHS) is risk management. Risk management is a process of deciding trade-offs between available resources and the cost of minimizing the risk of unwanted consequences through an ongoing cycle of objective setting, risk assessment, alternatives evaluation, and implementation, in a way that buys-down risk over time. The statements of national leaders, federal legislation, and the Department of Homeland Security's own strategy documents, have set risk management as homeland security policy. Nonetheless, DHS has been challenged to implement a coordinated and integrated risk management program, to include compatible risk assessment methodologies among its component agencies. The National Infrastructure Protection Plan (NIPP) released in 2006, for the first time sets out a vision for a national risk management framework. That vision now extends the application of risk management to the nation's critical infrastructure owners and operators. This paper explores the challenges involved in implementing the risk management framework under the NIPP, examines how implementation has been managed as strategic change through the lens of change management theory, and offers recommendations for improvement. It is hoped that this paper will motivate further study into homeland security strategic change.

KEYWORDS: Risk Management, Risk Analysis, Risk Assessment, Strategic Change, Strategic Leadership, Organizational Change, Open Systems Theory, Complexity, Wicked Problems

DETECT AND DEFEAT – THE COMPLEXITIES OF ACCOMPLISHING THE HOMELAND SECURITY MISSION WITH EXISTING INTELLIGENCE COLLECTION PRACTICES

Jeffrey T. Robertson-DoD Civilian

M.S., University of Colorado, 2002

B.S., University of Colorado, 1999

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisor: Robert L. Simeral, Department of National Security Affairs

Second Reader: Richard D. Bergin, Department of Information Sciences

Since the tragic events of 11 September 2001, it has been argued that accurate and well-vetted intelligence is critical to securing the homeland; but over five years after the historic day, the realm of creating an "effective" domestic intelligence platform falls short of meeting desired milestones. The distinct threat of radicalism incubating within smaller communities (townships, rural communities) still exists, and the lack of intelligence collection efforts at the local level may be fueling this threat.

As a result of interviewing small townships and rural communities dispersed across the United States, it is discovered that though law enforcement resources of smaller populations have been recognized as critical assets in the realms of homeland security (HLS), small townships and countryside communities still experience shortfalls in available resources and HLS-related training. More times than none, these deficits revolve around domestic intelligence collection, processing, and dissemination.

In this research effort, the shortfalls plaguing the environment of intelligence collection and sharing are reviewed; a cost effective strategy to mitigate the identified intelligence discrepancies is offered; and a solution for improving information sharing between homeland security stakeholders is proposed.

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KEYWORDS: Domestic Intelligence, Law Enforcement, Local Community, Intelligence Cycle, National Guard, Surveillance, Homeland Security

WHAT TYPE OF STATE HOMELAND SECURITY STRATEGY SHOULD THE STATE OF NEW JERSEY DEVELOP

**Richard G. Rosell-Captain, New Jersey State Police
M.A., Seton Hall University, 2003**

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisor: Christopher J. Bellavita, DoD Contractor

Second Reader: Michael Panella, New Jersey State Police

The State of New Jersey does not have a written homeland security strategy. This thesis argues that New Jersey should have a strategy. The author reviews the reasons why New Jersey does not have a state strategy. Based on preliminary work, any justifications are no longer supportable. Beyond that, the thesis describes the elements that should be in that strategy. A by-product of this research is a homeland security strategy template that can be used by other states. As per the methodology, existing state strategies are reviewed and compared against national criteria for an acceptable strategy. New Jersey must create a strategy with a strong foundation, similar to the National Strategy for Homeland Security, which at the same time contains clear and concise goals, objectives, and activities, commonly found in conventional business plans. Based on that review, the author recommends that New Jersey create a homeland security strategy similar to the National Capital Region Homeland Security Strategic Plan. Further, New Jersey should construct this strategy using the Government Accountability Office (GAO) report, which identified six desirable characteristics that should appear in (national) homeland security strategies as a guide.

KEYWORDS: Homeland Security, Strategy, Strategic Plan, GAO, Goals, NCR, National Strategy

CONFLICT WITHOUT CASUALTIES: NON-LETHAL WEAPONS IN IRREGULAR WARFARE

**Richard L. Scott-Captain, United States Army
B.A., University of Washington-Tacoma, 2001**

Master of Arts in Security Studies (Stabilization and Reconstruction)-September 2007

Advisor: Robert M. McNab, Defense Resources Management Institute

Second Reader: Sophal Ear, Department National Security Affairs

This research shows that the casualties associated with warfare can be largely avoided. This includes both combatant casualties and noncombatant and friendly forces. The U.S. military is frequently tasked with deploying into foreign countries and performing duties ranging from conventional combat operations to humanitarian relief and training of host nationals. The politics of every deployment are complicated and invariably there will be some resistance, both domestically and internationally. People may feel victimized or marginalized and may demonstrate with protests, both peaceful and violent. How, then, may the use of non-lethal force be best applied in hostile situations in lieu of the “shoot or shoot” approach commonly associated with military operations? Scientific advances in non-lethal technology may serve to curb violence while still allowing Soldiers and Marines to accomplish their missions.

