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Compilation of thesis abstracts, September 2009

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Compilation of Thesis Abstracts

September 2009



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

PREFACE

This publication contains abstracts of unrestricted or unclassified theses submitted for the degrees doctor of philosophy, master of business administration, master of science, and master of arts for the March 2009 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.

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

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

INTRODUCTION

Mission

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

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

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

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

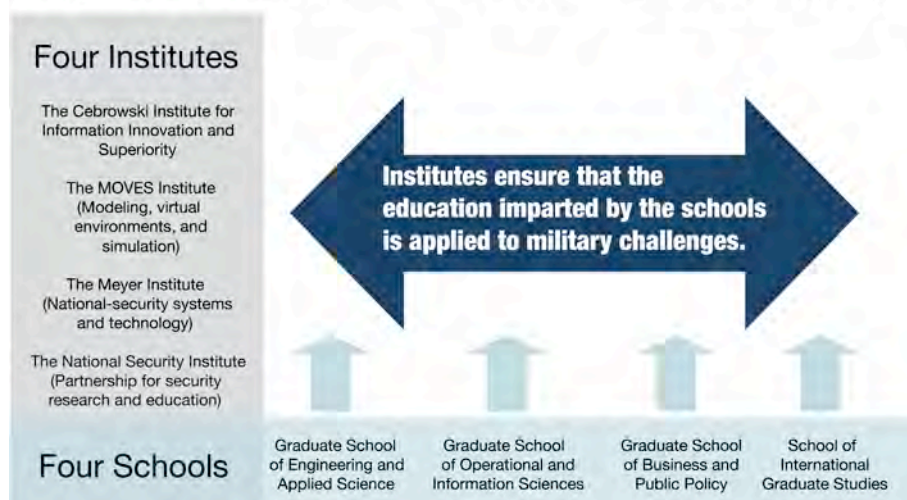
- maintains upper–division course content and programs at cutting edge;
- challenges students with creative problem solving experiences on DoD–relevant issues;
- advances DoN/DoD technology;
- solves warfare problems; and
- attracts and retains quality faculty.

Academic Programs

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

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

Integrated • Systems Oriented • Flexible • Partnered for Strength



INTRODUCTION

Programs of graduate studies at NPS are grouped as follows:

Graduate School of Operational and Information Sciences

- Computer Science
- Computing 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
- Joint Operational Logistics
- Modeling, Virtual Environments, and Simulation
- Operations Analysis
- Remote Sensing
- 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
- Mechanical Engineering for Nuclear-Trained Officers
- Meteorology
- Meteorology and Oceanography
- Naval/Mechanical Engineering
- Oceanography
- Operational Oceanography
- Reactors–Mechanical Engineering
- Space Systems Engineering
- Space Systems Operations
- Systems Engineering
- Systems Engineering Management
- Undersea Warfare
- Underwater Acoustic Systems

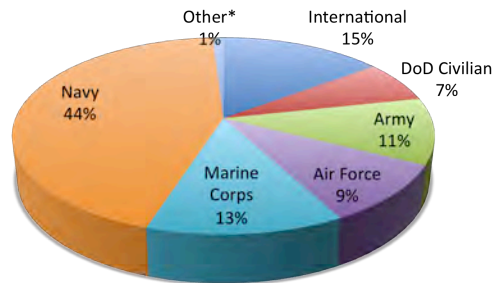
Graduate School of Business and Public Policy

- Acquisition and Contract Management
- Civilian Executive Master of Business Administration
- 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 (Civilian)
- Homeland Security and Defense (Military)
- 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

INTRODUCTION



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

Figure 1: Resident Degrees/Subspecialty Student Population for September 2009

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
Engineering Acoustics
Engineering Science
Engineering Systems
Executive Management
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
Remote Sensing Intelligence
Software Engineering
Space Systems Operations
Systems Analysis
Systems Engineering
Systems Engineering Analysis
Systems Engineering Management
Systems Technology

Engineer Degrees

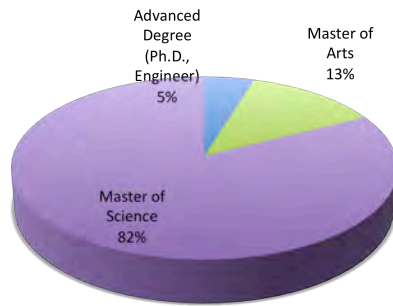
Astronautical Engineer
Electrical Engineer
Mechanical Engineer

Doctor of Philosophy

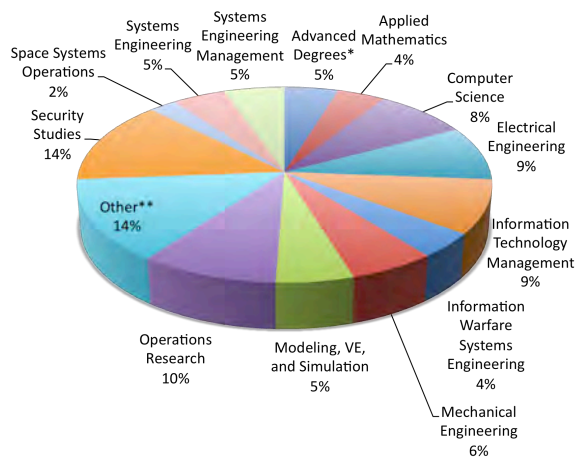
Applied Mathematics
Applied Physics
Astronautical Engineering
Computer Science
Electrical Engineering
Engineering Acoustics
Information Sciences
Mechanical Engineering
Meteorology
Modeling, Virtual Environments, and Simulation
Operations Research
Physical Oceanography
Physics
Security Studies
Software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

INTRODUCTION

In September 2009, 190 degrees were conferred. Figure 2 indicates distribution by type, Figure 3 by degree area.



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



*Advanced degrees: doctorates in meteorology (1), mechanical engineering (2), electrical engineering (4), and operations research (1); engineer degrees in electrical engineer (1), and mechanical engineer (1)

**Other master's degrees: applied physics (2), contract management (5), defense analysis (2), electronic warfare systems engineering (3), human systems integration (1), meteorology (1), meteorology and physical oceanography (5), physical oceanography (2), systems technology (1)

**Figure 3. Degrees Conferred in September 2009
(190 Degrees Conferred)**

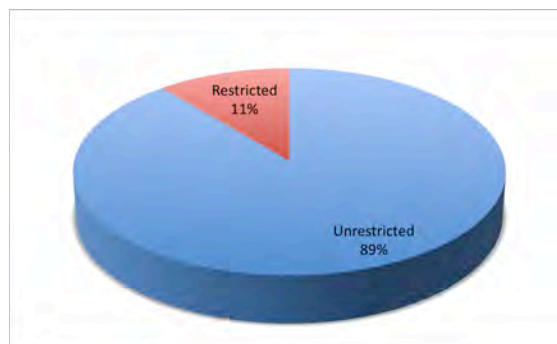
INTRODUCTION

Theses

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

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

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



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

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ADVANCED DEGREES

**Doctor of Philosophy
Electrical Engineer
Mechanical Engineer**

DOCTOR OF PHILOSOPHY

AMBIGUITY IN ENSEMBLE FORECASTING: EVOLUTION, ESTIMATE VALIDATION, AND VALUE

Mark S. Allen–Major, United States Air Force

B.S., Florida State University, 1998

M.S., Air Force Institute of Technology, 2003

Doctor of Philosophy in Meteorology–September 2009

Advisor: Maj. F. Anthony Eckel, USAF, Department of Meteorology

An ensemble prediction system (EPS) generates flow-dependent estimates of uncertainty (i.e., random error due to analysis and model errors) associated with a numerical weather-prediction model to provide information critical to optimal decision making. Ambiguity, or uncertainty in the prediction of forecast uncertainty, arises due to EPS deficiencies, including finite sampling and inadequate representation of the sources of forecast uncertainty. An EPS based on a low-order dynamical system is used to investigate the behavior of ambiguity, validate two practical estimation methods against a theoretical (impractical) technique, and apply ambiguity in decision making. Ambiguity generally decreases with increasing lead time and is found to depend strongly on ensemble forecast variance and the variability of ensemble mean error. The practical estimation techniques provide reasonably accurate ambiguity estimates, although they are too low at early lead times. The theoretical ambiguity estimate adds significant value when combining ambiguity with forecast uncertainty to provide a single, normative, decision input. Additionally, value added to secondary user criteria (e.g., minimizing repeat false alarms) is explored using the practical estimations. Repeat false alarms are significantly reduced while maintaining primary value by using ambiguity information to selectively reverse normative decisions to take protective action, which effectively redistribute negative outcomes.

KEYWORDS: Ensemble Forecast, Ambiguity, Uncertainty, Ensemble-of-Ensemble, Calibrated Error Sampling, Randomly Calibrated Resampling, Optimal Decision Making, Cost-Loss, Uncertainty-Folding, Secondary Criteria, Lorenz '96, Ensemble Prediction Systems

ANALYSIS AND EXPERIMENTATION OF CONTROL STRATEGIES FOR UNDERACTUATED SPACECRAFT

Jason S. Hall–Lieutenant Commander, United States Navy

B.S., United States Naval Academy, 1997

M.S., Naval Postgraduate School, 2006

Doctor of Philosophy in Mechanical Engineering–September 2009

Advisor: Marcello Romano, Department of Mechanical and Astronautical Engineering

A laboratory spacecraft-simulator test bed is first introduced to examine the problem of multiple spacecraft interacting in close proximity. This test bed enables validation of guidance, navigation, and control algorithms by combining a six-degrees-of-freedom (6-DoF) computer simulation with 3-DoF hardware-in-the-loop (HIL) experimentation. The 3-DoF spacecraft simulator presented employs a novel control-actuator configuration consisting of a miniature, single-gimbaled, control-moment gyroscope (MSGCMG) and dual, on/off, cold-gas, in-plane, vectorable thrusters. The dual vectorable-thruster design enables simultaneous translation and attitude control, allowing it to act both in conjunction with the MSGCMG and to provide sole actuator control throughout a commanded closed-path maneuver. Small-time local controllability (STLC) of this uniquely actuated system via Lie algebra methods is formally demonstrated, and results of experiments conducted on the described test bed are included. From this study in 3-DoF, a 6-DoF, minimally control-actuated, asymmetric spacecraft design is proposed. Six-DoF control of this underactuated mechanical system is achieved via two oppositely mounted,

DOCTOR OF PHILOSOPHY

hemispherically vectorable thrusters. In order to capitalize on the unique nature of this system with only two control torques, a quaternion feedback regulator is developed to yield three-axis stabilization of its attitude. This regulator capitalizes on recent advancements in generalized inversion and perturbed-feedback linearizing control to stabilize the dynamics of an underactuated, asymmetric spacecraft and extends this to include stabilization of the kinematics of the system. Two control-design methodologies are derived. The first is Lyapunov-based, yielding a globally stable system; the second yields local stability within a domain of attraction through perturbed-feedback linearization. Results of several numerical simulations are presented for an asymmetric spacecraft with two bounded, body-fixed, control torques. The proposed attitude-control method is not intended to provide attitude maintenance for attitude tracking or in the presence of relatively large disturbance torques; however, it may prove widely applicable for detumbling and reorientation maneuvers of spacecraft with only two available control torques.

KEYWORDS: Underactuated Spacecraft, Hardware-in-the-Loop, Vectorable Thrusters, Control Moment Gyros, Small-Time Local Controllability, Generalized Inverse, Pseudo-Inverse

AN INFORMATION-CENTRIC APPROACH TO AUTONOMOUS TRAJECTORY PLANNING UTILIZING OPTIMAL CONTROL TECHNIQUES

Michael A. Hurni—Commander, United States Navy

B.S., University of New Hampshire, 1989

M.S., Naval Postgraduate School, 1997

Doctor of Philosophy in Mechanical Engineering—September 2009

Advisor: I. Michael Ross, Department of Mechanical and Astronautical Engineering

This work introduces a new information-centric, pseudospectral, optimal-control-based algorithm for autonomous trajectory planning and control of unmanned, ground vehicles with real-time information updates. It begins with a comprehensive study and comparison of the various path-planning methods currently in use. It then provides an analysis of the optimal control method, including vehicle- and obstacle-modeling techniques, several different problem formulations, and a number of important insights on unmanned, ground-vehicle motion planning. The new algorithm is then utilized on a collection of motion-planning scenarios with varying levels of information; the performance of the planner and the solution accuracies under these varying levels of information are studied for both single- and multi-vehicle scenarios. The multi-vehicle scenarios compare and contrast centralized, decentralized, decoupled, coordinated, cooperative, and prioritized control methods. Finally, the versatility of the planner (and the optimal control technique) is demonstrated, as it is used as both a path follower and trajectory planner in a collection of scenarios, including multi-vehicle formations and sector keeping.

KEYWORDS: Optimal Control, Pseudospectral, Autonomous Trajectory Planning, Unmanned Ground Vehicles, Real-Time, Path Planning, DIDO

RADIO-FREQUENCY SIGNAL RECEPTION VIA DISTRIBUTED, WIRELESSLY NETWORKED SENSORS UNDER RANDOM MOTION

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B.E.E., Villanova University, 1992

M.S., Naval Postgraduate School, 1997

Doctor of Philosophy in Electrical Engineering—September 2009

Advisors: John C. McEachen, Department of Electrical and Computer Engineering

Murali Tummala, Department of Electrical and Computer Engineering

Committee Members: Roberto Cristi, Department of Electrical and Computer Engineering

David C. Jenn, Department of Electrical and Computer Engineering

Christopher Frenzen, Department of Applied Mathematics

This research investigates the reception of radio-frequency signals using wirelessly networked, autonomous, sensor nodes under random motion. Emphasis is placed on investigating the effects of random motion on sensor-array beamforming. Novel techniques to conduct array operations in spite of the node motion are offered. Conflicting priorities of energy consumption and array operational requirements are addressed to demonstrate the performance of the proposed solutions.

The issues of node management in a beamforming application, degradation of beamforming performance due to element motion, the need for a weight-reset-time determination method, and the effect of unsteady element orientation in network communications are explored for system implementation. An examination of Doppler shift due to node motion demonstrates that its impact is negligible on beamforming performance. The management system proposed for the wireless-sensor network enables sensor operation while preserving node energy. The analysis of independent node motion on beamforming performance produces a relationship between motion and gain percent change on aim point. A novel methodology is offered to determine weight reset times with elements in motion. An investigation of unsteady antenna orientation produces an innovative method to mitigate communications degradation. Each proposal proves superior to alternate approaches in terms of performance and energy conservation.

KEYWORDS: Sensor Networks, Beamforming, Random Motion, Orientation

APPLICATIONS OF ASSIGNMENT ALGORITHMS TO NONPARAMETRIC TESTS FOR HOMOGENEITY

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B.S., United States Naval Academy, 1991

M.A., University of Texas, 1993

Doctor of Philosophy in Operations Research—September 2009

Advisor: Robert Koyak, Department of Operations Research

The author proposes new, non-parametric, statistical tests to identify whether each element in a sequence of independent, multivariate observations is drawn from a common probability distribution or whether some distributional change has occurred over the course of the sequence. Each test is formulated using matching techniques based on distances between observations. These tests are capable of detecting changes of a quite general nature and, unlike most similar tests, require no distribution assumptions or any prior separation of the data into hypothetical pre- and post-change subsets. A central limit theorem is derived for one of the tests and an exact distribution for another. A third culminating test, which is a cumulative sum of statistics on a collection of orthogonal matchings associated with the observation sequence, exhibits noteworthy power to detect whether a distributional change has occurred. The performance of the tests is examined by computer simulation and results are compared to a state-of-the-art parametric competitor.

KEYWORDS: Nonparametric Test, Distribution-Free Test, Nonbipartite Matching, Bipartite Matching, Change Point

TRAFFIC-ADAPTIVE, FLOW-SPECIFIC, MEDIUM ACCESS FOR WIRELESS NETWORKS

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B.S., Cornell University, 1987

M.S., Naval Postgraduate School, 1995

Doctor of Philosophy in Electrical Engineering—September 2009

Advisors: Murali Tummala, Department of Electrical and Computer Engineering

John C. McEachen, Department of Electrical and Computer Engineering

This dissertation pioneers the concept of traffic-adaptive, flow-specific, medium access and demonstrates that it outperforms contention, non-contention, and hybrid techniques. The novel traffic-adaptive, cooperative, wireless-sensor network, medium-access control (CWS-MAC) scheme is proposed and shown to provide better throughput and delay performance than slotted, non-persistent, carrier-sense multiple access (CSMA), upon which the IEEE 802.11 standard is based, and time-division multiple access (TDMA). A general model for traffic-adaptive, flow-specific, medium-access control is developed, and hybrid, contention, and non-contention schemes are shown to be special cases.

This work also compares the energy efficiency of centralized and distributed solutions and proposes an energy-efficient version of traffic-adaptive CWS-MAC that includes an adaptive sleep cycle coordinated through the use of preamble sampling. A preamble-sampling probability parameter is introduced to manage the trade-off between energy efficiency and throughput and delay performance.

DOCTOR OF PHILOSOPHY

Finally, this research quantifies the effect of large propagation delays on contention and contention-free medium access and proposes a flow-specific medium-access scheme for networked satellite systems that is based on traffic-adaptive CWS-MAC and is shown to outperform both CSMA- and TDMA-based solutions.

KEYWORDS: Flow-Specific, Traffic-Adaptive, Cross Layer, Medium Access Control, Wireless, Energy-Efficiency, Preamble Sampling, Networked Satellite Systems

ROBUST ADAPTIVE CONTROL USING A FILTERING ACTION

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

Doctor of Philosophy in Electrical Engineering–September 2009

Advisor: Roberto Cristi, Department of Electrical and Computer Engineering

This dissertation describes the design of an adaptive controller for single-input, single-output (SISO) systems with guaranteed bounds on the transient response and robustness with external disturbances and unmodeled dynamics. Developed from a current approach called the “L1 adaptive controller,” it is shown that by adding two properly designed, low-pass filters at the input and at the estimator, the transient response and the sensitivity of the overall system to external disturbances and unmodeled dynamics can be controlled. Global stability of the overall adaptive system is mathematically proven under the assumption that the system is minimum phase (i.e., with the zeros of the transfer function in the stable region) and that the bounds of the system’s parameters are known to the designer.

The extension of this approach to non-minimum-phase systems, such as systems with flexible appendages, is also considered. It is shown that a non-minimum-phase plant augmented with a properly designed parallel system results in a minimum-phase system. The augmenting system most easily comes from the inverse of a stabilizing proportional-integral-derivative (PID) controller, designed to be least sensitive to parameter uncertainties. This approach is applied to a flexible arm in a test bed at the Naval Postgraduate School, called the flexible spacecraft simulator, which emulates realistic conditions in space. Experimental results prove the effectiveness of the controller presented in this dissertation.

KEYWORDS: Adaptive Control, System Identification, Global Stability, Non Minimum Phase, Flexible Systems

ELECTRICAL ENGINEER

DESIGNING A SENSORLESS TORQUE ESTIMATOR FOR DIRECT TORQUE CONTROL OF AN INDUCTION MOTOR

Athanasios Tsoutsas–Lieutenant, Hellenic Navy

B.S., Hellenic Naval Academy, 1999

Electrical Engineer–September 2009

Master of Science in Electrical Engineering–September 2009

Advisor: Alexander L. Julian, Department of Electrical and Computer Engineering

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

Xiaoping Yun, Department of Electrical and Computer Engineering

Transportation is a major cause of air pollution. Electric propulsion could replace the internal combustion engines of automobiles and reduce the emission of exhaust gases. The propulsion of an electric vehicle requires the design of an accurate electromagnetic torque estimator and an efficient control system in order to control the speed of the vehicle. This concept is conveyed through this thesis. The electromagnetic torque calculator of an induction motor is designed in the Simulink/MATLAB environment through Xilinx block sets. The accuracy of the torque estimator is verified using the field-programmable gate array (FPGA). Furthermore, using the proper hardware and software, realistic conclusions about the performance of the electromagnetic torque estimator are drawn.

KEYWORDS: Induction Motor, Electromagnetic Torque Estimator, Field Programmable Gate Array, FPGA, Xilinx

MECHANICAL ENGINEER

MODELING LAMB WAVES AND APPLICATION TO CRACK IDENTIFICATION

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B.S., Hellenic Naval Academy, 2002

Master of Science in Mechanical Engineering—September 2009

Mechanical Engineer—September 2009

Advisors: Young W. Kwon, Department of Mechanical and Astronautical Engineering

Randall D. Pollak, Department of Mechanical and Astronautical Engineering

The objective of this study is to model Lamb-wave generation and sensing for application to crack identification in engineering structures. Three topics are analyzed numerically using multiphysics finite-element analysis. Initially, different types of Lamb-wave generation techniques are investigated. A comparison between modeling the sinusoidal application of horizontal force (or displacement) as input and modeling the piezoelectric response of an actuator subjected to sinusoidal voltage input is performed. Secondly, the effects of a crack (disbond) between a piezoelectric wafer and the structure is analyzed, both for the piezoelectric actuator that generates the waves and the sensor that measures the response. Finally, the appropriate fidelity of modeling a structural crack is investigated. In particular, the use of contact elements is evaluated based on their role in the accurate prediction of the wave scattering from cracks or defects inside the structure.

KEYWORDS: Lamb Waves, Modeling, Finite Element, Longitudinal, Shear Mode, ANSYS, Debonding, Sensor, Piezoelectric

MASTER OF SCIENCE

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

MASTER OF SCIENCE IN APPLIED MATHEMATICS

GENERAL USE OF UNMANNED, AERIAL SYSTEMS (UAS'S) IN THE ELECTRONIC WARFARE (EW) ENVIRONMENT—EW CONCEPTS AND TACTICS FOR SINGLE OR MULTIPLE UAS'S OVER THE NET-CENTRIC BATTLEFIELD

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B.S., Turkish Air Force Academy, 2001

Master of Science in Applied Mathematics—September 2009

Advisors: Edward Fisher, Department of Information Sciences

Wolfgang Baer, Department of Information Sciences

As technology has developed, the importance of electronic warfare (EW) to the modern battlefield has increased. It can even be referred to as the heart of today's net-centric battlefield.

Unmanned, aerial systems (UAS) are becoming more important every single day. Nations are working on more complex and more effective UAS in order to accomplish missions that are very difficult, or even impossible, for manned aircraft.

Electronic-warfare missions are often dangerous and risky. Mounting electronic-warfare equipment on a UAS and using it to conduct the EW mission is the most rational solution, because it does not endanger human life.

This thesis examines the possible ways in which UAS can be paired with EW equipment. These two technologies can be integrated into a single mission over the net-centric battlefield. Furthermore, this thesis explains the concepts and tactics required to use these integrated technologies more effectively.

A scenario is run to help the reader understand the applicability of these tactics in the real environment.

KEYWORDS: Unmanned Aerial Vehicle, Network Centric Warfare, Unmanned Aerial System, UAV Missions, NCW, UAS, UAV, Electronic Warfare, EW Missions, EW and UAS Tactics

AN ANALYSIS OF A MAN-IN-THE-MIDDLE ATTACK ON THE DIFFIE-HELLMAN KEY-EXCHANGE PROTOCOL

Aaron C. Geary—Lieutenant, United States Navy

B.S., United States Naval Academy, 2003

Master of Science in Applied Mathematics—September 2009

Master of Science in Information Technology Management—September 2009

Advisors: Pantelimon Stanica, Department of Applied Mathematics

Valery Kanevsky, Department of Information Sciences

The ability to securely distribute cryptographic keys has been a challenge for centuries. The Diffie–Hellman key-exchange protocol was the first practical solution to the key-exchange dilemma. The Diffie–Hellman protocol allows two parties to exchange a secret key over unsecured communication channels without meeting in advance. The secret key can then be used in a symmetric encryption application, and the two parties can communicate securely. However, if the key exchange takes place in certain mathematical environments, the exchange becomes vulnerable to a specific man-in-the-middle attack, first observed by Vanstone. This man-in-the-middle attack is explored, countermeasures against the attack are analyzed, and the attack is extended to the multiparty setting.

KEYWORDS: Cryptography, Diffie-Hellman, Man-in-the-Middle Attack

APPLIED MATHEMATICS

SIMULATING FULL-WAVEFORM LIDAR

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Master of Science in Applied Mathematics—September 2009

Advisors: Carlos F. Borges, Department of Applied Mathematics

Richard C. Olsen, Department of Physics

LIDAR (light detection and ranging) is used to remotely measure the three-dimensional shapes and arrangements of objects with high efficiency and accuracy by making precise measurements of time-of-flight of pulses of light. Discrete-return LIDAR systems provide a discrete series of elevation points corresponding to reflections from objects in the scene. Full-waveform LIDAR systems measure the intensity of light returned to the sensor continuously over a period of time. Relatively little research has been done on full-waveform LIDAR signals.

This thesis presents a Monte Carlo model of laser propagation through a tree that allows simulation of full-waveform LIDAR signatures. The model incorporates a LIDAR system and a naturalistic scene, including an atmosphere, a tree, and the ground surface.

Test cases are presented that enlighten various aspects of the model and give insight into full-waveform LIDAR data collection and analysis. Changes in the scene, such as varying ground reflectance, sloped versus flat ground, and comparisons of “leaf-on” and “leaf-off” conditions, are analyzed. Changes in the LIDAR system are also studied, such as changing laser wavelength, shape and length of transmitted pulses, sensing geometry, etc. Results of the simulations and analysis of the effects of physical changes in the scene and sensor are presented.

KEYWORDS: Full-Waveform LIDAR, Monte Carlo Simulation, L-Systems, PROSPECT Leaf Reflectance Model

OPTIMIZING THE ROUTER CONFIGURATIONS WITHIN A NOMINAL AIR FORCE BASE

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Master of Science in Information Warfare Systems Engineering—September 2009

Master of Science in Applied Mathematics—September 2009

Advisors: Raymond Elliott, Department of Information Sciences

Craig W. Rasmussen, Department of Applied Mathematics

Routing information is a delicate balance between theoretical ideas, such as optimization of flow and shortest path routing, and the reality of threats to the security of the network. The way in which information is routed can be massaged to give the best solution, that being one that aptly satisfies both of these constraints. But are the routers on a nominal Air Force base set up with all of these things in mind? The basis for this study is graph theory, which supplies the tools necessary to analyze the underlying mathematical construct of the router configuration. A nominal Air Force base is constructed with all of the functions and organizations that one would find on a nominal Air Force base organized in a nominal physical fashion. The optimal router setup for such a base is then developed. From there, the design’s feasibility is analyzed from the standpoint of cost, security, and implementation. The scope of this research is the routing of all traffic internal to the base—i.e., traffic originating or terminating off base is not examined.

KEYWORDS: Network Architecture, Graph Theory, Spanning Tree, Network Security

CUBE-TYPE ALGEBRAIC ATTACKS ON WIRELESS ENCRYPTION PROTOCOLS

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Master of Science in Computer Science–September 2009

Master of Science in Applied Mathematics–September 2009

Advisors: George W. Dinolt, Department of Computer Science

James Bret Michael, Department of Computer Science

Pantelimon Stanica, Department of Applied Mathematics

An algebraic-type attack (known as the cube attack) against wireless networks is investigated. The cube attack is implemented in a wireless system, namely Bluetooth. The encryption function of the E0 Bluetooth key generator is formally modeled, and the process of the cube attack on E0 of the factorization process (preprocessing phase) is automated. In this phase, an attacker finds as many maxterms (a term of the encryption function such that its co-factor is a linear, non-constant polynomial) as possible. In the actual attacking phase, the attacker solves the system of linear equations through a chosen plaintext attack and reveals useful information about the cryptosystem. The number of operations needed in the computational process is **Error! Objects cannot be created from editing field codes.** and is considerably less than that of similar algebraic types of attacks, but it is limited to the output of the LFSRs at any clock cycle. The main contribution of this thesis is that if the attacker is an unauthorized participant of the security protocol, then by manipulating some of the output bits of the LFSRs of two arbitrary clock cycles and intercepting the output bits of the entire machine, the attacker then succeeds in finding the output bits of the LFSRs at any clock tick. The most important question that needs to be answered next is how one can recover the encryption key of E0 after knowing the output bits of every LFSR at any clock that this study provides.

Building on these results, the next stage of the research is to validate the integration of the cube-type attack into the Bluetooth encryption protocol. As demonstrated in this and other research cited in this thesis, one needs to understand and formally evaluate the strength of a given cryptosystem and be able to evaluate its implementation to ensure that there are no flaws at that stage. The cryptosystem and the protocol it uses may be good; however, if poorly implemented, they will most likely be untrustworthy.

KEYWORDS: Wireless Security, Cryptanalysis, Boolean Functions, Algebraic Attacks, Correlation Attacks, Cube Attacks, Bluetooth, Security Protocols

A GAME-THEORETIC, ANTISUBMARINE-WARFARE, MISSION PLANNER (HEURISTIC-BASED, FULLY EXCEL CAPABLE)

Scott D. Scherer–Lieutenant, United States Navy
B.S., United States Naval Academy, 2003

Master of Science in Applied Mathematics–September 2009

Advisor: Gerald G. Brown, Department of Operations Research

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

This thesis introduces a game-theoretic, antisubmarine-warfare, mission planner (G-TAMP) that can quickly operate on a Navy Marine Corps Intranet (NMCI) computer without any software other than NMCI-standard Microsoft Office, Visual Basic for Applications (VBA), and a freely available optimization package called LP-SOLVE employed as a dynamically linked library. The expensive and non-NMCI-approved mathematical-modeling software used by Adam Thomas in his 2008 thesis is replaced with a purpose-built, fast, heuristic solver implemented in VBA. This heuristic, called the alternating-flows heuristic, approximately solves the Thomas defender–attacker/defender (D-A/D) model, thereby deploying both visible and secret anti-submarine warfare platforms around a high-value unit (HVV) to minimize the probability that a hostile diesel-electric submarine could penetrate these platforms undetected and reach the HVV. Five scenarios are analyzed and the heuristic solution is compared with the optimal ones produced by Thomas' D-A/D model.

KEYWORDS: Optimization, Mathematical Programming, Heuristic Algorithms, Network Flows, Anti-Submarine Warfare, Search and Detection, Game Theory

SIMULATED E-BOMB EFFECTS ON ELECTRONICALLY EQUIPPED TARGETS

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B.S., Turkish Air Force Academy, 2002

Master of Science in Applied Mathematics—September 2009

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

Like a high-altitude electromagnetic pulse (HEMP), high-power microwaves (HPM) produce intense energies, which may overload or damage various electrical system components, such as microcircuits. This thesis investigates the possible effects of a hypothetically designed, HEMP-like weapon, an “e-bomb,” on electronically equipped target systems.

The procedure to determine these possible effects is to estimate the electromagnetic coupling from first principles and simulations using a coupling model program (CEMPAT), pursuing a feasible geometry of attack, practical antennas, best coupling approximations of ground conductivity and permittivity, a reasonable system of interest representation from specifications, threat waveshape, and operating frequency. The analysis investigates the roles these factors contribute to the e-bomb coupling scenario.

Those possible e-bomb effect results are then compared to a published and experimentally created threshold-level table to determine whether any upset or damage is formed on the target system. Based on this comparison, the results are evaluated with respect to the factors that cause them to exceed, or not exceed, the threshold levels. Additionally, a conventional weapon-attack scenario for the same target system is created. Its results are compared to the e-bomb attack. Finally, operational recommendations are provided, along with the advantages and disadvantages for each type of attack.

KEYWORDS: High Altitude Electromagnetic Pulses, High Power Microwaves, Electromagnetic Coupling, E-Bomb, Electronically Equipped Targets, Threshold Level, Upset, Damage, Burnout, Conventional Weapon, Attack Scenario, Directed Energy, Threat Environment, Damage Assessment, E-Field, Cable Shielding

MASTER OF SCIENCE IN APPLIED PHYSICS

VERIFICATION OF THE COLOSI SINGLE-SCATTERING ANALYTICAL MODEL FOR MODE COUPLING EFFECTS CAUSED BY SOLITONS

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B.S., West University Institute of Technology, 2002

Master of Science in Applied Physics—September 2009

Advisors: John A. Colosi, Department of Oceanography

Kevin B. Smith, Department of Physics

The shallow-water environment poses many obstacles to submerged and surface operations, including the obstacles posed to acoustic detection of quiet contacts. The presence of internal solitary waves (ISWs) within this environment induces acoustic variability and phase fluctuations which limit signal processing capability and further complicate operations in this environment. However, a better understanding of how ISWs affect sound propagation may lead us to take advantage of some of the effects of the ISWs, such as how ISWs focus acoustic energy into certain modes, allowing detection of quiet sources above background noise. An understanding of the phase fluctuation may also lead to better processing algorithms. While multiple numerical simulations have been conducted that allow for the effects of ISWs to be intuited from them, an analytical model that can predict the effects on acoustic propagation by the physical parameters of the ISWs had not been produced until Professor John A. Colosi of the Naval Postgraduate School developed a single-scattering analytical model of those effects.

In this thesis, the Colosi single-scattering model is compared to an accepted 3D PE model in order to further validate the model. In the comparison, numerous simulations from both models are used to determine how closely the single-scattering model can predict the vertical mode-coupling effects of ISWs.

KEYWORDS: Shallow-Water Environment, 3-D Simulations, Vertical Mode Coupling, Internal Solitary Waves, Solitons, Acoustic Variability

MASTER OF SCIENCE IN COMPUTER SCIENCE

AN ASSESSMENT OF VULNERABILITIES FOR SHIP-BASED CONTROL SYSTEMS

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B.S., San Diego State University, 1999

Master of Science in Computer Science—September 2009

Advisors: Karen L. Burke, Department of Computer Science

George W. Dinolt, Department of Computer Science

Growing asymmetric threats, such as international terrorism, have replaced the hostile nation-state as the adversary of choice. As embodied by the September 11 attacks, the United States now faces enemies that seek to create havoc and disruption in nontraditional ways. This new adversarial paradigm makes protection of the nation's critical infrastructure more important than ever.

Unfortunately, this is the nation's soft underbelly. Computer-based control systems form the heart of the critical infrastructure, and these control systems are riddled with vulnerabilities. A combination of industry apathy, physical challenges, and the growing reliance on the Internet has exacerbated these vulnerabilities.

The critical infrastructure of a Navy warship is just as vital to the operation of the vessel as the national infrastructure is to the operation of the nation. Unfortunately, a ship's infrastructure is similarly permeated with control systems, which have similar weaknesses and face similar threats as their civilian counterparts.

This thesis examines the importance of the critical infrastructure on both a national and shipboard scale. Threats and vulnerabilities are established and corrective actions are explored with the goal of developing some strategies to improve the security of shipboard systems. As part of these corrective actions, a template security policy and a computer security checklist have been developed.

KEYWORDS: Vulnerability Assessment, Supervisory Control and Data Acquisition, SCADA, Critical Infrastructure, Information Assurance, Control System

MAINTAINING HIGH AVAILABILITY IN DISTRIBUTED, MOBILE SYSTEMS

Brad P. Boitnott—Major, United States Marine Corps

B.A., Saint Leo University, 2001

Master of Science in Computer Science—September 2009

Advisors: Gurminder Singh, Department of Computer Science

John H. Gibson, Department of Computer Science

Distributed, mobile systems often require the ability to continue working even when a major system component fails or there is a fault in the system. In some situations when a distributed mobile system is used, the difference between success and failure could mean the difference between life and death. Therefore, distributed, mobile systems that require a high availability must be able to survive faults and resist failures.

The user of a distributed, mobile system depends on the ability of the system to share information between the other users of the system. The information and its delivery may be the most important parts of the system, whether it is a data file, picture, or instant message.

A survey is conducted of the different failsafe and fault-tolerant techniques available; the information is then grouped for potential effectiveness and cost efficiency. An experiment with a distributed mobile system and different combinations of failsafe and fault-tolerant techniques is used to validate the effectiveness of the techniques. The expected results of the experiments are a higher availability rating than the system had before the experiments. TwiddleNet, a distributed, mobile system with a high-availability requirement, is used as the platform for experimentation.

KEYWORDS: High Availability, Failsafe, Fault-Tolerant, Distributed Mobile System, TwiddleNet

COMPUTER SCIENCE

A STUDY OF TOPICS AND TOPIC CHANGE IN CONVERSATIONAL THREADS

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B.S., Queen's University, 2003

Master of Science in Computer Science—September 2009

Advisor: Craig H. Martell, Department of Computer Science

Second Reader: Simson L. Garfinkel, Department of Computer Science

This thesis applies latent Dirichlet allocation (LDA) to the problem of topics and topic change in conversational threads using email. It is demonstrated that LDA can be used to successfully classify raw email messages with threads to which they belong, and results are compared with those for processed threads, where quoted and reply text have been removed. Raw thread classification performs better, but processed threads show promise. Two new, unsupervised techniques for identifying topic change in email are presented. The first is a keyword-clustering approach using LDA and DBSCAN to identify clusters of topics and transition points between them. The second is a sliding-window technique that assesses the current topic for every window, identifying transition points. The keyword clustering performs better than the sliding-window approach. Both can be used as a baseline for future work.

KEYWORDS: Latent Dirichlet Allocation, Machine Learning, Data Mining, Natural Language Processing, Topic, Topic Change, Email, Conversation

BLOG FINGERPRINTING: IDENTIFYING ANONYMOUS POSTS WRITTEN BY AN AUTHOR OF INTEREST USING WORD AND CHARACTER FREQUENCY ANALYSIS

David J. Dreier—Captain, United States Marine Corps

B.A., University of San Diego, 2003

Master of Science in Computer Science—September 2009

Advisor: Craig H. Martell, Department of Computer Science

Second Reader: Andrew I. Schein, Department of Computer Science

Internet blogs are an easily accessible means of global communications. Monitoring blogs for criminal and terrorist activity is a serious challenge, due to blogs's anonymous nature and the sheer volume of data. The intelligence community is often faced with more information than it can process. The need exists to develop methods for processing the massive amounts of data this media presents, without a significant increase in manpower. An automated tool capable of identifying posts written by an individual, given a sample of his writing, would allow law enforcement and intelligence agencies to gather evidence that would otherwise be overlooked due to manpower and time constraints.

This research focuses on identifying blog posts written by a particular author when a model of every potential author is not available. Previous research either builds a distinct model for every possible author or limits itself to large documents. Neither approach is appropriate for processing blog posts. Blog posts tend to be short documents, and building a distinct model of each author is unreasonable if you are looking for one author among millions. This problem is addressed by combining sample posts by other authors to create a model of an average author.

KEYWORDS: Author Attribution, Authorship Attribution, Authorship Verification, Natural Language Processing, Machine Learning, Blogs, Bayes, Bayesian, Support Vector Machine, Internet Communication

TOPIC DETECTION IN ONLINE CHAT

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Master of Science in Computer Science—September 2009

Advisor: Craig H. Martell, Department of Computer Science

Second Reader: Andrew I. Schein, Department of Computer Science

The ubiquity of Internet chat applications has benefited many different segments of society. It also creates opportunities for criminal enterprise, terrorism, and espionage. This thesis proposes statistical, natural-language processing (NLP) methods for creating systems that would detect the topic of chat in support of larger NLP goals, such as information retrieval, text classification, and illicit activity detection.

A novel method is proposed for determining the topic of chat discourse. Latent Dirichlet allocation (LDA) models are trained on source documents and then inferred topic distributions are used as feature vectors for a support-vector machine (SVM) classification system. The LDA models are constructed in three ways: the collective posts of authors are considered as documents, hypothesizing that the topic physics could be detected given only one side of the conversation, and the resultant classifiers obtain f-scores of 0.906; next, individual posts are considered as documents, hypothesizing that physics posts could be detected, and the resultant classifiers obtain f-scores of 0.481; finally, physics-textbook paragraphs are considered as documents, hypothesizing that the topic of an author or a post could be determined based on an LDA model created from a textbook and a sample of noisy chat. The resultant classifiers obtain f-scores of 0.848 and 0.536, respectively.

KEYWORDS: Latent Dirichlet Allocation, Support Vector Machine, Natural Language Processing, Chat, Topic Detection

ENERGY HARVESTING FOR SELF-POWERED, ULTRA-LOW-POWER MICROSYSTEMS WITH A FOCUS ON VIBRATION-BASED ELECTROMECHANICAL CONVERSION

**Sean M. Forester—Captain, United States Marine Corps
B.S., United States Naval Academy, 1999**

Master of Science in Computer Science—September 2009

Advisors: Gurminder Singh, Department of Computer Science

John H. Gibson, Department of Computer Science

Wireless, distributed, microsensor systems offer reliable monitoring and control of a myriad of applications, ranging from machine state and perimeter security to nuclear, chemical, biological, and other military applications. Historically, batteries have supplied power to mobile, embedded, and ultra-low-power microsensors. While there are many obvious short-term advantages in using batteries, they do have a long-term, negative environmental impact. An alternative to batteries exists in harnessing the ambient energy surrounding the system and subsequently converting it into electrical energy.

Once a long-established concept, energy harvesting offers an inexhaustible replacement for batteries. Energy harvesting systems scavenge power from optical, acoustic, thermal, and mechanical energy sources. The proliferation of and advances in wireless technology, particularly wireless-sensor nodes and mobile electronic devices, has increased the volume of energy harvesting research as of late. This thesis reviews the principles of the state of the-art in energy-harvesting systems. The focus is on generating electrical power from mechanical energy in a vibrating environment due to its dominant scalability. Microelectromechanical systems (MEMS) are explored, including electromagnetic, electrostatic, and piezoelectric transduction. Power management, trends, suitable applications, and possible future developments are also discussed.

KEYWORDS: Microelectromechanical Systems, Photovoltaic, Piezoelectric, Thermocouple, Power Harvesting, Energy Scavenging, Thermoelectric

DESIGN CONSIDERATIONS FOR A COMPUTATIONALLY LIGHTWEIGHT, AUTHENTICATION MECHANISM FOR PASSIVE RFID TAGS

**John H. Frushour—Captain, United States Marine Corps
B.S., University of Kentucky, 1998**

Master of Science in Computer Science—September 2009

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Passive RFID tags are attractive due to their low cost, small footprint, and ability to function without batteries. The lack of onboard power, however, limits the complexity of operations that can be performed by the tags' integrated circuits, and this limitation prevents the tags from being able to perform the typical functions required to support e-authentication. This thesis quantifies the delta between the power that would be required to perform MAC-based authentication and the power made available to a tag via the interrogator. A modified MAC protocol is then proposed that would theoretically close this delta while still providing sufficient authentication assurance.