KEYWORDS: Non-Lethal Weapons, NLW, Less Lethal, Irregular Warfare, Unconventional, Asymmetric, Guerilla Warfare, Counterinsurgency, COIN, Military Operations in Urban Terrain, MOUT, Low Intensity Conflict, Stabilization and Reconstruction, Stability Operations, Support Operations, SOSO, Security Operations

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THE INTEGRATION OF VIRTUAL PUBLIC-PRIVATE PARTNERSHIPS INTO LOCAL LAW ENFORCEMENT TO ACHIEVE ENHANCED INTELLIGENCE-LED POLICING

Matthew J. Simeone, Jr.-Inspector, Nassau County Police Department

B.S., New York Institute of Technology, 1991

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisors: Richard D. Bergin, Department of Information Sciences

Robert L. Simeral, Department of National Security Affairs

In light of the recent emergence of fusion centers and centralized intelligence units, and the move to develop intelligence capacity within local law enforcement agencies in the United States, intelligence-led policing (ILP) is well-positioned to be on the nation's law enforcement agenda for the next decade. ILP relies on robust data collection from a wide range of sources to create intelligence products that can influence decision makers, and ultimately, impact the criminal environment.

Virtual public-private partnerships (VP3) offer local law enforcement agencies an effective and efficient way to leverage a vast and resourceful private sector for the purpose of enhancing ILP. A VP3 can exponentially enhance data collection capacity, facilitate the utilization of the private sector as a force multiplier, and provide the means by which local policing agencies can begin to instill a culture of preparedness in the citizens they serve.

This thesis includes case studies of three VP3s - Citizen Observer, NYPD Shield, and the Nassau County Security/Police Information Network (SPIN). In addition, virtual communities and social capital are examined with an eye towards the potential impact on crime, homeland security, and ILP. The findings of this thesis form the framework for a VP3-enhanced model of intelligence-led policing.

KEYWORDS: Intelligence-Led Policing, Public Private Partnerships, Information Sharing, Law Enforcement Intelligence Network, Virtual Communities, Social Capital, Communities of Interest, Communities of Practice, Civic Engagement, Private Security, VP3, Homeland Security

LEADERSHIP TRANSITION IN KAZAKHSTAN AND UZBEKISTAN: IMPLICATIONS FOR POLICY AND STABILITY IN CENTRAL ASIA

Shane A. Smith-Major, United States Air Force

B.S., East Tennessee State University, 1992

M.A., East Tennessee State University, 1995

Master of Arts in Security Studies (Stabilization and Reconstruction)-September 2007

Advisor: Thomas H. Johnson, Department of National Security Affairs

Second Reader: James A. Russell, Department of National Security Affairs

After September 11, 2001, Central Asia leapt into the vernacular of international politics. This forgotten region, where the "Great Game" was played, received new emphasis in the Global War on Terrorism. Analysts found a region brimming with both promise and concern. This thesis focuses on the future succession of two regional presidents, Nursultan Nazarbayev (Kazakhstan) and Islam Karimov (Uzbekistan), who are the only post-Soviet leaders their countries have known. These are also the only two Central Asian states not to experience a leadership transition since independence. These impending successions are potentially watershed events for Central Asia. Succession outcomes in these states will not only have ramifications throughout the region given its interconnectedness, but will also have foreign policy and economic implications for the global powers. This thesis studies the neopatrimonial nature of the regimes, the clan politics permeating the societies, and trajectories literature to examine the succession issue in these states. Conclusions reveal the conservative status quo tendencies presently embedded in these areas. This indicates that regime stability in the same vein as Turkmenistan at Saparmurat Niyazov's death is a more likely outcome for the states in question than are events such as the Tajik Civil War or Kyrgyz Tulip Revolution.

KEYWORDS: Central Asia, Kazakhstan, Uzbekistan, Neopatrimonialism, Clan Politics, Succession, Transition, Regime Trajectories

SECURITY STUDIES

STRATEGIC CHANGES FOR THE FIRE SERVICE IN THE POST 9/11 ERA

Douglas M. Weeks-Captain, City of Orange Fire Department

B.S., Cogswell Polytechnical College, 2005

Master of Arts in Security Studies (Homeland Security and Defense)-September 2007

Advisor: David Brannan, DoD Contractor

Second Reader: William Austin, West Hartford Fire Department

The fire service mission has changed since September 11, 2001, and the threat of terrorism is placing new demands on fire service leaders. Expectations by the community and a duty to maximize safety for fire service employees have created complex problems requiring unique and non-traditional solutions. The challenge for fire service leadership is how to best manage the contemporary threat of terrorism while maintaining its growing list of traditional mission-oriented requirements. This challenge is especially difficult given the low frequency but high risk and impact of terrorism. As the nation moves further away from 9/11, the easier it is to become complacent. Yet all accounts suggest that the threat is growing and another attack is inevitable. This thesis outlines and provides recommendations in four key areas the fire service must address if it is to be successful in meeting its current mission: intelligence, community engagement, response, and leadership. Although fire service agencies vary across the nation, the recommendations included herein are intended to be universal. Furthermore, this thesis seeks a viable balance between threat, impact, and sustainability.

KEYWORDS: Fire Service, Terrorism, Intelligence, Community Engagement, Community Expectations, Response, Management, Freedom of Information Act, 29CFR1910.120, Transactional Leadership, Transformational Leadership, Leadership, International Association of Fire Chiefs

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