KEYWORDS: Radio Frequency Identification, Secure Hash Algorithm, Field Programmable Gate Array, FPGA, Wireless Power Generation, Message Authentication Code

DEVELOPING A MODULAR FRAMEWORK FOR IMPLEMENTING A SEMANTIC SEARCH ENGINE

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Current methods of information retrieval (IR) are adequate for everyday search needs, but they are not appropriate for many military and industrial tasks. The underlying mechanism of typical search methods is based upon keyword matching, which has demonstrated very poor performance over the highly technical requirements-documents found within the field of acquisitions. Instead of matching keywords, IR methods that understand the meaning of the words in a query are needed to provide the necessary performance over these types of documents; this is known as semantic search.

This work utilizes sound software-engineering practices to specify, design, and develop a modular framework to aid in the design, testing, and development of new semantic-search methods and IR techniques. The development of a modular, search-engine framework is documented in its entirety, from user-needs analysis to the production of a full application programming interface.

By exploiting the powerful techniques of polymorphism and object-oriented programming in the Java programming language, users are able to design new IR techniques that will function seamlessly within the framework.

Finally, a reference implementation is provided as a proof-of-concept to demonstrate the capabilities and usefulness of the framework design.

KEYWORDS: Semantic Search, Modular Search Engine, Object-Oriented Programming, Java, UML

DOMAIN-NAME SYSTEM (DNS) REBINDING ATTACKS

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A domain-name system (DNS) rebinding attack compromises the integrity of name resolution in DNS with the goal of controlling the IP address of the host to which the victim ultimately connects. The same origin policy and DNS pinning techniques were introduced to protect web browsers from DNS rebinding attacks, but their effectiveness has been undermined by vulnerabilities introduced by plug-ins such as JavaScript and Adobe Flash Player. The new attacks fall into two broad categories: firewall circumvention and IP hijacking, depending on the consequences of each attack.

Using a realistic network test bed, this research enacts two firewall-circumvention attack scenarios, with JavaScript and Adobe Flash Player. Also confirmed is the effectiveness of several published countermeasures, including configuration options for DNS and web servers, and security updates released by plug-in vendors. Finally, the research analyzes the defense-readiness of the DNS server and client configuration guidelines currently used by the U.S. Department of Defense, including the Defense Information Systems Agency (DISA) DNS Security Technical Implementation Guidance (STIG), the Windows Vista client-specialized security, limited-functionality (SSLF) guidance, and the split-DNS architecture.

KEYWORDS: Network Security, DNS Rebinding, DNS Pinning, Same Origin Policy, Anti DNS Pinning, Adobe Security Updates, DNS STIG, Windows Vista Security, Split DNS

IMPLEMENTING REMOTE IMAGE CAPTURE/CONTROL IN A WIRELESS SENSOR NETWORK UTILIZING THE IEEE 802.15.4 STANDARD

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Today's warfighter requires an indepth view of the battlespace to best plan for future operations, assess the current operating environment, and prevent or respond to attacks. The deployment and use of wireless-sensor devices could serve as a force multiplier by enhancing the commander's security posture, providing a view of the current environment, and gathering intelligence for analysis. The use of low-power imaging devices, coupled with the flexibility provided by a wireless sensor network, could provide such enhancements.

The objective of this research is to explore the feasibility of remote management and control of a low-power, low-cost wireless-sensor network by implementing a point-to-point wireless network utilizing IEEE 802.15.4-equipped devices to control, capture, and transfer image data from a remote-sensor node to the controlling host. This platform is used to test the viability of the system at various ranges and operating environments. The results demonstrate that the IEEE 802.15.4-compliant devices used in this research are able to operate over long distances (1000 meters), in harsh RF environments, with a high degree of reliability.

KEYWORDS: IEEE 802.15.4, Wireless Sensor Network, Remote Imaging, Remote Control

CUBE-TYPE ALGEBRAIC ATTACKS ON WIRELESS ENCRYPTION PROTOCOLS

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An algebraic-type attack (known as the cube attack) against wireless networks is investigated. The cube attack is implemented in a wireless system, namely Bluetooth. The encryption function of the E0 Bluetooth key generator is formally modeled, and the process of the cube attack on E0 of the factorization process (preprocessing phase) is automated. In this phase, an attacker finds as many maxterms (a term of the encryption function such that its co-factor is a linear, non-constant polynomial) as possible. In the actual attacking phase, the attacker solves the system of linear equations through a chosen plaintext attack and reveals useful information about the cryptosystem. The number of operations needed in the computational process is considerably less than that of similar algebraic types of attacks, but it is limited to the output of the LFSRs at any clock cycle. The main contribution of this thesis is that if the attacker is an unauthorized participant of the security protocol, then by manipulating some of the output bits of the LFSRs of two arbitrary clock cycles and intercepting the output bits of the entire machine, the attacker then succeeds in finding the output bits of the LFSRs at any clock tick. The most important question that needs to be answered next is how one can recover the encryption key of E0 after knowing the output bits of every LFSR at any clock that this study provides.

Building on these results, the next stage of the research is to validate the integration of the cube-type attack into the Bluetooth encryption protocol. As demonstrated in this and other research cited in this thesis, one needs to understand and formally evaluate the strength of a given cryptosystem and be able to evaluate its implementation to ensure that there are no flaws at that stage. The cryptosystem and the protocol it uses may be good; however, if poorly implemented, they will most likely be untrustworthy.

KEYWORDS: Wireless Security, Cryptanalysis, Boolean Functions, Algebraic Attacks, Correlation Attacks, Cube Attacks, Bluetooth, Security Protocols

COMPUTER SCIENCE

THE FORENSIC POTENTIAL OF FLASH MEMORY

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This thesis explores the forensic opportunities afforded by flash memory. It starts with a discussion of flash storage, from the physics of flash devices, to the development of flash translation layers (which allow flash devices to be used with unmodified, legacy operating systems) and flash file systems (which provide for better utilization of flash storage at a somewhat higher cost). A comprehension survey of the relevant academic literature is provided and the work that others have done in the field of flash data recovery is evaluated. It provides a theory of circumstances when residual data may exist on flash memory through the intentional deletion and overwrite of previously saved data, based on a thorough patent review and freely available documentation. It clearly documents the steps for configuring a Linux kernel to use the YAFFS2 (Yet Another Flash File System used in Android) and the JFFS2 (the Journaling Flash File System used on the "One Laptop per Child" program) flash file systems. Experiments are conducted to confirm or deny these theories, with a focus on the recovery of data and other evidence that overwritten and deleted data once existed. Finally, recommendations for further research are provided.

KEYWORDS: Flash Memory, Forensics, Flash File Systems, Flash Transition Layer, YAFFS, JFFS2

DETECTING AGE IN ONLINE CHAT

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Over 90% of teens in the United States use the Internet, and many use it for social interaction. Due to the faceless nature of digital communication, criminals can easily pose as legitimate users to build friendship and trust with potential victims.

Even though fewer youths are going to chat rooms and talking to people they do not know, the number of youths receiving aggressive solicitations for offline contact has not declined. Most sexual solicitations go unreported to law enforcement and parents.

Though it is a crime for an adult to sexually exploit a minor, it is not always a crime for teens to solicit other teens. It would be of great help to law enforcement agencies if they could automatically detect adults soliciting teens versus teens soliciting other teens in online chat. This study analyzes the effectiveness of different machine-learning techniques to distinguish chat conversation by teens and adults. Using proposed techniques, teen and adult conversations are classified with an accuracy of 86%. The goal of this research is to build an automatic recognition system of adults conversing with teens, capable of detecting predators and alerting agencies or parents to possible inappropriate conversations.

KEYWORDS: Author Profiling, Age Detection, Online Chat, Naïve Bayes, Support Vector Machine

COMPUTER SCIENCE

A FUNCTIONALITY MINIMIZATION ANALYSIS OF ASTERISK FOR FUTURE USE IN SECURE ENVIRONMENTS

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Asterisk, the open-source PBX, supports various implementations of voice-over-Internet protocol (VoIP), a popular alternative to public switched telephone networks (PSTN) that offers cost benefits and ease of management. The Monterey Security Architecture (MYSEA) is a distributed, multilevel security (MLS) environment designed to provide secure, collaborative sharing of information. It does not currently support either real-time voice communications or voice mail. The purposes of this thesis are to determine high-level VoIP requirements and to build a minimized version of Asterisk that supports these requirements. This minimized version of Asterisk could then be ported to run within the MYSEA architecture.

To achieve this goal, threats are enumerated and requirements are determined. The modules within Asterisk are minimized to eliminate unnecessary functionality while still supporting the mechanisms required for voice communications and voice mail. Testing shows that voice calls could be placed and voice-mail messages could be left and retrieved using the minimized Asterisk server.

Asterisk's functionality is successfully minimized to meet the requirements determined through the VoIP analysis by reducing the number of modules used for the build. This work provides the groundwork for future implementations of VoIP and voice mailboxes provided by Asterisk within MYSEA.

KEYWORDS: Asterisk, MYSEA, Open-Source PBX, VoIP, Voice over Internet Protocol, Voice Mail

MASTER OF SCIENCE IN CONTRACT MANAGEMENT

AN EXPLORATORY STUDY OF ALPHA CONTRACTING: ANTECEDENTS, PROCESSES, ISSUES, SUCCESS FACTORS, AND CONSEQUENCES

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Alpha contracting is a collaborative effort between buyer and supplier during contract formation; the goal is to maximize efficiency and effectiveness. Although several benefits of alpha contracting are espoused in the literature, the concept is neither ubiquitous nor well understood. The purpose of this joint applied project is to evaluate current Department of Defense (DoD) procedures for the use of alpha contracting. Specifically, alpha contracting is explored to define what constitutes successful and unsuccessful alpha contracting and contributing factors to both outcomes. Antecedents for, and consequences of, use, and variations of the processes employed, are also identified. This research identifies the utility of alpha contracting and explains its narrow usage to date. Using a case study methodology, experienced alpha contracting teams are interviewed—including contracting officers, DCAA, DCMA, end users/customers, program managers, and acquisition directors—to better understand the alpha contracting phenomenon. Interview results and research are used to develop recommendations to address the factors that lead to successful alpha contracting, as well as the barriers that arise once used.

KEYWORDS: Alpha Contracting

ASSESSING CONTRACT-MANAGEMENT MATURITY: THE U.S. ARMY JOINT MUNITIONS AND LETHALITY CONTRACTING CENTER, ARMY CONTRACTING COMMAND, PICATINNY ARSENAL

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In this joint applied project, the maturity levels of the contracting-processes capabilities at the Joint Munitions and Lethality (JM&L) Contracting Center, located at Picatinny Arsenal, New Jersey, are assessed by applying the contract-management maturity model (CMMM). The JM&L contracting center is one of the Army's six major contracting commands under the Army Contracting Command. As a metric to measure the results of the CMMM, an analysis of the results of recent procurement-management reviews is completed to determine whether the outcomes are consistent with the finding of the CMMM. Additionally, survey participants are questioned to determine their opinions as to the reasons for reported strengths and weaknesses, as well as suggested methodologies for improvement. Finally, these responses are evaluated to provide opportunities to leverage best practices and knowledge sharing at both the JM&L contracting center and potentially at other centers within the Army Contracting Command. The successful application of the assessment tool and appropriate analysis provides an

CONTRACT MANAGEMENT

effective way to identify unique challenges and expose opportunities for improving the organization's contracting processes.

KEYWORDS: Contract Management Maturity, Contracting Processes Capabilities, Contract Management Maturity Model, Contract Management Assessment Tool

MASTER OF SCIENCE IN DEFENSE ANALYSIS

THE UTILITY OF MASS VIOLENCE

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Violence: the word itself has a distinctly negative connotation. It seems as though our entire society is fixated on preventing violence. However, despite our keen desire to repel violence in all its forms, we are still enthralled by it. Perhaps our fascination with violence is much more than a simple manifestation of the deviant within. Could it be that our violent tendencies are not necessarily all bad? This is precisely the topic explored in this research. To this end, several prominent facets of violence are examined, including warfare, suicide, coercion, and revenge. Using the events of the Great Jewish Revolt against the Romans in 66 A.D. and the Warsaw ghetto uprising during the Holocaust, this research strives to answer the question: what is the utility of mass violence? As this question is addressed, several central themes emerge. The utility of mass violence is proportional to the perpetrator's ability (or willingness) to employ violence absolutely. In other words, in order for mass violence to serve a useful purpose, it must be used without significant restraint. Nonetheless, in the majority of the examples considered, it is found that mass violence is only effective in the short term. Eventually, even the most definitive acts spawn further violence. Thus, in terms of long-term conflict resolution, less violent options are actually more efficient.

KEYWORDS: Romans, Jews, Masada, Great Revolt, Warsaw Ghetto, Counterinsurgency, Violence, Holocaust

AN ANALYTICAL APPROACH TO EDUCATING FUTURE IRREGULAR-WARFARE (IW) STRATEGISTS AND CAMPAIGN PLANNERS

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This thesis examines USSOCOM's proposal to educate irregular-warfare (IW) strategists/campaign planners and compares it to the existing model utilized by SAMS for educating conventional campaign planners. SAMS is a good comparative model because the SAMS program has a proven record in conventional campaign planning. Simply put, SAMS is a success and a model for other advanced ILE programs. This comparative analysis extracts educational best practices from both approaches and provides recommendations for consideration. Even with an optimal approach, implementation is an equally challenging problem. Future research opportunities for the utilization of USSOCOM's IW-educated officers are identified.

KEYWORDS: IW, JSOU, Execution Roadmap, QDR, SAMS, SOMDP, Campaign Planners, CJCS

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

A TESTBED FOR THE DETECTION OF BOTNET INFECTIONS IN LOW DATA-RATE TACTICAL NETWORKS

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The propagation of bots into a botnet, and the various malicious activities that could be carried out from within a tactical network, pose a significant threat to network security and tactical operations. This thesis presents a network architecture with the objective of near-real-time detection of malicious activity and its propagation within a data rate (bandwidth)-limited environment with periodic losses of connectivity without adding significant burden to the network.

A test bed is constructed that makes use of an intrusion-detection-system driven correlation tool, BotHunter, focused on outbound and inbound connections, rather than solely on inbound connections and a honeynet located in a high-data-rate area of a tactical network. The ability of the proposed architecture to identify malicious activities is validated when both BotHunter and the honeynet successfully detect a bot infection.

KEYWORDS: Botnet, Tactical Network, BotHunter, Honeynet, Honeypot, Low Data Rate, Network Security

THE DESIGN OF SCALABLE RECEIVERS FOR LOW-PROBABILITY-OF-DETECTION COMMUNICATIONS SYSTEMS

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Conventional approaches for a distributed, low-probability-of-detection communications system with a large number of transmitters and a single or a few receivers require receiver complexity proportional to the number of transmitters. To improve efficiency in terms of receiver complexity, two alternative designs are analyzed and compared to a reference receiver whose complexity grows linearly as the number of transmitters increases. The first alternative system groups the transmitters into clusters whose pseudorandom noise codes have some chips in common. The resulting receiver would then perform two stages of processes: identification of the transmitting cluster and received bit detection. The total number of processes required for any given transmitter would be substantially less than the traditional receiver. The second alternative design would utilize a common, long-spreading code and a shorter, cyclically shifted, spreading code in each transmitter. The receiver utilizes the cyclic shift property of the fast Fourier transform to efficiently recover both the identity of the active receivers and the data sent using a single branch. The complexity of the two proposed systems is compared to the complexity of the reference system.

KEYWORDS: Direct Sequence Spread Spectrum, Binary Phase Shift Keying, Fourier Transform, Pseudo-Random Noise

ELECTRICAL ENGINEERING

THE APPLICATION OF COPPER-INDIUM-GALLIUM-DISELENIDE PHOTOVOLTAIC CELLS TO EXTEND THE ENDURANCE AND CAPABILITIES OF UNMANNED, AERIAL VEHICLES

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In this thesis, the advantages of modifying current, military, unmanned, aerial vehicles (UAV) with available thin-film photovoltaic (PV) cells to increase their endurance and capabilities are investigated. The approach taken is to explore available, off-the-shelf, flexible, solar technology and to integrate it in a proof-of-concept model for testing and analysis. A physically similar, commercially available, battery-powered plane is used to demonstrate the materials and methods by which the RQ-11B (Raven) small, unmanned, aerial vehicle (SUAV) could be modified. This research extends academic and private pursuit of solar flight to near-term improvement of military SUAVs. In addition to increasing the on-station time of reconnaissance assets, this research displays the additional advantage of enabling systems on the ground to self-charge. This will enable tactical units to operate further afield, untethered from conventional power sources. Beyond the proof of concept, findings are extended to other potential military uses and greater improvement through new or modified UAV design.

KEYWORDS: Thin-Film Photovoltaics, CIGS, Unmanned Aerial Vehicles, Solar Plane, Maximum Power Point Tracker, MPPT, Lithium Polymer

A PERFORMANCE ANALYSIS OF A LINK-16/JTIDS-COMPATIBLE WAVEFORM WITH NON-COHERENT DETECTION, DIVERSITY, AND SIDE INFORMATION

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The Joint Tactical Information Distribution System (JTIDS) is a hybrid, frequency-hopped, direct-sequence spectrum system. A (31,15) Reed–Solomon (RS) code is used for forward error-correction coding, and cyclical code-shift keying (CCSK) M-ary modulation is used, where each encoded symbol represents five bits. In this thesis, a compatible waveform consistent with the existing JTIDS channel waveform is analyzed. The system considered uses the same (31, 15) RS encoding as JTIDS. The coded symbols are then transmitted on the in-phase (I) and quadrature (Q) components of the carrier using 32-ary orthogonal signaling with 32-chip baseband waveforms and detected non-coherently. For non-coherent detection, only one five-bit symbol is transmitted on both the I and Q components of the carrier, so the data throughput for non-coherent detection is half that of coherent detection. This alternative waveform is consistent with the direct-sequence waveform generated by JTIDS. A sequential diversity of two, consistent with the double-pulse structure of JTIDS, is also assumed, and performance is examined both for the case of linear, soft-diversity combining and also for soft-diversity combining with side information. The type of side information considered is perfect side information (PSI). Based on the analysis, it is concluded that the double-pulse structure outperforms the single-pulse structure for the alternative JTIDS waveform under examination. Moreover, pulsed-noise interference (PNI) degrades the performance of the receiver, but the use of PSI reduces the effect of PNI.

KEYWORDS: Link-16/JTIDS, (31, 15) Reed-Solomon Coding, RS Coding, 32-ary Orthogonal Signaling, Additive White Gaussian Noise, AWGN, Pulse-Noise Interference, PNI, Perfect Side Information, PSI

ELECTRICAL ENGINEERING

PSK SHIFT-TIMING INFORMATION DETECTION USING IMAGE PROCESSING AND A MATCHED FILTER

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This thesis investigates the detection of phase shifts contained within a noisy phase-shift keyed (PSK), modulated signal. The approach derived in this work applies image-processing techniques, including two-dimensional filters, edge detection, morphological processing, and a two-dimensional, cross-correlation, matched filter, to detect the phase shifts from the angle of the signal temporal correlation function. Results show that the proposed algorithm is robust to additive white noise distortions down to SNR levels of 4 dB.

KEYWORDS: Phase Shift Keyed Signals, Image Processing, Temporal Correlation Function, Edge Detection, Morphological Operations, Two-Dimensional Matched Filter

THE DEVELOPMENT OF A NONLINEAR, 6-DEGREE-OF-FREEDOM, MINIATURE, ROTARY-WING, UNMANNED-AERIAL-VEHICLE SOFTWARE MODEL AND PID FLIGHT- PATH CONTROLLER USING MATHWORKS SIMULINK SIMULATION ENVIRONMENT

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This paper describes the development of a 6-degree-of-freedom (6-DOF), nonlinear, miniature, rotary-wing, unmanned-aerial-vehicle (RW UAV) simulation environment using MathWorks Simulink simulation software. In addition to the modeling process, this research also conducts flight-path controller design using proportional derivative (PD) controllers. This model's development is motivated by the desire to develop a rapid prototyping platform for design and implementation of various flight-control techniques, with further seamless transition to the hardware-in-the-loop (HIL) and flight testing. The T-Rex Align 600 remote-controlled helicopter, with COTS autopilot, is chosen as a prototype rotary-wing UAV platform.

The development of the nonlinear simulation model is implemented starting with extensive literature review of helicopter aerodynamics and flight-dynamics theory; the mathematical models of the helicopter components are applied to generate helicopter inertial-frame motion-simulations from operator commands. The primary helicopter components modeled in this thesis include the helicopter main-rotor inflow, thrust, flapping dynamics, and the tail-rotor inflow and thrust responses. The inertial frame motions are animated using Flight Gear Version 0.9.8 software.

After obtaining simulations with verifiable results, the nonlinear model is linearized about the hovering flight condition, and a linear model is extracted. Last, the PD controller is designed and flight-path software-in-the-loop (SIL) test results are presented and explained. The SIL tests are conducted for autonomous flight along specified rectangular and figure-8 flight paths.

KEYWORDS: Software in the Loop Simulation Environment, SIL Simulation Environment, 6-Degree of Freedom Rotary-Wing Unmanned Aerial Vehicle Model, 6-DOF Rotary-Wing Unmanned Aerial Vehicle Model, RW UAV Model, PID Flight Path Controllers

ELECTRICAL ENGINEERING

COMPUTATIONAL ALGEBRAIC ATTACKS ON THE ADVANCED ENCRYPTION STANDARD

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In this thesis, the author examines the vulnerability of the Advanced Encryption Standard (AES) from algebraic attacks. In general the thing that has to be examined is the, how strong the Rijndael algorithm is in order to secure important federal information.

There are several algebraic methods of attacks in order to break a specific cipher as Buchburger's F4 and F5 methods. The method used and evaluated is the multiple right-hand-sides linear equations (MRHS), a new attack method that gives the advantage more efficient computations and more compact equations, in comparison with previous referred methods.

Because of the increased complexity of the Rijndael's algorithm, this thesis investigates the results of the MRHS linear equations attack in a small-scale variant of the AES, since it is impossible to break the actual algorithm by using only existent knowledge. Particularly, instead of the original ten-rounds AES algorithm, variants of up to four rounds are used.

Simple examples of deciphering some cipher texts are presented for different variants of the AES and the new attack method of MRHS linear equations is compared with other older methods as far as concerns algorithmic complexity.

KEYWORDS: Advanced Encryption Standard, AES, Rijndael's Algorithm, Block Cipher, Decipher, Round of the Algorithm, Sparse Multivariate Polynomial

CHARACTERISTICS OF THE BINARY DECISION DIAGRAM OF BOOLEAN BENT FUNCTIONS

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Boolean bent functions have desirable cryptographic properties in that they have maximal nonlinearity, which hardens a cryptographic function against linear cryptanalysis attacks. Furthermore, bent functions are extremely rare and difficult to find. Consequently, little is known generally about the characteristics of bent functions.

One method of representing Boolean functions is with a reduced, ordered, binary-decision diagram. Binary decision diagrams (BDD) represent functions in a tree structure that can be traversed one variable at a time. Some functions show speed gains when represented in this form, and binary decision diagrams are useful in computer-aided design and real-time applications.

This thesis investigates the characteristics of bent functions represented as BDDs, with a focus on complexity. In order to facilitate this, a computer program is designed that is capable of converting a function's truth table into a minimally realized BDD.

Disjoint quadratic functions (DQF), symmetric bent functions, and homogeneous bent functions of 6-variables are analyzed, and the complexities of the minimum, binary-decision diagrams of each are discovered. Specifically, DQFs are found to have size $2n - 2$ for functions of n -variables; symmetric bent functions have size $4n - 8$; and all homogeneous bent functions of 6-variables are shown to be P-equivalent.

KEYWORDS: Binary Decision Diagrams, Boolean Bent Functions, Homogeneous Functions, Disjoint Quadratic Functions, Symmetric Bent Functions, P-Equivalence, Minimization, Hardware Complexity, Circuit Complexity, Graphical Interface, Nonlinearity, Hamming Distance, Cryptography

ELECTRICAL ENGINEERING

FINDING BENT FUNCTIONS WITH GENETIC ALGORITHMS

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In this thesis, a generic genetic algorithm (GA) is presented that is implemented on a reconfigurable computer. The GA is implemented such that many problems can be solved by simply adapting the problem to the GA. For example, part of this process involves the customization of the fitness function of the given problem to the GA. The size of the problem is limited by the capacity of a field-programmable gate array that is part of the reconfigurable computer. This is applied to bent functions, which are Boolean functions that are well suited for cryptographic applications and are extremely rare. Experimental results show the effectiveness of this technique. Different methods are used to discover bent functions. These methods take advantage of the properties of bent functions to reduce the total search space. This allows a brute force search to be conducted on the reduced search space to locate the set of bent functions in that search space. Two different methods are used to reduce the search space. The first is through rotationally symmetric functions, which reduce the number of bent functions that can be found, while the second is by the degree of the function, which locates all bent functions.

KEYWORDS: Genetic Algorithm, Bent Functions, Reconfigurable Computer, Field Programmable Gate Array, FPGA, Cryptology

IDENTIFICATION AND CLASSIFICATION OF OFDM-BASED SIGNALS USING PREAMBLE CORRELATION AND CYCLOSTATIONARY EXTRACTION

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In this thesis, a scheme for the identification and classification of OFDM-based signals is proposed. Specifically, the cyclostationary signature of IEEE 802.11- and 802.16-standard-compliant wireless-communication systems are investigated. A model is introduced that initially identifies the waveform by preamble cross-correlation and then, in the case of IEEE 802.11, confirms the waveform identification by cyclostationary feature extraction. If the waveform is identified as IEEE 802.16 compliant, the model classifies the signal's cyclic prefix (CP) size. IEEE 802.16 utilizes four possible CP sizes when constructing the OFDM symbols that form the foundation of the waveform. Once the CP is determined, the model confirms the identification results of preamble cross-correlation by cyclostationary feature extraction. The cyclostationary signature of each waveform is generated via a computationally efficient algorithm called the FFT-accumulation method (FAM), which estimates this signature through MATLAB simulation.

KEYWORDS: Wireless Network, IEEE 802.11, 802.16, Wi-Fi, WiMAX, OFDM, Cyclostationarity, Cyclostationary Feature Extraction, FFT Accumulation Method, FAM

ELECTRICAL ENGINEERING

AN ANALYSIS OF BENT-FUNCTION PROPERTIES USING THE TRANSEUNT TRIANGLE AND THE SRC-6 RECONFIGURABLE COMPUTER

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Linear attacks against cryptosystems can be defeated when combiner functions are composed of highly nonlinear Boolean functions. The highest nonlinearity Boolean functions, or bent functions, are not common—bent functions are difficult to find, especially when they have many variables. Understanding what properties are common to bent functions will help ease the search for them.

Using the SRC-6 reconfigurable computer, functions can be generated or tested at a rate much higher than a PC. This thesis uses the SRC-6 to characterize data for functions with four, five, and six variables. The data compiled show trends based on the order, homogeneity, balance, and symmetry of Boolean functions. The transeunt triangle is used to convert a Boolean function into algebraic normal form so that the properties are easily determined. The first known proof that the transeunt triangle correctly converts between the two Boolean functions' representations is included.

The SRC-6, while capable of pipelining code so that it runs up to six-thousand times faster than a PC, is limited by the speed of the FPGA, 100 MHz. Functions with up to six variables are tested. Predictions on this data, as well as ways to improve the computing capability of the SRC-6, are included.

KEYWORDS: Bent Functions, Cryptography, Field Programmable Gate Array, FPGA, Reconfigurable Computer, Transeunt Triangle

OPTIMIZATION OF A CYCLOSTATIONARY, SIGNAL-PROCESSING ALGORITHM ACROSS MULTIPLE, FIELD-PROGRAMMABLE GATE ARRAYS ON THE SRC-6 RECONFIGURABLE COMPUTER

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This thesis implements a cyclostationary estimation technique, the time-smoothing FFT accumulation method, on a reconfigurable computer to generate a frequency-versus-cycle-frequency approximation of the input signal. This signal-processing method can be used to identify signal modulation type and extract the parameters of low probability-of-intercept signals in electronic-intelligence discrimination receivers. This implementation builds on previous work at the Naval Postgraduate School and focuses on reducing the overall runtime to approach real-time processing. The focus of the implementation is to utilize dual field-programmable gate arrays (FPGAs) within a single multi-adaptive processor (MAP). Hardware decisions are made by analyzing the relationships between frequency resolution, Grenander's uncertainly condition, and desired cycle-frequency resolution. Implemented on the SRC-6 reconfigurable computer utilizing Xilinx Virtex 2 FPGAs, this work uses the cyclostationary algorithm and takes advantage of the techniques for which the SRC-6 is optimized, such as pipelining, array processing, and memory-access techniques.

KEYWORDS: SRC-6, Reconfigurable Computers, FPGA, Cyclostationary Processing, Time-Smoothing FFT Accumulation Method

ELECTRICAL ENGINEERING

COOPERATIVE, WIDEBAND-SPECTRUM SENSING AND LOCALIZATION USING RADIO-FREQUENCY-SENSOR NETWORKS

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Spectrum sensing and localization tasks are implemented using a radio-frequency-sensor network; the performance of this implementation is analyzed through simulation. A cooperative, wideband-spectrum sensing and localization scheme using RF-sensor networks is proposed for implementing the tasks. In the proposed scheme, wavelet-based, multi-resolution, spectrum-sensing and received-signal-strength-based localization methods, which were originally proposed for cognitive radio applications, are adapted to radio-frequency-sensor networks. For cooperation of the nodes in the proposed scheme, a new three-bit, hard-combination technique is developed. A simulation model is created in the MATLAB programming language to implement the proposed scheme and to analyze its performance. The results of the simulation show that the proposed cooperative, wideband-spectrum, sensing-and-localization scheme is appropriate for radio-frequency-sensor networks and the proposed three-bit, hard-combination scheme is superior to the traditional hard-combination schemes in terms of false-alarm reduction.

KEYWORDS: Cooperative Spectrum Sensing, Source Localization, Multi-Resolution Spectrum Sensing, Three-Bit Hard Combination, RSS-Based Localization, Cognitive Radio, Wireless Sensor Networks, Electronic Warfare

DESIGNING A SENSORLESS TORQUE ESTIMATOR FOR DIRECT TORQUE CONTROL OF AN INDUCTION MOTOR

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Transportation is a major cause of air pollution. Electric propulsion could replace the internal-combustion engines of automobiles and reduce the emission of exhaust gases. The propulsion of an electric vehicle requires the design of an accurate, electromagnetic torque estimator and an efficient control system in order to control the speed of the vehicle. This concept is conveyed through this thesis. The electromagnetic torque calculator of an induction motor is designed in the Simulink/MATLAB environment through Xilinx block sets. The accuracy of the torque estimator is verified using the field-programmable gate array (FPGA). Furthermore, using the proper hardware and software, realistic conclusions about the performance of the electromagnetic torque estimator are drawn.

KEYWORDS: Induction Motor, Electromagnetic Torque Estimator, Field Programmable Gate Array, FPGA, Xilinx

ELECTRICAL ENGINEERING

THE FEASIBILITY OF DEVELOPING ACADEMIC LABORATORIES USING A LOW-COST ROBOT

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The objective of this research is to investigate the feasibility of developing new academic laboratories for an introductory robotics course at the Naval Postgraduate School (NPS) using low-cost, commercially available robots.

In particular, this research uses a desktop computer with the Fedora 8 Linux operating system, a wireless network, and the Garcia robot from Acroname Incorporated. The Garcia is a wheeled robot that has many onboard sensors, such as encoders, infrared, and a laser rangefinder, with the capability of further expansion. Furthermore, the Garcia robot is programmed in C++, a common programming language among engineers.

The investigation of the feasibility of developing laboratories using a low-cost, commercially available robot yields mixed results. The positive results are that such a robot, the Garcia, is found to be a flexible and powerful academic tool. The Garcia allows for the development and implementation of a collection of laboratories to ensure that basic robotic functions are understood. The drawbacks are that the Garcia robot is difficult to get started due to lack of proper documentation and that the selected host configuration limits performance because the configuration injects an initial latency of 15 to 20 seconds. The latency is noted when communicating with the robot and the laser simultaneously.

KEYWORDS: Robotics, Infrared, Encoders, Laser, Garcia

MASTER OF SCIENCE IN ELECTRONIC WARFARE SYSTEMS ENGINEERING

A PERFORMANCE ANALYSIS OF THE LINK-16/JTIDS WAVEFORM WITH CONCATENATED CODING

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Link-16 is the designation of a tactical data link that is being introduced into operations of the United States Navy, the joint services, and forces of the North Atlantic Treaty Organization (NATO). Link-16 does not significantly change the basic concepts of tactical data-link information exchange, but rather provides certain technical and operational improvements to existing tactical data-link capabilities. The communication terminal of Link-16 is called the Joint Tactical Information Distribution System (JTIDS); it features Reed–Solomon (RS) coding, symbol interleaving, cyclic code-shift keying (CCSK) for M-ary symbol modulation, minimum-shift keying (MSK) for chip modulation and combined frequency-hopping (FH), and direct-sequence spread spectrum (DSSS) for transmission security. In this thesis, researchers investigate the performance of a Link-16/JTIDS-type waveform in both additive, white Gaussian noise (AWGN) and pulsed-noise interference (PNI) when an alternative, error-correction coding scheme for the physical layer waveform is employed. The performance obtained using the alternative, error-correction coding scheme is compared to that of the existing JTIDS waveform when the same assumptions are made for both waveforms.

Based on the analyses, it is concluded that the proposed alternative Link-16/JTIDS communication scheme performs better than the existing Link-16/JTIDS waveform in both AWGN and PNI for both coherent and non-coherent demodulation, in terms of both required signal power and throughput.

KEYWORDS: Link-16/JTIDS, Reed-Solomon Coding, RS Coding, Cyclic Code-Shift Keying, CCSK, Minimum-Shift Keying, MSK, Convolutional Codes, Concatenated Codes, Perfect Side Information, PSI, Pulsed-Noise Interference, PNI, Additive White Gaussian Noise, AWGN, Coherent Detection, Noncoherent Detection

COOPERATIVE, WIDEBAND SPECTRUM-SENSING AND LOCALIZATION USING RADIO- FREQUENCY-SENSOR NETWORKS

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Spectrum sensing and localization tasks are implemented using a radio-frequency-sensor network; the performance of this implementation is analyzed through simulation. A cooperative, wideband-spectrum, sensing and localization scheme using RF-sensor networks is proposed for implementing the tasks. In the proposed scheme, wavelet-based, multi-resolution, spectrum sensing and received signal-strength-based localization methods, which were originally proposed for cognitive radio applications, are adapted to radio-frequency sensor networks. For cooperation of the nodes in the proposed scheme, a new three-bit hard-combination technique is developed. A simulation model is created in the MATLAB programming language to implement the proposed scheme and to analyze its performance. The results of the simulation show that the proposed cooperative, wideband spectrum-sensing and localization scheme is appropriate for radio-frequency sensor networks and the proposed three-bit hard-combination scheme is superior to the traditional hard-combination schemes in terms of false alarm reduction.

ELECTRONIC WARFARE SYSTEMS ENGINEERING

KEYWORDS: Cooperative Spectrum Sensing, Source Localization, Multi-Resolution Spectrum Sensing, Three-Bit Hard Combination, RSS-Based Localization, Cognitive Radio, Wireless Sensor Networks, Electronic Warfare

DEVELOPMENT OF THE PHASE SYNCHRONIZATION CIRCUIT FOR A WIRELESSLY DISTRIBUTED, DIGITAL PHASED ARRAY

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The wirelessly distributed, digital phased array (WDDPA) is an ongoing Naval Postgraduate School research program with numerous possible applications in radar and communication systems. The WDDPA incorporates many array elements randomly or non-uniformly in the environment or on a platform. Array elements are synchronized and controlled over a wireless channel. Compared to conventional phased-array systems, its advantages are adaptability, survivability, and flexibility.

Phase synchronization is a critical component of the WDDPA development. The common phase reference is vital to steer the beam and control the radiation pattern for the phased-array system. The objective of this paper is to improve WDDPA synchronization operation. Previous hardware and software architectures are replaced or modified to improve the accuracy and speed of phase synchronization.

A series of experiments, first for hardwired channels, then for wireless channels, are successfully conducted to verify the synchronization operation for two elements. Several problems with the circuit are diagnosed and addressed. The overall performance of the improved synchronization circuit for the demonstration array is satisfactory, allowing phases to be synchronized within 20° wirelessly. The architecture for the potential successor of the synchronization circuit is introduced. It is more flexible and robust than the current circuit and thus more desirable for future applications of the WDDPA.

KEYWORDS: Radar, Distributed Array, Phased Array, Phase Synchronization, Digital Radar, Digital Beamforming, DBF, Wireless Beamforming, Wireless Network Sensor, Aperiodic Structure, Opportunistic Array, LabVIEW, Ballistic Missile Defense, BMD, CG(X), DDG-1000, Network-Centric Warfare, NCW, UAV, Modulator, Demodulator, Filter, Transmit/Receive Module, T/R Module, Leakage Cancellation

MASTER OF SCIENCE IN HUMAN SYSTEMS INTEGRATION

A COMPARATIVE ANALYSIS BETWEEN THE NAVY STANDARD WORKWEEK AND THE WORK-REST PATTERNS OF SAILORS ABOARD U.S. NAVY CRUISERS

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In March 2008, two U.S. Navy ships failed their inspection and survey (INSURV) assessments, with deficiencies ranging from inoperable equipment to inadequate housekeeping practices. The question of why these problems exist must be addressed. A study to determine the total number of hours sailors actually work in contrast with the Navy standard-workweek model is extremely important. Previous research regarding this topic has indicated that the Navy standard workweek does not accurately reflect the daily activities of sailors. In fact, results from a recent study on the USS *CHUNG HOON* (by Haynes) showed that a majority of sailors received much less sleep and worked longer hours than allocated in the Navy standard-workweek model. This research focuses on widening the scope of the Haynes study on U.S. Navy destroyers to determine if similar conditions exist onboard U.S. Navy cruiser vessels. The results indicate that 85% of participants within the study exceeded the 81 hours of available time allotted by the standard Navy workweek. On average, sailors in the current study, excluding officers, worked 9.90 hours per week more than allotted in the Navy standard workweek.

KEYWORDS: Navy Standard Workweek, Circadian Rhythm, Fatigue Avoidance Scheduling Tool, FAST, Sleep Activity Fatigue and Task Effectiveness Model, Sleep, Fatigue Management, Actigraphy

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

IPV6 TACTICAL NETWORK MANAGEMENT

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Current and emerging technologies and equipment, such as unmanned, aerial vehicles, ground sensors, networked radios, operator-worn sensor vests, and nanotechnology applications, offer warfighters unprecedented command-and-control and information-detection capabilities, yet the use of this technology has not been fully realized. The current protocol, IPv4, is incapable of providing enough addresses, due to a depletion of IPv4 address space. IPv6, however, offers unprecedented network support for tactical-level sensor- and communications assets in terms of increased address space, quality of service (QoS), flexibility, and security.

The Department of Defense is transitioning from IPv4 to IPv6 to capitalize on IPv6's expanded capabilities. However, one unresolved area is proper IPv6 network management. Currently, the majority of the configuration and operational knowledge is in the mind of a very few individuals. The expertise currently available must be developed for application by the tactical network manager operating on the edge of the network, in order to properly administer both an IPv4/IPv6 dual-stacked network during the phased protocol transition and a purely native IPv6 network. Second, IPv6 features a robust QoS capability previously unavailable through IPv4, which requires research to determine the optimal configuration for the warfighter's diverse requirements.

KEYWORDS: IP, Tactical Sensor Network, TNT, Internet Protocol Version 6, Network Management, Quality of Service, DiffServ, Information Management

AN ANALYSIS OF A MAN-IN-THE-MIDDLE ATTACK ON THE DIFFIE-HELLMAN KEY-EXCHANGE PROTOCOL

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The ability to securely distribute cryptographic keys has been a challenge for centuries. The Diffie–Hellman key-exchange protocol was the first practical solution to the key-exchange dilemma. The Diffie–Hellman protocol allows two parties to exchange a secret key over unsecured communication channels without meeting in advance. The secret key can then be used in a symmetric encryption application, and the two parties can communicate securely. However, if the key exchange takes place in certain mathematical environments, the exchange becomes vulnerable to a specific man-in-the-middle attack, first observed by Vanstone. This man-in-the-middle attack is explored, countermeasures against the attack are analyzed, and the attack is extended to the multi-party setting.

KEYWORDS: Cryptography, Diffie–Hellman, Man-in-the-Middle Attack

INFORMATION TECHNOLOGY MANAGEMENT

APPLYING BUSINESS PROCESS REENGINEERING TO THE MARINE CORPS INFORMATION-ASSURANCE CERTIFICATION AND ACCREDITATION PROCESS

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This thesis focuses on applying business-process reengineering (BPR) to the Marine Corps information-assurance (IA) certification and accreditation (C&A) process as it pertains to the Technology Services Organization-Kansas City (TSO-KC). The area of research concentrates on analyzing TSO-KC–developed Department of Defense information-assurance certification and accreditation process (DIACAP) packages for manpower, personnel, and pay systems as they currently operate, and the feasibility of applying BPR to the IA security posture required by these systems. The goal of this thesis is to effect a radical change in the IA C&A system process, resulting in a significant increase in quality or efficiency, a considerable reduction in process duration, and an appreciable diminution of cost.

This thesis discusses the current, “as-is,” state of the IA C&A process model for TSO-KC IT systems and applications and discusses methods of improving this process. Potential desired “to-be” state models are explored using the knowledge-value added (KVA) methodology; the most efficient model is developed and validated by applying it to the current IA C&A process flow at the TSO-KC.

Finally, this thesis recommends aspects of BPR initiatives to apply to the IA C&A process at the TSO-KC to realize positive change. Areas of follow-on study to augment the research in this thesis are also briefly discussed.

KEYWORDS: Business Process Reengineering, Information System, Department of Defense Information Assurance Certification and Accreditation Process, Services Organization, BPR, DIACAP, TSO-KC

CONSOLIDATED TACTICAL NETWORK ANALYSIS FOR OPTIMIZING BANDWIDTH: MARINE CORPS SUPPORT WIDE-AREA NETWORK (SWAN) AND TCP ACCELERATORS

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In 2004, the support wide-area network (SWAN) system added significant capability to the way Marines communicate on the battlefield. Today, the SWAN system is still a critical segment in Marine communications, and the TCP accelerator is being evaluated for a potential upgrade. Due to the rapid nature of the SWAN procurement process, in-depth testing procedures have never been established for this system. As a result, there are no procedures to effectively test and evaluate SWAN components for equipment upgrade.

Currently, MCSC relies on two IT consulting agencies, the U.S. Army Information Systems Engineering Command and the SWAN lab on Camp Pendleton, to evaluate components being considered for upgrade. This thesis explores these testing approaches, specifically addressing the TCP accelerator. It also evaluates the testing efforts and combines them into a single, standardized, repeatable, and more accurate test that can be applied to the SWAN system or any other tactical Marine Corps network and its components.

KEYWORDS: TCP/IP, TCP, IP, Accelerator, Acceleration, SATCOM, Tactical Network, Communication, Bandwidth, Optimization, SWAN, Testing

INFORMATION TECHNOLOGY MANAGEMENT

EMPLOYING A SECURE, VIRTUAL PRIVATE NETWORK (VPN) INFRASTRUCTURE AS A GLOBAL COMMAND-AND-CONTROL GATEWAY TO DYNAMICALLY CONNECT AND DISCONNECT DIVERSE FORCES ON A TASK-FORCE-BY-TASK-FORCE BASIS

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GHOSTNet is a secure, anonymous, virtual private network (VPN) service. Coupling ethernet tunneling and proxy services to provide users safe and anonymous Internet access, GHOSTNet utilizes TLS (SSL) protocol with AES-256 encryption to secure the network along with PKI certificates and HMAC protection from replay attacks and UDP flooding.

This thesis is a system-level test and evaluation of the GHOSTNet infrastructure. The primary objective is to determine the functional performance of GHOSTNet as a global command and control gateway, with the goal of being able to dynamically connect and disconnect diverse forces on a task-force by task-force basis. To accomplish this objective, a robust test and evaluation plan is implemented to baseline the system in the moderate operating conditions of COASTS field experiments conducted at Camp Roberts. The system will then be tested in various operational environments, including, but not limited to Fort Ord, the U.S. Coast Guard Station Monterey Bay, and southern Thailand, as part of the COASTS field experimentation program spanning FY2008 and FY2009.

KEYWORDS: Virtual Private Network, GHOSTNet, Maritime Interdiction Operations, Internet Protocol Security, Encapsulating Security Protocol, Data Encryption Standard

POSITIONING THE RESERVE HEADQUARTERS SUPPORT SYSTEM FOR MULTI-LAYERED ENTERPRISE USE

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Currently, the Navy stores and retains data in multiple data warehouses, in various formats, in numerous legacy systems. The Navy's bureau of personnel is responsible for four distinct data stores that house unique data for active duty officers, active duty enlisted, drilling reserve officers and enlisted, and all inactive service members. Decision makers within the Navy have proposed combining the data into one cleansed, metadata-tagged, indexable, and searchable enterprise-data environment. This environment will resolve redundant storage issues and eliminate outdated, end-of-lifecycle equipment and legacy infrastructure.

First, this research focuses on the current state of IT systems from the Department of Defense level through the Department of the Navy level to the focal system—the reserve headquarters-support (RHS) system. Second, research on current departmental guidance regarding the desired state of these systems is conducted and a summary is provided. Third, economic, technical, and strategic management theories are studied and applied in order to conduct an economic analysis of the possibility of migrating the RHS application to a more modern IT solution. In the final chapter, conclusions and recommendations are provided concerning the most attractive way to proceed with the RHS application. Finally, possibilities for follow-on work are discussed.

KEYWORDS: Enterprise Architecture, Project Management, Business Process Transformation, Operating Model, IT Governance, IT Systems, Data Quality, Data Migration, Business Operating Model, Personnel IT Systems, HRM, ERP

INFORMATION TECHNOLOGY MANAGEMENT

CONTROL-BASED, MOBILE, AD-HOC NETWORKING FOR SURVIVABLE, DYNAMIC, MOBILE, SPECIAL-OPERATION-FORCE COMMUNICATIONS

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In the next generation of wireless-communication systems, there will be a need for the rapid deployment of independent mobile users. Significant examples include establishing survivable, efficient, dynamic, mobile communication for tactical special-operation force (SOF) networks, as well as SOF units that are ad-hoc networking with first responders conducting emergency/rescue and disaster-relief operations. Such network scenarios cannot rely on centralized and organized connectivity, and should instead employ applications of newly developing control-based, mobile, ad-hoc Networking (CBMANET). In a CBMANET environment, an autonomous collection of mobile users communicate over relatively bandwidth-constrained wireless links by taking benefit of node mobility and topology control in combination with mobile platform switching. The network is decentralized. All network activity, including discovering the topology and delivering messages, must be executed by the nodes themselves (i.e., routing functionality will be incorporated into mobile nodes).

Harnessing the tremendous flexibility and efficiency of CBMANET would allow for better control and protection of ad-hoc mobile networks. Therefore, we need to work tirelessly to improve capabilities in the three aforementioned control spaces.

KEYWORDS: Control Based Mobile Ad Hoc Networking, CBMANET, MANET, Routing Protocol, Wireless Network

ENABLING ENHANCED COMPANY OPERATIONS: AN ANALYSIS OF TACTICAL COMMUNICATION REQUIREMENTS AND SOLUTIONS FOR A MARINE CORPS COMPANY AND BELOW

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This research evaluates and describes the optimal communications solution that will enable the Marine Corps Warfighting Lab's (MCWL) concept of enhanced company operations (ECO). Formerly known as distributed operations (DO), ECO is a concept that is intended to maximize tactical flexibility through decentralized operations of Marine infantry units in a distributed environment. The ECO environment can be characterized by large geographic areas and unconventional operations that have the potential to pose unique challenges for tactical information-system networks.

Proposed current and emerging solutions are designed with proprietary protocols and interfaces, as opposed to the development of modularity that enables common standards internetworking. An information-systems model, defined by sense, decide, and act nodes, decoupled from the communications network, and the Buddenberg interoperability reference model (BIRM), are employed to evaluate the suitability of current and emerging USMC communications systems for ECO. This thesis posits that the optimal communications solution is one that is designed to ensure interoperability across the inter-network and endpoint devices. The authors conclude that the optimal solution is a tactical mesh network that converges both IP (Internet protocol)-voice and data at the layer-3 (ISO Model) and extends the Global Information Grid's (GIG) convergence layer to the individual Marine.

INFORMATION TECHNOLOGY MANAGEMENT

KEYWORDS: Enhanced Company Operations, ECO, Distributed Operations, DO, Internetworking, Interoperability, Mesh, Network, BIRM, Information Systems Model, AN/PRC-117G, TW-220, EPLRS, CONDOR, IISR, PRR, AN/PRC-150, Node, Marine, Infantry, Architecture

DATA VISUALIZATION OF ISR AND C2 ASSETS ACROSS MULTIPLE DOMAINS FOR BATTLESPACE AWARENESS

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In this thesis, a prototype application is developed that is capable of providing ISR situational awareness to C2 nodes at the joint task force (JTF) level and below. The prototype application is intended to increase the JTF's level of visibility on information-request, process-related ISR activities. The application also demonstrates the capability of providing information that will allow joint intelligence planners to plan ISR operations more efficiently, including allocation of intelligence-gathering platforms and sensors and processing, exploitation, and dissemination (PED) of assets to information requests.

KEYWORDS: ISR Situational Awareness, Information Request

IMPLEMENTATION OF PHASED-ARRAY ANTENNA TECHNOLOGY PROVIDING A WIRELESS, LOCAL-AREA NETWORK TO ENHANCE PORT SECURITY AND MARITIME INTERDICTION OPERATIONS

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This thesis focuses on field testing to evaluate the feasibility of employing electronically steered (phased-array) antennas to provide a ship-to-shore wireless-network connection (802.11g) for littoral maritime assets. Specific areas examined include the evaluation of voice, video, and other data transmitted from a maritime-interdiction team, in real-time, to a remote command-and-control center in support of visit, board, search, and seizure and maritime-interdiction operations.

KEYWORDS: MIO, VBSS, Electronically Steered Antenna, Phased Array Antenna, Wireless Network Connection, Wi-Fi, IEEE 802.11g, Boarding Team, COTS, WLAN, Smart Antenna, OpenVPN Application, Wireless Base Station, OFDM, Latency, Point-to-Point Wireless Link

INFORMATION TECHNOLOGY MANAGEMENT

TELECOMMUNICATIONS GROWTH IN LATIN AMERICA: A COMPARATIVE ANALYSIS— THE DEVELOPMENT AND POLICY OF TECHNOLOGIES IN EMERGING MARKETS

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This thesis focuses on the area of telecommunications technologies and their policies as developed and adopted in Latin America. Though the whole of Latin America would provide a great area of research interest, this thesis delves into the countries of Colombia, Mexico, and Venezuela. These three countries play vital roles in the development of Latin America and retain unique relationships with the United States as allies and trade partners.

The exploration of telecommunications policy and how it has influenced regional development is considered. Specifically, policies, regulatory bodies, and agreements are examined in comparison to the rates of growth over the last one or two decades. Through the discovery of principal actors, infrastructure, resources for development, and the creation of and conforming to policies, a potential outlook for continued growth and expansion throughout Latin American is produced. Analysis of the extent to which these actors have developed locally and regionally through the use of political and international agreements further assists in this endeavor. Finally, an overall comparison between these countries, Latin America, and the United States' own policies and regulations enables further insight for recommendations regarding continued development within the United States and Latin America.

KEYWORDS: Telecommunications, Wireless, Cellular, Telephone, Internet, Television, Policy, Regulation, Latin America, Colombia, Mexico, Venezuela, Telmex, CANTV, America Móvil

RE-ENGINEERING THE DEFENSE BIOMETRIC IDENTIFICATION SYSTEM (DBIDS) EQUIPMENT-TRACKING DATABASE

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The Defense Manpower Data Center (DMDC) manages the Defense Biometric Identification System (DBIDS). DBIDS captures personal and biometric information to manage DoD-wide access, control, and personnel accountability. DBIDS equipment is installed globally and managed by a central office on the Monterey Peninsula. Program managers track data about the numbers and type of equipment installed at each site. Program managers were tracking DBIDS data using a single Microsoft Excel workbook comprised of several, interlinking worksheets (DBIDS master-plan spreadsheet). Data updates were error-prone and difficult, requiring close coordination to keep the number of “current” versions of the spreadsheet to a minimum. This thesis initially focused on reviewing the business rules and processes surrounding DBIDS documentation, and then transitioned into designing, developing, and implementing a relational database solution to improve problem areas identified during the initial review. After implementation of the database, this thesis explores the effects of making such a change within an organization. This is attempted by identifying and measuring changes in the performance and accuracy of the system; by measuring pre- and post-user satisfaction through the qualitative methods of questionnaires and interviews; and finally, using this analysis to improve the project through maintenance and growth iterations.

KEYWORDS: Database, Database Development Life Cycle, Rapid Prototyping, Business Process Management Software, Business Process Improvement, Business Process Redesign

MASTER OF SCIENCE IN INFORMATION WARFARE SYSTEMS ENGINEERING

UNDERSTANDING AND PREDICTING URBAN PROPAGATION LOSSES

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Modern-day warfare has presented the United States with a more technically savvy opponent in conflicts that have moved away from the traditional battlefield to the populated environment of the big city. Battlespace dominance no longer refers simply to the physical nature of war, but now also encompasses a digital environment with a greater influence on information warfare. One of the keys to successfully maintaining open wireless lines of communication and extracting data or denying the adversary the ability to communicate is a complete understanding of radio-wave propagation and the positive and negative effects of spreading and propagation losses. In a communication link, or radio-wave transmission, several sources of degradation are mathematically accounted for, including losses due to materials used, equipment setup, environmental factors, and interference associated with the actual frequencies. Up until recently, there were no studies evaluating the potential multipath losses that exist between a transmitter and a receiver in an urban environment. This thesis examines existing urban propagation models and evaluates their effectiveness in a variety of urban environments through a range of frequencies.

KEYWORDS: Radio Wave Propagation, Urban Propagation Loss, Okumura, Hata, Friis, Propagation Loss Model, Propagation Loss Calculator, Free Space Path Loss

PASSIVE FINGERPRINTING OF COMPUTER NETWORK-RECONNAISSANCE TOOLS

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This thesis examines the feasibility of passively fingerprinting network-reconnaissance tools. Detecting reconnaissance is a key early indication and warning of an adversary's impending attack or intelligence-gathering effort against a network. Current network-defense tools provide little capability to detect, and much less to specifically identify, network reconnaissance. This thesis introduces a methodology for identifying a network reconnaissance tool's unique fingerprint. The methodology confirms the utility of previous research on visual fingerprints, produces characteristic summary tables, and introduces the application of TCP sequence-number analysis to reconnaissance-tool fingerprinting. The use of these methods to fingerprint network-reconnaissance tools is demonstrated in a real-world, cyber-defense-exercise scenario.

KEYWORDS: Cyberspace Defense, Network Defense, Passive Fingerprinting, Computer Network Reconnaissance, Network Scanning, Port Scanning

INFORMATION WARFARE SYSTEMS ENGINEERING

THE EFFECTS OF THE JOINT MULTI-MISSION ELECTRO-OPTICAL SYSTEM ON LITTORAL MARITIME INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE OPERATIONS

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The United States Department of Defense finds itself in a period of reduced resources and growing requirements. In the field of intelligence, surveillance, and reconnaissance (ISR), there have been calls for both manpower and system cuts, while collection requirements continue to increase. One proposed method for maximizing ISR collection efforts is the development of multi-mission-capable collection equipment. In support of this concept, BAE Systems has developed the joint multi-mission, electro-optical system (JMMES). Designed for potential use on both manned and unmanned aircraft, JMMES is capable of multi-mission integration and target prosecution without the need to exchange system components or system operator, thus increasing flexibility, responsiveness, and capabilities, while reducing manning and cost requirements. JMMES incorporates multi-spectral technology and advanced search algorithms to enhance autonomous collection capabilities.

This thesis investigates how a JMMES-equipped, SH-60-variant aircraft affects U.S. ISR capabilities in the littoral regions, specifically in the areas of antisubmarine warfare, surface warfare, maritime interdiction operations, and search and rescue. Researchers teamed with the faculty research group in conducting JCTD test flights during Trident Warrior 2009. Utilizing both quantitative and qualitative results and analysis from the exercise flights and post-flight surveys, an organizational simulation model is developed, using VDT, to evaluate the benefits of JMMES.

KEYWORDS: Infrared, Electro-Optic, Joint Capability Technology Demonstration, Intelligence Surveillance and Reconnaissance

COLLECTING, RETRIEVING, AND ANALYZING KNOWLEDGE-VALUE-ADDED DATA FROM U.S. NAVY VESSELS AFLOAT

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Program managers throughout the Department of Defense (DoD) 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 method that can gather real-world data from United States Naval vessels afloat and use that data to generate return-on-investment (ROI) estimates based upon knowledge-value-added (KVA) analysis. This research builds upon the already-developed KVA-analysis method through providing a means by which a constant flow of real-world data can feed this process, thereby providing an output that is both current and meaningful. The ability of decision makers to access this information will provide them with a critical tool that they can leverage to help make wise financial decisions with respect to the CCOP program.

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

INFORMATION WARFARE SYSTEMS ENGINEERING

OPTIMIZING THE ROUTER CONFIGURATIONS WITHIN A NOMINAL AIR FORCE BASE

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Routing information is a delicate balance between theoretical ideas, such as optimization of flow and shortest path routing, and the reality of threats to the security of the network. The way in which information is routed can be massaged to give the best solution, that being one that aptly satisfies both of these constraints. But are the routers on a nominal Air Force base set up with all of these things in mind? The basis for this study is graph theory, which supplies the tools necessary to analyze the underlying mathematical construct of the router configuration. A nominal Air Force base is constructed with all of the functions and organizations that one would find on a nominal Air Force base organized in a nominal physical fashion. The optimal router setup for such a base is then developed. From there, the design's feasibility is analyzed from the standpoint of cost, security, and implementation. The scope of this research is the routing of all traffic internal to the base—i.e., traffic originating or terminating off-base is not examined.

KEYWORDS: Network Architecture, Graph Theory, Spanning Tree, Network Security

PORTABLE, SIGNALS-ANALYSIS SOLUTIONS USING SIGNALWORKS: A PROCESS GUIDE FOR ANALYSTS AND STUDENTS

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Signalworks is a signals-analysis software suite designed to be installed on Windows and Linux portable computing platforms. The demodulation applications within the program offer considerable processing capability for a variety of signals, coupled with a graphical interface that is both easy to use and configure. This thesis examines the process of building test signals within Signalworks and then processing them with the available demodulation applications to define important parameters used to identify and analyze signals.

Although Signalworks version 4.0 is unable to demodulate the orthogonal frequency division multiplexed (OFDM) signals often used in wireless communications, it can process the binary phase-shift keyed (BPSK) and quadrature phase-shift keyed (QPSK) signals used in the 802.11b standard. While future versions may include an OFDM demodulation capability, this analysis includes the feasibility of using Signalworks in a lab environment to demonstrate and educate students on signal characteristics, including wireless communication signals.

KEYWORDS: Signals Analysis, Portable Signal Processing, Signalworks

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

A STUDY OF COMPOSITE INTERFACE STRENGTH AND CRACK-GROWTH MONITORING USING CARBON NANOTUBES

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The interface strength of woven-fabric composite layers is studied using Mode II fracture-strength testing. Both carbon-fiber and glass-fiber composites are used with the vinyl-ester resin. First, the single-step cured (i.e., co-cured) composite interface strength is compared to that of the two-step cured interface as used in the scarf-joint technique. The test results show that the two-step cured interface is as strong as the co-cured interface, and the former have even higher fracture toughness than the latter. The second study applies carbon nanotubes to the composite interface using the two-step curing technique. Mode II fracture testing is performed for the interface containing carbon nanotubes. The results indicate great improvement of the interface fracture toughness due to carbon nanotubes. Finally, a study is conducted to detect interface crack growth using the carbon nanotubes introduced at the interface. Because carbon nanotubes have high electrical conductivity, the electrical resistance is measured through the interface. As the interface crack grows under a loading, there is a gradual increase of electrical resistance. As a result, the change of electrical resistance in terms of crack-length change is determined. The study shows that using carbon nanotubes at a critical composite interface would strengthen its fracture toughness and detect crack growth.

KEYWORDS: Carbon Nanotubes, CNTs, Carbon Fiber Composite, Fiberglass Composite, Crack Propagation, Mode II, Health Monitoring, Resistance Testing

AN INVESTIGATION OF POTENTIAL PERFORMANCE IMPROVEMENTS, INCLUDING THE APPLICATION OF INLET GUIDE VANES TO A CROSSFLOW FAN

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The inherent characteristics of a crossflow fan allowing for easy thrust vectoring and potential airfoil boundary-layer control make it an attractive propulsive means for a theoretical vertical-takeoff-and-landing aircraft. However, to compete with current methods of aircraft propulsion, further performance improvements of the crossflow fan are needed.

A baseline model of a crossflow fan geometry developed by Vought Systems in the 1970s is scaled from a 12-inch diameter rotor to a 6-inch diameter rotor as a more realistic size for integration into a fan-in-wing concept to provide both thrust vectoring and boundary-layer control over the wing. Using the computational fluid dynamics software ANSYS CFX, baseline-performance trends are verified against previous 12- and 6-inch diameter models. Data from this model is then used to design a configuration of inlet guide vanes in an effort to increase the loading on the first stage of the fan and gain an improvement in pressure ratio over the baseline crossflow fan.

The CFD results are then compared with experimental results from a crossflow-fan test assembly modified to replicate the CFD model with inlet guide vanes. While the application of the particular inlet guide vane configuration does not result in the desired performance improvements, it does validate that computational fluid

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dynamics can adequately predict the impact of various design changes on the performance of the crossflow fan, as well as provide valuable insight into the behavior of the crossflow fan for future efforts in performance improvement.

KEYWORDS: Fan, Crossflow, Crossflow, Inlet Guide Vanes, Thrust Vectoring, Vertical Take Off

A COST BENEFIT AND CAPABILITY ANALYSIS OF SEA-BASE CONNECTORS

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A cost benefit and capability analysis is conducted on a number of sea base connectors. In conducting this analysis, the average yearly operating and sustainment (O&S) cost of the connectors studied is used, along with specific performance data, such as maximum payload (in tons), maximum speed (in knots) when loaded to maximum payload, and maximum range (in nautical miles) when operated at maximum payload and maximum speed, to obtain a number of comparative metrics. These metrics include, but are not limited to tons per hour (tph), cost per ton (\$/ton), and cost per ton per nautical mile (\$/ton-NM).

A number of air and surface connectors are considered consisting of both legacy platforms in use today and a number of future concept platforms currently being developed. The surface connectors considered are the Landing Craft Air Cushioned, the Ship-to-Shore Connector, the Joint High-Speed Vessel, the Landing Craft Utility Replacement (LCU(R)), and the Ultra Heavy-Lift Amphibious Connector (UHAC). The air connectors considered are the MV-22 Osprey, the CH-53E Sea Stallion, the Hybrid Ultra-Large Aircraft, and the Hybrid Very-Large Aircraft.

KEYWORDS: Sea-Base, Seabasing, Cost Benefit, Surface Connectors, Air Connectors, Sea-Base Connectors

A NUMERICAL STUDY OF THE EFFECTS OF FLUID-STRUCTURE INTERACTION ON DYNAMIC RESPONSES OF COMPOSITE PLATES

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Composite materials are seeing increased use in structural applications because of their various benefits. When composite structures are employed in a water environment, their dynamic responses are greatly affected by the fluid medium. Water density is comparable to many composite materials, and the effects of fluid-structure interaction on the dynamic behaviors of composite structures are significant. The effects of fluid-structure interaction include changes of frequency, magnitude, energy dissipation, etc., of structural characteristics. Hence, it is critical to understand the fluid-structure interaction of composite structures subjected to dynamic loading in water environments. This work focuses on finding parameters affecting the transient dynamic responses of composite structures. Coupled fluid-structure interaction analyses of composite plates are conducted numerically using finite element models, including various parametric studies. The results are compared to those of dry structures to identify the role of each parameter.

KEYWORDS: Fluid-Structure Interaction, Composite, Carbon Fiber Composite, Dynamic Response, Finite Element

MECHANICAL ENGINEERING

AN EXPERIMENTAL STUDY OF FIBERGLASS COMPOSITES CONTAINING METAL-WIRE JOINTS

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The U.S. Navy has been incorporating increasing amounts of composite materials during construction, especially in the areas of submarine sails and surface-ship superstructures. The benefit of using composite material with imbedded metal-wire layers is that these metal-wire layers may be welded to the steel superstructure of a naval vessel, resulting in maximum joint strength. Joining a composite structure to a metallic structure requires the metal-wire layers to be co-cured with composite layers using Vacuum Assisted Resin Transfer Molding (VARTM). The interface fracture strength is measured for a Mode I fracture for various lay-up and interface conditions. The study includes metal-wire to composite, composite to composite, and metal-wire-to-metal-wire interfaces. Metal-wire lay-up orientations studied are 0 and 90 degrees with varying combinations. The study also examines the crack propagation from a composite to a metal/composite interface. The failure mode is studied by creating a finite element model in ANSYS 12.0. The results suggest that a metal-wire/composite laminate could effectively connect a composite structure to a metallic structure.

KEYWORDS: Vacuum Assisted Resin Transfer, VARTM, Composite, Fiberglass, Metal Wire, Metal Composite, Mode I, ANSYS 12.0

INCORPORATING MULTI-CRITERIA OPTIMIZATION AND UNCERTAINTY ANALYSIS IN THE MODEL-BASED SYSTEMS ENGINEERING OF AN AUTONOMOUS SURFACE CRAFT

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This thesis presents an effective methodology and toolset that explicitly consider technological uncertainty to enable the design, development, and assessment of alternative system-concept architectures for an autonomous, unmanned, surface vessel (USV) in a system-of-systems (SoS) context.

Complex system designs often fail due to poor communication of customer needs and inadequate understanding of the overall problem. This frequently results in the design team missing the mark in transforming requirements into a successful conceptual design. Effective system design requires a defined, flexible, and structured context within which new technological ideas can be judged. Alternative physical architectures are then modeled, simulated, and compared to find the best solution for further examination.

Using model-based systems engineering (MBSE) principles and a derived, multi-criteria, decision-making (MCDM) model allows designers to perform a solution-neutral investigation of possible alternative physical-architecture concepts. This ensures a consistent, quantitative evaluation of warfighting capability, suitability, effectiveness, technology maturation, and risk before and during program execution. This effort is in support of an extended program to design a system of unmanned systems intended to provide the Department of Defense with a coordinated, multi-domain, multi-mission, autonomous security and warfighting asset.

KEYWORDS: Autonomous, Unmanned Vehicle, USV, UV Sentry, Model-Based, Multicriteria, Model-Based Decision Making, MCDM, Unmanned Surface Vessel, Model-Based Systems Engineering, MBSE, Uncertainty

MECHANICAL ENGINEERING

AERODYNAMIC PERFORMANCE PREDICTIONS OF AN SA-2 MISSILE USING MISSILE DATCOM

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In preliminary missile design, a fast and efficient way of determining a missile's aerodynamic performance is required. Determining a missile's aerodynamic capabilities is also part of forming the requirements for a missile defense system to counter a particular missile design or an array of designs. Aerodynamic-prediction software packages provide this tool. Unlike computational fluid dynamics (CFD), they rely heavily on semi-empirical methods derived from aerodynamic flow data from a myriad of missile designs to predict the performance of a new missile design through an inference. This is the inherent strength of these packages and also a possible weakness. They provide a rapid output, but may not produce the most accurate results. Many have strived to produce aerodynamic prediction codes that produce accurate results. Missile DATCOM (version 08) is a promising member of this group of software packages.

Experimental and extrapolated data from the Russian-designed SA-2 missile is used to validate the output from Missile DATCOM (version 08). Additionally, a CFD model is included as part of the analysis, using ANSYS CFX, a compressible flow solver. Previous work has been done on this topic using the previous version of Missile DATCOM and a similar geometry. More accurate geometries have been obtained from the sponsor that will ultimately lead to better comparisons with the empirically determined data. This validation will permit this software to be used as a predictive tool for future missile design.

KEYWORDS: Missile Aerodynamics, Missile DATCOM, Missilelab, SA-2 Missile

STEADY AND UNSTEADY AERODYNAMIC FLOW STUDIES OVER A 1303 UCAV CONFIGURATION

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This study generates new information through qualitative documentation of the main flow features and direct measurements of the aerodynamic performance of a tailless, unmanned, combat air vehicle (UCAV) 1303 configuration under both steady and unsteady maneuvering conditions. Photographic evidence of flow features, measurements of large-scale flow effects and that of forces and aerodynamic coefficients during static and dynamic pitch, roll, and yaw maneuvers are obtained. Flow visualization images and force measurements are taken at various Reynolds numbers, model attitudes, and pitch rates for comparison.

A 1/72nd scale- model, with a 47 deg leading edge sweep and a cranked trailing edge delta wing with a fuselage, is investigated in the Naval Postgraduate School water tunnel. Phase locked, high-resolution, flow images are obtained using a five-color dye-injection system over the maneuvering model. Both static and dynamic pitch-up, roll, and yaw maneuvers are considered. Additionally, a five-component strain gage and flow-monitoring software are employed to record yawing, pitching, and rolling moment information in real-time and derive the aerodynamic force and moment coefficients for selected maneuver conditions.

Flow visualization reveals the presence of a strong spanwise flow at low angles of attack and strong vertical-flow structures at larger angles of attack, as can be expected, but not clearly established earlier, for such low sweep angle wings. It also indicates that the vortical structures and reverse flow are highly Reynolds number dependent. Normal force and pitching moment load-data correlate well with trends observed for low sweep angle delta wings, but unexpected side force, yawing moment, and rolling moment variations are observed that are attributable to asymmetrical vertical-flow behavior on the tailless UCAV geometry.

KEYWORDS: Unmanned Combat Air Vehicle, UCAV, UCAV 1303

MECHANICAL ENGINEERING

MODELING LAMB WAVES AND APPLICATION TO CRACK IDENTIFICATION

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The objective of this study is to model Lamb-wave generation and sensing for application to crack identification in engineering structures. Three topics are analyzed numerically using multiphysics finite-element analysis. Initially, different types of Lamb-wave generation techniques are investigated. A comparison between modeling the sinusoidal application of horizontal force (or displacement) as input and modeling the piezoelectric response of an actuator subjected to sinusoidal voltage input is performed. Secondly, the effects of a crack (disbond) between a piezoelectric wafer and the structure are analyzed, both for the piezoelectric actuator that generates the waves and the sensor that measures the response. Finally, the appropriate fidelity of modeling a structural crack is investigated. In particular, the use of contact elements is evaluated based on their role in the accurate prediction of the wave scattering from cracks or defects inside the structure.

KEYWORDS: Lamb Waves, Modeling, Finite Element, Longitudinal, Shear Mode, ANSYS, Debonding, Sensor, Piezoelectric

FLOWPATH DESIGN OF A THREE-TUBE, VALVELESS, PULSE-DETONATION COMBUSTOR

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This research investigates the effects of inlet dump angle on the size, shape, location, and magnitude of recirculation zones for single-side dump, pulse-detonation combustor, detonation tubes, and describes the methods and results of hypothesized improvements to the internal flow path of those engines to ensure complete inter-cycle quenching. Additional analysis is conducted to visualize the dispersion of fuel along the feed tube and into the dump region as a means of providing initial validation of the design with respect to appropriate fuel concentration within the geometry.

KEYWORDS: Pulse Detonation Engine, Side-Dump Combustor, Humphrey Cycle, Computational Fluid Dynamics

MASTER OF SCIENCE IN METEOROLOGY

LONG-RANGE ATMOSPHERE-OCEAN FORECASTING IN SUPPORT OF UNDERSEA WARFARE OPERATIONS IN THE WESTERN NORTH PACIFIC

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Skillful, long-range forecasts of acoustic variables have the potential to be very useful in planning Navy undersea-warfare operations. This study assesses the potential to predict sonic layer depth (SLD) in the western North Pacific at lead times of one to several months. Correlations between SLD and remote climate-system variables are conducted, and a high potential for skillful, long-range forecasts of SLD in the western North Pacific using sea surface temperature in the equatorial and South Pacific as predictors is identified. Tercile matching and composite analysis forecast (CAF) methods are used to develop hindcasts and forecasts of SLD based on SST predictors at lead times of one to four months. The forecast verification metrics show that the resulting long-lead probabilistic forecasts are a clear improvement over presently available, long-term, mean climatology products. Conditional compositing techniques are also used to create mean and environmental threshold probability products based on the long-lead forecasts.

Results indicate that the support of undersea warfare operations by the Navy meteorology and oceanography community could be improved by the use of advanced climate data sets, climate analysis, and long-range forecasting methods.

KEYWORDS: Sonic Layer Depth, Undersea Warfare, USW, Military Operations, Planning Timeframe, Anti-Submarine Warfare, ASW Western North Pacific, Climate, Climatology, Climate Analysis, Climate Prediction, Smart Climatology, Conditional Climatology, Long Range Forecast, Statistical Forecast, Simple Ocean Data Assimilation, SODA, Meteorology, Oceanography

MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

OCEAN SURFACE WAVE TRANSFORMATION OVER A SANDY SEA BED

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Projecting naval forces in littoral areas requires a thorough understanding of the environmental processes that take place in those areas, especially ocean wave evolution and the associated surf and wave-driven currents. The transformation of wave spectra in coastal environments is predicted with numerical models that include the effects of refraction, nonlinear wave-wave interactions, and parameterizations of wave breaking and bottom friction. This thesis presents a comparison between a new field dataset and model predictions of wave transformation in shallow water. An array of sixteen wave-measuring instruments was deployed outside the surf zone on the sandy sea bed of Martha's Vineyard's inner continental shelf in the fall of 2007. Data from these instruments are analyzed and the performance of the spectral wave prediction model SWAN (simulating waves nearshore) is tested against the observations.

The observations generally show gradual wave decay towards the shore with a reduction of as much as 15% of the incident wave height across only 4 km of continental shelf. Wave-height variability is observed in both the cross-shore and the alongshore directions, suggesting that the effect of bottom processes on wave energy is two-dimensional. Comparisons of these observations with SWAN model predictions show that both bottom friction and refraction play a dominant role in the wave energy transformation outside the surf zone. Overall, the spectral wave decay is handled well by SWAN with any of the bottom friction parameterizations activated, including the widely used JONSWAP (Hasselmann, et al., 1973) empirical parameterization. Deactivating bottom friction in SWAN yields a slight overprediction of nearshore wave heights.

KEYWORDS: Ocean Waves, Energy Spectrum, SWAN, Numerical Prediction Models, Refraction

SURFACE WIND-FIELD ANALYSES OF TROPICAL CYCLONES DURING TCS-08: RELATIVE IMPACTS OF AIRCRAFT AND REMOTELY SENSED OBSERVATIONS

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The objective of this research is to investigate tropical-cyclone wind-field structure and development utilizing comprehensive observation sets collected during the Tropical Cyclone Structure 2008 (TCS-08) and the Observing System Research and Predictability Experiment (THORPEX) Pacific Asian Regional Campaign (T-PARC). Rare aircraft measurements in the western North Pacific are utilized to define surface-wind distributions of TY Nuri, TY Sinlaku, and STY Jangmi. Stepped Frequency Microwave Radiometer (SFMR) surface winds are compared to Global Positioning System (GPS) dropwindsondes to determine eyewall slope and flight-level reduction factors. The combined SFMR and dropwindsonde wind-speed observations are highly correlated ($r = 0.88$) with an RMSE of 2.58 m s⁻¹. The three mature storm systems had a combined mean-slant reduction factor and relative slope similar to that observed in Atlantic hurricanes. Analysis accuracy is defined by the RMSE between H*Wind

METEOROLOGY AND PHYSICAL OCEANOGRAPHY

analyses and 0-150 m-average dropwindsonde wind speeds. Satellite observations have the largest speed RMSE, and the SFMR observations have the smallest speed RMSE. The ECMWF analyses have the largest intensity differences from the JTWC best-track intensity, and SFMR-based analyses have the smallest intensity differences from the JTWC best-track intensity.

KEYWORDS: Tropical Cyclone, Joint Typhoon Warning Center, Surface Wind Field, THORPEX Asian Regional Campaign, Tropical Cyclone Structure 2008, Western North Pacific Typhoons, H*Wind Analyses

WAVE OVERTOPPING OF A BARRIER BEACH

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An ephemeral river is a seasonal river that flows into the ocean, forming an inlet at certain times of the year; the river is blocked by a barrier beach that usually forms a lagoon during the rest of the year. Ephemeral rivers are important for both military and civilian communities because these areas are susceptible to rapid, unpredictable flooding and beach breaching. Wave overtopping of barrier beaches is the first step to modeling beach breaching. Carmel River State Beach, in central California, acts a barrier beach for the Carmel River, which flows into the Carmel Lagoon. Lagoon height changes are converted to volume changes by a stage-volume curve, then center differenced and averaged to provide total volume rates of change in the lagoon. The van der Meer and Janssen (VJ), European, and Hedges and Reis (HR) overtopping models are compared. The lagoon volume rate of change is compared to the predicted model rate of change for three different overtopping cases in 2006, 2008, and 2009.

KEYWORDS: Overtopping, Run-Up, Barrier, Natural Beach, Carmel River Beach

MASTER OF SCIENCE IN MODELING, VIRTUAL ENVIRONMENTS, AND SIMULATION

FRIGATE-DEFENSE EFFECTIVENESS IN ASYMMETRICAL, GREEN-WATER ENGAGEMENTS

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Asymmetric threats pose increasing challenges to combatant commanders in stability, security, transition, and reconstruction (SSTR) operations. Threats once confined to littoral waters now extend out to the green-water theater. Many NATO countries operate their post-Falkland War-built frigates in these missions, in which lightly armed, small, agile, and fast craft are often encountered.

This study uses freely available real-world data to build a simulation using an agent-based modeling platform called MANA. The simulation is exercised over a broad range of factor settings that are determined by an efficient experimental design. Using linear regression and partition trees, a robust analysis is performed on the resulting dataset to create statistical models.

Conclusions gained through these models suggest that a swarm of small craft, armed with handheld weapons, could attack and achieve a mission kill on a typical NATO FFH operating in a SSTR mission. It further implies that mission survival is dependent on the sophistication of installed weapons, and that a mix of advanced, automated weapons is best suited for close-in defense against multiple, small, seaborne attackers. Therefore, it will benefit mission survivability to improve or replace the existing body-aimed weapons of frigates serving on SSTR missions.

KEYWORDS: Agent Based Simulation, Asymmetric Warfare, Data Farming, Design of Experiments, Evolving Design, MANA, Modeling and Simulation, Naval Swarm Defense, Robust Design, Regression Analysis, Simulation Experiments and Efficient Design Center, Taguchi Method

NEAREST-NEIGHBOR CLASSIFICATION USING A DENSITY-SENSITIVE DISTANCE MEASUREMENT

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This work proposes a density sensitive distance measurement that takes into account the density of an underlying dataset to better represent the shape of the data when measuring distance. Kernel density estimation, using kernel bandwidths determined by k -nearest neighbor distances, is used to approximate the density of the underlying dataset. A scale is applied to the resulting kernel density estimate and a line integral is performed along its surface resulting in a density sensitive distance. This work tests the utility of the proposed density sensitive distance measurement using supervised learning. K -Nearest Neighbor classification using both the proposed density sensitive distance measurement and Euclidean distance are compared on the Wisconsin Diagnostic Breast Cancer dataset and the MNIST Database of Handwritten Digits. For perspective, these classifiers are also compared to Support Vector Machine and Random Forests classifiers. Stratified 10-fold cross validation is used to determine the generalization error of each classifier. In all comparisons, k -Nearest Neighbor classification using the proposed density sensitive distance measurement had less generalization error than k -Nearest Neighbor classification using Euclidean distance.

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For the MNIST dataset, k -Nearest Neighbor classification using the density sensitive distance measurement also had less generalization error than both Support Vector Machine and Random Forests classification.

KEYWORDS: Classification, Supervised Learning, k -Nearest Neighbor Classification, Euclidean Distance, Mahalanobis Distance, Density Sensitive Distance, Parzen Windows, Manifold Parzen Windows, Kernel Density Estimation

A SIMULATION TOOL FOR THE DUTIES OF COMPUTER-SPECIALIST, NONCOMMISSIONED OFFICERS ON A TURKISH AIR-FORCE BASE

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Staff assignment is one of the major problems in many lines of business. Knowing that the human being is one of the most expensive and demanding resources, efficient employment of personnel becomes significant. Simulation techniques can help accomplish effective staff assignments.

The aim of this thesis is to create a simulation tool by using a prototypical model of computer-system specialist, noncommissioned officers' jobs on a Turkish air-force base, and to identify the effective factors on the computer-specialist shortage problem. This aim is accomplished by using event graph and discrete event simulation techniques for modeling purposes, and Simkit and Viskit to implement the model into simulation code.

After evaluating the simulation results from an experiment involving fifteen input factors, it is concluded that the staff shortage problem can be addressed by using this study after updating the parameters used in the model to reflect the most recent distributions. On the other hand, increasing the number of personnel is not the only solution for addressing the problem. The study suggests some other ways to improve the measure of effectiveness values, such as increasing the number of cars that are assigned to repair personnel, reducing logistic delay times, or increasing the inter-arrival times for computer and network failures. There are different setups or combinations of factors that are capable of solving the staff shortage problem, and the most cost-effective setup can be decided after a trade-off analysis.

KEYWORDS: Simulation, Model, Staff Assignment Problem, Simkit, Viskit, Design of Experiment, NOLH, Regression Analysis

INTEGRATION OF ROBOTICS AND 3D VISUALIZATION TO MODERNIZE THE EXPEDITIONARY WARFARE DEMONSTRATOR

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In the summer of 2008, the Commandant of the Marine Corps (CMC) released a message to all Marines and sailors detailing plans to revitalize U.S. naval amphibious competency. Current responsibilities in Iraq and Afghanistan have significantly reduced available training time, causing overall amphibious readiness to suffer. In response, this thesis evaluates 3D-visualization techniques and other virtual-environment technologies available to support these mission-critical training goals. The focus of this research is to modernize the Expeditionary Warfare Demonstrator (EWD) located aboard the Naval Amphibious Base (NAB) in Little Creek, Virginia. The EWD has been used to demonstrate doctrine, tactics, and procedures for all phases of amphibious operations to large groups of Navy, Marine Corps, joint, coalition, and civilian personnel for the last 55 years. However, it no longer reflects current doctrine and is therefore losing credibility and effectiveness.

In its current configuration, the EWD is limited to a single training scenario because the display's ship models rely on a static pulley system to show movement and the terrain display ashore is fixed. To address these shortfalls, this thesis recommends using the wireless communication capability within Sun's Small Programmable Object Technology (SunSPOT) to create robotic vehicles to replace the current ship models. This enables large-group

visualization and situational awareness of the numerous, coordinated, surface maneuvers needed to support Marines as they move from ship to shore. The second recommendation is to improve visualization ashore through the creation of Extensible 3D Graphics (X3D) scenes depicting high-fidelity 3D models and enhanced 3D-terrain displays for any location. This thesis shows how to create these scenes and project them from overhead in order to modernize the gymnasium-sized EWD into an amphibious wargaming table suitable for both amphibious staff training and operational planning. Complimentary use of BASE-IT projection tables and digital 3D holography can further provide small-group close-up views of key battlespace locations. It is now possible to upgrade an aging training tool by implementing the technologies recommended in this thesis to support the critical training and tactical needs of the integrated Navy and Marine Corps amphibious fighting force.

KEYWORDS: Battlespace Visualization, SunSPOT, X3D Earth, Amphibious Operations

GENETIC ALGORITHMS IN THE BATTLESPACE TERRAIN REASONING AND AWARENESS-BATTLE COMMAND (BTRA-BC) BATTLE ENGINE

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The U.S. Army Corps of Engineers Research and Development Center's (ERDC) Battlespace Terrain and Reasoning Awareness–Battle Command (BTRA–BC) battle engine (BBE) is a tool that enables command staffs to semi-automate the creation and evaluation of potential courses of action (COA) for use in military planning. The BBE uses data generated during the initial steps of the military decision-making process (MDMP) and a genetic algorithm to produce and evaluate a population of COAs. This thesis provides a basic background of both the MDMP and genetic algorithms. It describes the features of the BBE and the parameters that control its genetic algorithm. The thesis describes an experiment to test the genetic algorithm parameter effects on the BBE search results. Recommendations to improve the performance and functionality of the BBE are provided.

KEYWORDS: Genetic Algorithms, Military Decision Making Process, Mission Planning, Course of Action, Wargaming, Battle Simulation

REALISTIC REFLECTIONS FOR MARINE ENVIRONMENTS IN AUGMENTED-REALITY TRAINING SYSTEMS

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Training systems for emerging threats often require complex, realistic, and flexible scenarios. Two recent studies analyzed small-boat swarming attacks and found that no adequate training systems exist, particularly since live-firing at multiple targets is impractical. Augmented reality (AR)—compositing real environments and simulated objects—can overcome this training gap, as it allows replacing real ammunition and targets with virtual rounds and boats. Recent advancements in AR address the generation and display of shadows and lighting effects from the virtual objects onto the real scene. However, creating maritime AR environments bears additional difficulties due to the ocean's dynamics and its reflective surface.

This thesis presents methods for creating realistic reflections of computer-generated ships on live ocean video. After mirroring the ship, a custom graphics shader is applied to the reflection to distort the reflection and to smoothly blend it with the background ocean video. A user study is conducted in which the participants have to determine the authenticity of real and automatically augmented images, yielding over 30% of augmented images to be considered authentic.

The implementation of these believable reflections into an augmented reality improves an AR training system used to train for shipboard personnel in small boat defense, and other high-fidelity augmentations for marksmanship

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or convoy training improve immersion, hence training effectiveness, and could potentially save the Navy money, ships, and even lives.

KEYWORDS: Augmented Reality, Small Boat Defense, Fragment Shader, AR-VAST, Realistic Reflection, Ocean Environment

INTEGRATING DISTRIBUTED, INTERACTIVE SIMULATIONS WITH THE “PROJECT DARKSTAR” OPEN-SOURCE, MASSIVELY MULTIPLAYER, ONLINE GAME (MMOG) MIDDLEWARE

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Recently, a great deal of attention has been given to the use of massively multiplayer, online games (MMOGs) for both gaming and military applications. The revenue generated by MMOGs and their effect on the network infrastructure has resulted in significantly more developmental resources being applied to commercial MMOG technology than to military distributed virtual (DVE) development. All DVEs share a common set of characteristics and additional requirements exist for the interoperability of military DVEs. It is possible to exploit these similarities to take advantage of developments in the supporting technologies of commercial MMOGs.

Specific capabilities of interest include scalability for large numbers of players, capacity for large amounts of network traffic, portability across operating systems, and adaptability to connect diverse codebases, network protocols, and data formats. Project Darkstar is a Sun Labs research project that has developed an open-source middleware for MMOGs. This thesis produces and tests an MMOG server that interconnects heterogeneous simulators in a DVE using the Project Darkstar middleware and locally developed network gateways. The performance of the system and the character of the network traffic it generates are analyzed. Initial test results warrant further development and eventual deployment.

KEYWORDS: Distributed Interactive Simulation, Massively Multiplayer Online Game, Simulation Interoperability

INTEGRATING INTELLIGENCE AND BUILDING TEAMS WITHIN THE INFANTRY IMMERSION TRAINER

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The trend of focusing on technology in “technology augmented environments” and practicing a set of skills in isolation needs to shift towards user-centered training, with skills being integrated earlier in the training process as long as conditions for that integration exist. The purpose of this thesis is to examine whether incorporating intelligence briefs and debriefs with a Squad Planning Operations Center (SPOC) supported by suitable technologies improves infantry training in urban warfare training situations. To prepare for this task, a pilot study is conducted following current Infantry Immersion Trainer (IIT) procedures for the control group, while the experimental group utilizes an Augmented Combat Operations Center (A-COC). Information gained from this study is utilized for the main study conducted at the IIT aboard Camp Pendleton, California. This study is conducted utilizing 60 participants in the control group (following current IIT procedures) and 93 participants in the experimental group (IIT procedure augmented with the use of a SPOC). The most statistically significant difference between the groups comes from the participants’ self-assessment on training confidence and overall success of training. Members of the experimental group, after utilizing the SPOC for planning, feel more confident in completing their training tasks, and their view of achieving success in executing their mission is also higher.

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KEYWORDS: Augmented, Immersive, Leadership, Presence, Co-Presence, Teamwork

DOCUMENT-BASED MESSAGE-CENTRIC SECURITY USING XML AUTHENTICATION AND ENCRYPTION FOR COALITION AND INTERAGENCY OPERATIONS

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Different agencies and different nations are unable to securely communicate and share structured information due to differences in security policies and data formats. The current evolution of security and data policies is not solving this fundamental problem. Document-based, message-centric, XML security can provide satisfactory security within a diversified communications framework between traditional and non-traditional partners by utilizing existing web standards for XML canonicalization, XML digital signature, XML compression, and XML encryption. Vulnerabilities related to the exchange of cryptographic technologies are minimized by strictly adhering to open-standards technology. This approach thus resolves multi-partner trust challenges in regards to using another entity's equipment, software, or policy requirements through the proper adoption of standards-based, structured data and alternative cryptographic algorithms. Exemplar results demonstrated in this thesis show that XML security is a feasible approach for operations that include multiple agencies and coalition partners.

Alternative solutions are also available using proprietary technologies, but such approaches lock participants into commercial contracts, prohibit distribution, and provide suspect capabilities. Therefore, they cannot attain interagency or international acceptance. Such methods involve the use of unique or proprietary message formats with customized encryption and compression algorithms that are not available for broad scrutiny by open source communities. Closed approaches cannot gain group trust.

This thesis specifically investigates XML standardization methods for various categories of unclassified data to provide secure information exchange among a wide audience, e.g., multi-agency task force or multinational coalition partners. Using an XML document-centric approach is a helpful organizing principle for this problem that provides levels of security consistent with common business practices achieved, within the constraints of the respective organizational security policies of each participant. The resulting design patterns for XML document development enhance confidentiality, integrity, and authentication commensurate with the nature of the unclassified document generated, while maintaining information objects at an appropriate level of security and an acceptable level of risk.

KEYWORDS: Extensible Markup Language, XML, Extensible Markup Language for Transformations, XSLT, Extensible Markup Language Security, Extensible Markup Language Encryption, Extensible Markup Language Digital Signature, Extensible Markup Language Authentication

MASTER OF SCIENCE IN OPERATIONS RESEARCH

TRI-LEVEL OPTIMIZATION OF CRITICAL INFRASTRUCTURE RESILIENCE

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Researchers introduce a new way to perform network analysis on critical infrastructure that is superior to the risk analysis and management for critical asset protection (RAMCAP) model currently used by the Department of Homeland Security. The idea of a design–attack–defend (DAD) model that determines the optimal defense plan for a critical infrastructure network within a specified budget constraint is introduced. Design–attack–defend first determines worst-case attacks and then determines where to defend or build additional infrastructure that will maximize the surviving efficiency of the infrastructure after a malicious attack or natural disaster. DAD ensures that the defense plan suggested is optimal to a range of attacks, out of all possible defense plans, within budget constraints. The design–attack–defend model will always give a solution at least as good as RAMCAP and as a simpler, bi-level attacker–defender model—and in many cases it can be expected to suggest a better plan for where to defend or build additional critical infrastructure. A model of the western U.S. railroad network is used as a demonstration.

KEYWORDS: Network Analysis for Critical Infrastructure, Attacker-Defender Model, Design-Attack-Defend Model

MODELING THE EFFECTS OF A TRANSPORTATION SECURITY INCIDENT ON THE COMMERCIAL TRANSPORTATION SYSTEM

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A modeling tool is developed to represent freight-container flows and the potential changes in cost of those flows inflicted on the U.S. commercial transportation system by a transportation security incident (TSI). The model includes available data on container movements, origin-destination (O-D) matrices for international container flows entering or leaving the U.S., and development of an attacker–defender model to determine best contingency plans after a TSI. A multi-commodity network-flow model is designed, representing flows between foreign countries and North American ports, the modal volumes into and out of each port, and volumes between each port and the 84 U.S. transportation-analysis zones. Each O-D flow is a commodity with a specified origin and destination. Subject to constraints on total flow volume over the arcs, these commodities flow through the network at minimum cost. The model finds paths through the network for containers to minimize their total transportation costs and identifies a set of the most critical infrastructure components of the commercial-container transportation system that could be affected by a transportation security incident. This tool can help decision makers identify critical components to improve security and capacity on existing commercial-transportation infrastructure in an environment with limited available funding.

KEYWORDS: Transportation Security Incident, Container Shipping, TEU Shipping, Bimodal Transportation, Over Land Transportation, Truck Transport, Rail Transport, Optimization, Operations Research, Linear Programming

OPERATIONS RESEARCH

AN ANALYSIS OF NAVY FLIGHT-SCHEDULING METHODS USING FLYAWAKE

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Sleep-related fatigue has negative effects on both human performance and decision making. Pilots are particularly vulnerable to these adverse effects due to environmental and operational requirements that entail both long and irregular duty cycles.

The Air National Guard received funding from Office of the Secretary of Defense, Defense Safety Oversight Council to create FlyAwake, a software application that predicts aircrew fatigue based on circadian cycles. FlyAwake uses the Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) Model and calculates predicted effectiveness. Recently, contract modifications have permitted integration with the U.S. Navy’s Sierra Hotel Aviation Readiness Program (SHARP) as an operational risk management (ORM) tool. Naval aviation does not currently use fatigue modeling as part of operational flight scheduling; it is the intent of this thesis to provide a proof-of-concept analysis of FlyAwake for Commander, Navy Air Forces (CNAF).

In order to validate FlyAwake, flight schedules from February 2008 are collected from the Helicopter Antisubmarine Squadron Light Four Two (HSL-42) SHARP database. A statistical analysis compares fatigue levels of aircrew using conventional scheduling methods against those with fatigue modeling; improved fatigue-based performance effectiveness is shown with the utilization of FlyAwake.

KEYWORDS: FlyAwake, SHARP, Fatigue, Performance Effectiveness, Sleep, Shift Work, Continuous Operations, Sustained Operations, ORM

OPTIMIZING THE AIR-TO-GROUND KILL CHAIN FOR TIME-SENSITIVE TARGETS

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When groups of platforms, sensors, and weapons are able to communicate with each other in real time, they form a network. Modern warfare increasingly involves network-centric operations, the military strategy that seeks to translate informational advantages gained through the cooperation of all platforms in the network into increased overall mission effectiveness. For this thesis, time-to-kill is the metric to quantify mission effectiveness because a given time-sensitive target is vulnerable to attack only for a very short time. This thesis develops an optimizing heuristic kill chain assessment tool, “KCAT,” that rapidly identifies capability gaps and generates guaranteed feasible schedules that minimize time-to-kill for a given air-to-ground strike scenario. KCAT allows warfare analysts, budget programmers, and mission planners to quantitatively examine the value of network-centric warfare in time-sensitive targeting scenarios. In addition to optimizing existing platform and weapon network effectiveness, KCAT allows experimentation with future concepts and capabilities that are important for informing procurement and training decisions.

KEYWORDS: Kill Chain, Air-to-Ground, Optimization, Makespan, Time-Sensitive Targeting

OPERATIONS RESEARCH

A MANPOWER COMPARISON OF THREE U.S. NAVIES: THE CURRENT FLEET, A PROJECTED 313 SHIP FLEET, AND A MORE DISTRIBUTED, BIMODAL ALTERNATIVE

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A study conducted by the faculty at the Naval Postgraduate School entitled “The New Navy Fighting Machine” (NNFM) proposes a new fleet design with 677 ships. The study speculates that the manning would not be greatly different from the present Navy of 280 ships or the planned fleet of 313 ships. The purpose of this thesis is to determine whether the study’s conjecture is true by comparing the manpower requirements of the three fleets as rigorously as data and statistical methods will permit.

Manpower estimates of existing ships, ships being designed and procured for the planned future Navy, and non-existent ships proposed for the NNFM are developed through various methodologies.

A manpower baseline of 134,708 is calculated for the current ship inventory. Although the 313-ship Navy has more ships, the manpower afloat decreases to 130,810. The NNFM design requires an even lower manpower number of 121,318 for even more ships. Manpower is also more widely distributed. Fifty-six percent of its total afloat manpower is designated to blue-water missions, twenty-one percent are allocated to green water vessels, and seven percent to the submarine force. This long-term manpower information can provide valuable insight for future U.S. Navy fleet composition, size, requirements, and limitations.

KEYWORDS: Manpower, Crew Size, Manning, 313 Ship Navy, New Navy Fighting Machine, NNFM, Requirements

EVALUATING THE IMPACT OF THE FULLY BURDENED COST OF FUEL

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This thesis motivates and defines the concept of fully burdened cost of fuel (FBCF), assesses Department of the Navy major defense acquisition programs potentially impacted by FBCF estimates, and applies an experimental methodology developed by OUSD(AT&L) to estimate and analyze the FBCF of a notional capability.

This analysis shows that there are potentially large variations in energy-related costs (burdens) associated with the required fuel-delivery assets, the supporting infrastructure and associated manpower, and the assets providing force protection and security to the fuel-delivery assets in both peacetime and operational scenarios.

Recommendations for follow-on studies are provided.

KEYWORDS: Fully Burdened Cost of Full, FBCF, Energy, Analysis of Alternatives, AOA, Acquisition, Life-Cycle Costs, LCC

THE USE OF PROBABILISTIC TOPIC MODELS FOR SEARCH

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This thesis solves a common issue in search applications. Typically, the user does not know exactly which terms are used in a document he is searching for. Several attempts have been made to overcome this issue by augmenting the document model or query. In this thesis, a probabilistic topic model augments the document model. Probabilistic document models are formally introduced and inference methods are derived. It is shown how these models can be

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used for information-retrieval tasks and how a search application can be implemented. A prototype is implemented, and the implementation is tested and evaluated based on benchmark corpora. The evaluation provides empirical evidence that probabilistic document models improve the retrieval performance significantly, and shows which preprocessing steps should be made before applying the model.

KEYWORDS: Document Modeling, Information Retrieval, Semantic Search, Bayesian Nonparametric Methods, Hierarchical Bayes

A COMPARATIVE ANALYSIS OF COMMERCIAL, OFF-THE-SHELF NAVAL SIMULATIONS AND CLASSIC OPERATIONS-RESEARCH MODELS

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No longer does naval surface warfare merely entail battle between symmetric naval fleets conducted in large, open-water engagements. Today's surface warriors must have the training and capability to also fight asymmetric threats in congested locations of strategic value. Operations conducted within straits, choke points, and island-cluttered littorals pose considerable risk and numerous challenges for today's Navy. Shore-based anti-ship missiles, torpedo- and missile-carrying small, fast, patrol boats, and mines present capable threats across naval warfare areas such as anti-surface warfare and mine warfare. In addition, conventional and midget submarines present an ever-growing threat within strategic littorals.

Previous studies have generated high-end simulations to determine the composition of blue-force fleets and suggested tactics for addressing various modern threats. This thesis compares how well off-the-shelf simulation software, in the form of Larry Bond's HARPOON3 Advanced Naval Warfare (H3 ANW), emulates high-end simulations validated through modified Hughes's salvo equations.

The results demonstrate the complexities involved in comparing the output of two completely different analytical tools. The mathematical nature of Hughes's salvo equations provides a focused deterministic aspect; while the dynamic interaction of platforms, environments, and tactics designed into H3 ANW provides a completely different aspect with potential use as a learning tool for surface warriors.

KEYWORDS: Littoral Combat Ship, Steregushchiy, Iran, Strait of Hormuz, Hughes' Salvo Equations, Harpoon3 Advanced Naval Warfare

A COST-ESTIMATION ANALYSIS OF U.S. NAVY FUEL-SAVING TECHNIQUES AND TECHNOLOGIES

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The U.S. Department of Defense and the U.S. Navy are placing a greater emphasis on energy efficiency. Though the surface fleet comprises only a small percentage of petroleum usage, seemingly small efficiencies gained could yield substantial fuel savings. This thesis follows a process of researching and collecting fuel-saving ideas, developing a method to estimate savings, subjecting calculations to sensitivity analyses by discount factor, and cost of fuel, and creating prioritization listings of ideas based on predicted savings. Six techniques and twelve technology-based initiatives are examined. Calculations are estimated for each idea using inputs from various sources. Sensitivity analysis is performed on the independent variables of fuel price and discount factor and rankings are computed. The prioritized listing of techniques and technologies are stable when subjected to these sensitivity analyses. As expected, greater savings are realized when the cost of fuel is higher or when the discount factor is lower, or both. For several of the practices in this study, fuel savings are shown to be substantial and worthy of consideration despite any involved risk. These findings may be used by decision makers to pursue further testing and evaluation of

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practices and may subsequently be implemented throughout the surface fleet, knowing that savings will remain robust despite fluctuations in fuel prices.

KEYWORDS: Energy Efficiency, Fuel Savings, Cost of Fuel, Discount Factor, Prioritization Listing, Surface Fleet

A UNITED STATES MARINE CORPS PERFORMANCE PRICING MODEL

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Master of Science in Operations Research—September 2009

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Second Reader: Gregory Mislick, Department of Operations Research

The United States Marine Corps' installations and logistics department, located at the Navy Annex in Washington, D.C., conducts the sustainment-program evaluation board as part of the planning, programming, budgeting, and execution process. One of the functions of this board is to estimate the future funds required to support equipment maintenance worldwide in the Marine Corps. Since these estimates compete with other USMC funding needs, they must be based on reliable data using defensible methodologies.

In support of installations and logistics priorities, the department needs to improve the defensibility of its estimates in the current budgetary environment. The Assistant Deputy Commandant, Installations and Logistics, Headquarters Marine Corps, located at the Navy Annex in Washington, D.C., has requested this study to develop pricing models for operating and crew, field levels, and the sustainment level of maintenance in order to predict maintenance funding requirements at the Marine forces level. The inputs include historical inventory quantities for MARFOR equipment and corresponding cost data for each echelon of maintenance.

KEYWORDS: Maintenance, Ground Equipment, Descriptive Statistics, Table of Authorized Material Control Number

PLANNING THE OPTIMAL TRANSIT FOR A SHIP THROUGH A MAPPED MINEFIELD

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Master of Science in Operations Research—September 2009

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This thesis develops: a) a mission-planning tool for a Navy mine countermeasure (MCM) force to find a minimum-risk route for a surface ship through a mapped minefield, and b) a heuristic to identify a sequence of mines whose removal leads to a rapid reduction of the risk of a minimum-risk path. All modeling concepts reflect the requirements of the Republic of Chinese Navy's MCM operations.

The problem is formulated and solved as a shortest-path problem in a network. A grid of nodes, representing waypoints, is embedded in a representation of the operating area, while arcs are created to link waypoints. The risk function is defined in terms of the closest point-of-approach distance between each mine that falls within a maximum danger radius along a route.

A complete planning tool is implemented using Excel and Visual Basic for Applications. A basic test scenario describes an operational area of 1000 by 3000 yards containing 30 mines; node spacing is 100 yards. The minimum-risk path is found in a few seconds on a laptop computer, while a greedy "mine-disposal list" is found in a few minutes.

KEYWORDS: Shortest-Path Algorithm, Mine Countermeasure Warfare, Optimal Routing

OPERATIONS RESEARCH

COUNTER PIRACY: A REPEATED GAME WITH ASYMMETRIC INFORMATION

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This thesis presents a model of a counter-piracy operation, where a task force has one operational asset (a destroyer) and one reconnaissance asset (an unmanned, aerial vehicle) to reduce piracy in a large region. The region is divided into small areas, and each day the pirates operate in one area to hijack commercial vessels to collect ransoms. The information is asymmetric to the two players. The pirates know which area is more profitable, but the task force does not. The task force can use the operational asset to prevent piracy, and the reconnaissance asset to collect information on the profitability of each area. The pirates want to maximize their income over a thirty-day period, while the task force wants to minimize it. The numerical experiments quantify the value of the operational asset and the reconnaissance asset in this counter-piracy operation.

KEYWORDS: Piracy, Game Theory, Bayesian Update

A CONTRASTING LOOK AT NETWORK-FORMATION MODELS AND THEIR APPLICATION TO THE MINIMUM SPANNING TREE

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Master of Science in Operations Research—September 2009

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Networks are prevalent in manmade and natural systems throughout the world. Despite recent efforts to characterize and catalog networks of all kinds, considerably less is known about the forces that drive network formation. For many complex systems, it is unclear whether networks are the result of an explicit effort to achieve some overarching, global-system objective, or if network structure is just a byproduct of local, selfish decisions. In this thesis, network formation models are reviewed and numerical experiments are conducted to contrast their behavior and the structural features of the networks they generate. Researchers focus primarily on problems related to the formation of minimum spanning trees and consider the cost of selfish behavior, more commonly known as the price of anarchy, in network formation. Differences between local, decentralized methods for network formation and their global, centralized counterparts are also explored.

KEYWORDS: Network Formation, Graph Generation, Minimum Spanning Tree, Price of Anarchy

A COST BENEFIT ANALYSIS OF INTEGRATED, COMMERCIAL, OFF-THE-SHELF, ENERGY-RELATED TECHNOLOGIES FOR THE ARMY'S FORCE PROVIDER MODULE

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Master of Science in Operations Research—September 2009

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Second Reader: Barbara Brygider, DoD Contractor

This study evaluates the capability of several energy-efficient and renewable technologies that will potentially improve the operational readiness of the current Army expeditionary-shelter system. The two major motivations of this objective are decreasing the shelter's heavy dependence on generator use and lessening the tactical vulnerabilities in operating the systems in austere environments. Furthermore, this study determines whether a portfolio of these commercial, off-the-shelf (COTS) technologies is a good financial decision and estimates the return on investment (ROI).

The results of this analysis find that the technologies associated with improving the insulation of deployable shelters' systems have the most profound effect in reducing overall generator-fuel consumption. One of the largest

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consumers of generator-produced power is the environmental control units that provide the air conditioning and heating needs for expeditionary field shelters. The insulations evaluated in this study have high annualized returns on investments and payback periods of less than two years.

KEYWORDS: Net Zero Plus, Expeditionary Force Provider Kit, Fully Burdened Cost of Fuel, National Training Center, U.S. Army Soldier Systems Center Natick, Joint Capability Technology Demonstration

AN ANALYSIS OF CHANGE IN POPULATION STANCE ON INFRASTRUCTURE USING A CULTURAL GEOGRAPHY MODEL FOR STABILITY OPERATIONS

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Second Reader: MAJ Jonathan K. Alt, USA

Operations in counterinsurgency (COIN) and stability, security, transition, and reconstruction (SSTR) require a cultural understanding of the population in which they are conducted. TRAC Monterey has embarked on the development of a stochastic, discrete-event simulation model called the Cultural Geography (CG) model, intended to aid the decision maker in understanding the effects of his actions on the local population. The simulation model incorporates theories in social science, along with data pertaining to a specific region, to demonstrate how the population's culture will influence their stance on issues relevant to the region. A preliminary investigation of the capabilities of the CG model is conducted. Techniques in data-mining and experimental design are used to determine the inputs or factors that have a significant effect on the output or results of the model. The methods employed are able to aid in debugging the infrastructure portion of the CG model, and demonstrate the utility of efficient experimental design in developing and exploring simulations that represent human populations. Ongoing, in-depth explorations of the CG and related models will be beneficial as these models are refined, and will help establish the class of questions for which they are suitable.

KEYWORDS: Cultural Geography, Agent-Based Modeling, ABM, Stability Operations, Irregular Warfare, IW, Narrative Paradigm, Theory of Planned Behavior, Design of Experiments, Nearly Orthogonal Latin Hypercube, Simulation Analysis

THE EFFICIENT EMPLOYMENT OF IMPERFECT SEARCH SENSORS IN COMPLEX ENVIRONMENTS

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Master of Science in Operations Research—September 2009

Advisor: Roberto Szechtman, Department of Operations Research

Second Reader: Johannes O. Royset, Department of Operations Research

Defense planners must strive to develop and incorporate new, efficient procedures to allocate scarce resources in varied, complex environments. Two discrete-time, discrete-space, search-effort allocation situations are considered. Both involve the employment of an imperfect sensor, which is subject to both false-positive and false-negative errors. The area of interest, comprised of several disjoint area-cells, contains a single target of interest. In the first situation, the target moves according to a Markovian transition matrix, which is unknown to the sensor operator. The objective is to estimate the target's steady-state distribution, using only the sensor's detection signals and knowledge of its false-positive and false-negative rates. The second situation considers a stationary target, wherein the objective is to determine the area-cell occupied by the target in the fewest expected number of investigations, to within certain operator-prescribed error tolerances. An adaptive algorithm based on stochastic approximation for the first situation is developed, and it is shown that the resultant rate of error in determining target presence/absence in any area-cell converges to zero at the fastest possible rate. A sequential elimination procedure for the second situation is proposed, which provides an efficient determination of target location and guarantees its error rate not to exceed the operator-prescribed tolerance.

KEYWORDS: Search Theory, Stochastic Search and Optimization, Stochastic Approximation, Sequential Analysis, Markov Motion

MASTER OF SCIENCE IN PHYSICAL OCEANOGRAPHY

LONG-RANGE ATMOSPHERE-OCEAN FORECASTING IN SUPPORT OF UNDERSEA- WARFARE OPERATIONS IN THE WESTERN NORTH PACIFIC

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Master of Science in Meteorology–September 2009

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CDR Rebecca Stone, USN, Department of Oceanography

Skillful, long-range forecasts of acoustic variables have the potential to be very useful in planning Navy undersea-warfare operations. This study assesses the potential to predict sonic layer depth (SLD) in the western North Pacific at lead times of one to several months. Correlations between SLD and remote climate-system variables are conducted, and a high potential for skillful, long-range forecasts of SLD in the western North Pacific using sea surface temperature in the equatorial and South Pacific as predictors is identified. Tercile matching and composite analysis forecast (CAF) methods are used to develop hindcasts and forecasts of SLD based on SST predictors at lead times of one to four months. The forecast verification metrics show that the resulting long-lead probabilistic forecasts are a clear improvement over presently available, long-term, mean climatology products. Conditional compositing techniques are also used to create mean and environmental threshold probability products based on the long-lead forecasts.

Results indicate that the support of undersea warfare operations by the Navy meteorology and oceanography community could be improved by the use of advanced climate data sets, climate analysis, and long-range forecasting methods.

KEYWORDS: Sonic Layer Depth, Undersea Warfare, USW, Military Operations, Planning Timeframe, Anti-Submarine Warfare, ASW Western North Pacific, Climate, Climatology, Climate Analysis, Climate Prediction, Smart Climatology, Conditional Climatology, Long Range Forecast, Statistical Forecast, Simple Ocean Data Assimilation, SODA, Meteorology, Oceanography

DETERMINING ROUTE-SURVEY PERIODICITY FOR MINE WARFARE: AN INVESTIGATION OF BEDFORMS, WAVES, TIDES, AND CURRENTS

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Master of Science in Physical Oceanography–September 2009

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To retain maritime security, an up-to-date database of mine-countermeasures route surveys is essential. In 2005, the United Kingdom Hydrographic Office (UKHO) developed a GIS-weighted suitability model to determine survey periodicity, allowing optimization of survey resources and increasing time and cost efficiency. The U.S. currently has no such model. Bedforms are an integral part of the survey periodicity problem. Sediment grain size, tides, currents, and wind-generated waves are influential in bedform formation. In this thesis, San Francisco Bay is chosen as a case study. To investigate whether sediment properties change over time, localized grab samples for a three-year period are analyzed. The analysis shows little variability in sediment characteristics at a given location. A weighted suitability model based on the UKHO model is constructed. Three layers are developed, including sediment grain size, interpolated from 174 grab samples, tidal and current data from over fifty current stations, and

ripple height inferred from wind-generated wave height. A weighting for each layer is determined. Regions indicating the presence of bedforms are assigned a low survey periodicity; as bedforms reduce, survey periodicity is increased. High-resolution, multi-beam survey data is used as a comparison and validation, and this shows extremely good correlation with the model.

KEYWORDS: Mine Warfare, Route Survey, Bedforms, Waves, Tides, Currents, Survey Periodicity, Sediment Transport, Sediment Dynamics, Bathymetry, GIS, Weighted Suitability Model, San Francisco Bay

MASTER OF SCIENCE IN SPACE SYSTEMS OPERATIONS

NPS-SCAT: ELECTRICAL POWER SYSTEM

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The Naval Postgraduate School solar-cell array tester (NPS-SCAT) seeks to expand the CubeSat knowledge base and provide learning possibilities at the Naval Postgraduate School. This thesis discusses the design, testing, and integration of the electrical power subsystem for NPS-SCAT. The current design will be powered by a commercial, off-the-shelf power system developed by Clyde Space, Ltd. Solar power generation will be via Spectrolab's improved triple-junction solar cells. Satellite Tool Kit (STK) is used to approximate the expected power generation and communication periods while on orbit. The design, building, integration, and testing of the solar panels using NuSil adhesive tape is also discussed. Finally, the operational limits imposed on SCAT operations due to load and power-generation capabilities of the electrical power system are also discussed.

KEYWORDS: Satellite, CubeSat, NPS-SCAT, Solar Cell Tester, Power System, Clyde Space, Spectrolabs, Improved Triple Junction, Solar Power, NuSil

DIDO OPTIMIZATION OF A LUNAR-LANDING TRAJECTORY WITH RESPECT TO AUTONOMOUS LANDING-HAZARD AVOIDANCE TECHNOLOGY (ALHAT)

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The current and expected state of lunar-landing technology is assessed. Contrasts are drawn between the technology used during the Apollo era versus that which will be used in the next decade in an attempt to return to the lunar surface. In particular, one new technology, autonomous landing-hazard avoidance technology (ALHAT), and one new method, DIDO optimization (a pseudospectral optimal-control theory), are identified and examined. An approach to creating a DIDO-optimized lunar-landing trajectory that incorporates the ALHAT system is put forth and results are presented. The main objectives of the study are to establish a baseline analysis for the ALHAT lunar-landing problem, which can then be followed up with future research, and to evaluate DIDO as an optimization tool. Conclusions relating to an ALHAT-imposed concept of operations, sensor scanning methods, and DIDO functionality are presented, along with suggested future areas of research.

KEYWORDS: DIDO, Optimization, Lunar Landing, Trajectory, Autonomous Landing Hazard Avoidance Technology, Terrain Relative Navigation, Hazard Relative Navigation, Hazard Detection and Avoidance, Lunar Surface Access Module

SPACE SYSTEMS OPERATIONS

NAVAL POSTGRADUATE SCHOOL CUBESAT-LAUNCHER-PROGRAM MANAGEMENT

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The purpose of this thesis is to document activities related to managing the design, analysis, construction, testing, and integration of a qualification and, possibly, a flight article in support of the NPS CubeSat launcher (NPSCuL) project. This thesis describes the process, experience, and results of managing the NPSCuL program, including the program budget and schedule, in support of a flight opportunity as early as August 2010. NPSCuL is designed to utilize excess capacity on U.S. launch vehicles to place a significant volume of CubeSats into orbit in a single launch. The NPSCuL will be a secondary payload attached to the launch vehicle via the EELV secondary payload adapter (ESPA) or other compatible launch-vehicle structures. The NPSCuL-Lite, a modified version of the NPSCuL, integrates eight poly-picosatellite orbital deployers (P-PODs) with a deployment sequencer in a simple structure. NPSCuL-Lite will be able to accommodate up to twenty-four units of CubeSat volume. The goal of the NPSCuL project is to improve CubeSat access to space, advance U.S. space technology, and ensure that the next generation of U.S. space professionals will remain on the cutting edge of very small satellite development.

KEYWORDS: NPSCuL, CubeSat, Launcher, P-POD, ABC, Aft Bulkhead Carrier, Centaur, ESPA, Secondary Payload, Program Management

THE USE OF COMMERCIAL REMOTE-SENSING SYSTEMS IN PREDICTING HELICOPTER BROWNOUT CONDITIONS

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Polarimetric synthetic-aperture radar (SAR) data from RADARSAT-2 is analyzed for detection of soils susceptible to helicopter brownout. Helicopter brownout occurs when downwash disturbs the dust and sand beneath the aircraft during takeoff, landing, and low-altitude operations. Brownout may lead to pilot spatial disorientation and loss of control, causing helicopter damage or destruction, as well as personnel injury or death. The likelihood of helicopter brownout is related to soil moisture content, particle-size distribution, and surface texture. This research explores the polarimetric signatures of soils and determines if these characteristics can be used to predict areas that are susceptible to helicopter brownout. Preliminary results show that helicopter brownout regions can be predicted by means of a simple threshold.

KEYWORDS: Radar Polarimetry, Quadrature Polarimetry, Helicopter Brownout

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

ALLOWING THE ADVANTAGED USER IN A NETWORK-CENTRIC SYSTEM TO GET THROUGH THE DISADVANTAGED INTERFACE

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Networks and network-centric systems are a technology and industry that is growing and evolving daily. These systems play an integral part in most companies, industries, organizations, and governments. The United States Navy uses networks and network-centric systems in multiple facets of their daily and long-term operations. Whether on ships, submarines, aircraft, or land-based facilities, the Navy has implemented network-centric systems to take advantage of their processing abilities, organizational structure, information sharing, and other benefits.

Interfaces exist among these complex network-centric systems. These interfaces often present complications and challenges that prevent key personnel from participating in information sharing and data transmissions, often hindering mission success. By taking a systems engineering approach to finding, isolating, and categorizing the factors that create these interface complications, a solution or workaround to these factors can be readily implemented.

This study uses a systems engineering approach to identify those factors that cause disadvantaged interfaces within network-centric systems and provides recommendations to these challenges so that advantaged users (those with real-time, mission-critical information) of network-centric systems can maintain adequate use of their respective network-centric systems for continued mission success.

KEYWORDS: Networks, Systems, Disadvantaged Interfaces, Network-Centric Systems, Mitigating Disadvantaged Interfaces

NAVAL SHIP CONCEPT DESIGN FOR THE REPUBLIC OF KOREAN NAVY: A SYSTEMS-ENGINEERING APPROACH

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This thesis presents a new, systems-engineering-based approach to naval ship concept-design for the Republic of Korean (ROK) navy. The ROK Navy currently uses a traditional approach in concept design. Naval architects focus only on naval-architecture issues, such as speed, range, and displacement; combat-systems engineers focus on the performance of combat systems, weapons, and sensors. This design process creates some integration problems in the late design stage and during construction. For this reason, there is a growing interest in the systems-engineering-approach design-concept in the ROK navy.

Naval ship design is an aggregate of engineering, computer science, management, and even strategy and policy. Naval ship engineers should consider not only naval-architecture issues, such as hull form, stability, structure, maneuverability, and propulsion, but also mission needs, effectiveness, cost and risk benefits, and integration with all combat systems. Naval architecture and combat-systems engineering are a part of the design process, and they must

be considered simultaneously with a systems-engineering approach to combatant ship design. To properly design a naval ship, engineers should consider how each of the systems combines optimally into a system of systems.

The resulting process focuses on the systems-engineering process applied to naval combatant design. Two systems-engineering-based, naval concept-design processes, one from NATO and the other from the U.S. Navy's Total Ship Systems Engineering (TSSE) program at the Naval Postgraduate School, are presented. The difference between the concept-design process in the ROK navy and the TSSE processes is studied. Based on the above studies and comparison of the processes, a new concept-design process is proposed for the ROK navy. Finally, the Future Frigate (FFX) case study is performed using the newly proposed concept-design process.

KEYWORDS: Naval Combatant Ship, Concept Design Process, Systems Engineering Approach, System Architecture, Ship synthesis, OMOE, Optimization, FFX Case Study

TEMPO SOFTWARE MODIFICATIONS FOR SEVER EVALUATION

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In this thesis, researchers present a software-package update facilitating the evaluation of the systems-engineering value equation with risk (SEVER) using the TEMPO military-planning game originally developed by General Electric in the 1960's and currently used by Naval Postgraduate School to train future military decision makers in making critical resource-allocation decisions. The intent of this development lies in ultimately creating a software decision tool adaptable to different software-based resource-allocation models such that decision makers are presented with customized, relevant information for both "satisfaction" and "optimization" decisions, along with their evaluated probability of successful outcome prior to executing the decision and observing the effects. The software package development (identified as Tempo Version 3) involves porting software code from C++ into Visual Basic.NET, integrating MATLAB code for mathematical strategy execution, conducting post-processing, and allowing for future strategy generation and statistical analysis to compare against SEVER-predicted outcomes. SEVER is the algorithm proposed by Langford and Hyuhn (2006) that facilitates systems-engineering decision-making. TEMPO Version 3 is the particular software application proposed to evaluate the SEVER algorithm when it is eventually developed into a software package. SEVER is not implemented; however, it is considered during the development of the updated software package.

KEYWORDS: Decision, Decision Analysis, Decision Process, System Engineering Tool, SEVER, Resource Allocation, Military Planning, Software Tool, Strategy Evaluation

CVN-68 CLASS DISPLACEMENT CONCERNS: DEALING WITH THE DIFFERENCES BETWEEN THE MODELED AND ACTUAL DISPLACEMENTS

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The purpose of this thesis is to determine whether CVN-68 class aircraft carriers are actually exceeding displacement limits based on NAVSEA projections. The NAVSEA projections are based on commissioning displacement plus any weight added to the ship during subsequent availabilities. The NAVSEA data is augmented with historic displacement values collected from all commissioned CVN-68 class aircraft carriers. Analysis reveals that the NAVSEA projections are predicting the carrier's displacement at ~4,500LT heavier than what is being reported by the ships. The result is a recommendation to conduct an actual-operating-conditions (AOC) displacement check in order to update the NAVSEA displacement projections. By doing so, maintenance associated with weight removal will be minimized, a potential cost saving will be seen, and restrictions placed on ship maintainers will be reduced because a realistic operating condition will be known.

KEYWORDS: Naval Architecture, Aircraft Carrier Displacement Models

INCORPORATING MULTI-CRITERIA OPTIMIZATION AND UNCERTAINTY ANALYSIS IN THE MODEL-BASED SYSTEMS ENGINEERING OF AN AUTONOMOUS SURFACE CRAFT

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This thesis presents an effective methodology and toolset that explicitly consider technological uncertainty to enable the design, development, and assessment of alternative system-concept architectures for an autonomous, unmanned, surface vessel (USV) in a system-of-systems (SoS) context.

Complex system designs often fail due to poor communication of customer needs and inadequate understanding of the overall problem. This frequently results in the design team missing the mark in transforming requirements into a successful conceptual design. Effective system design requires a defined, flexible, and structured context within which new technological ideas can be judged. Alternative physical architectures are then modeled, simulated, and compared to find the best solution for further examination.

Using model-based systems engineering (MBSE) principles and a derived, multi-criteria, decision-making (MCDM) model allows designers to perform a solution-neutral investigation of possible alternative physical-architecture concepts. This ensures a consistent, quantitative evaluation of warfighting capability, suitability, effectiveness, technology maturation, and risk before and during program execution. This effort is in support of an extended program to design a system of unmanned systems intended to provide the Department of Defense with a coordinated, multi-domain, multi-mission, autonomous security and warfighting asset.

KEYWORDS: Autonomous, Unmanned Vehicle, USV, UV Sentry, Model-Based, Multicriteria, Model-Based Decision Making, MCDM, Unmanned Surface Vessel, Model-Based Systems Engineering, MBSE, Uncertainty

SECURITY CONSIDERATIONS FOR NETWORK-CENTRIC WEAPON SYSTEMS

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Second Reader: Theodore D. Huffmire, Department of Computer Science

This thesis describes the security risks for network-centric weapon systems as a combination of different aspects of security, each with its own threats and mitigation strategies. Computer and network security deals with cryptography, authentication, and attacks on software. Information security deals with the ability of the system to process information of different classifications, but prevent disclosure to unauthorized users. Physical security ranges from hardware destruction to reverse engineering of captured hardware. Operational security covers the inability of covert units to transmit to the network without compromising their positions. Personnel security discusses the ways that people can intentionally or accidentally weaken the system during development or operations.

Security of network-centric weapon systems is now a system-of-systems (SoS) engineering problem; system developers must therefore embrace a systems-engineering approach to security and consider all the threats and vulnerabilities facing the system. This examination must include the technical characteristics of the components, the people who operate and maintain the system, and the requirements of the mission. Only by mitigating the most efficient attacks on the system, regardless of the type of attack, can developers maximize the overall security of the system.

This thesis provides guidance for developers, operators, maintainers, and project managers of network-centric weapon systems to help them preserve system security through the lifecycle of the system. It also provides material for future network-centric track classes in the network-centric, systems-engineering program at the Naval Postgraduate School.

SYSTEMS ENGINEERING

KEYWORDS: Network-Centric, Weapons Systems, Systems Engineering, Security, Cryptography, Authentication, Espionage, Sabotage, Confidentiality, Integrity, Availability

A SYSTEMS-ENGINEERING SURVEY OF ARTIFICIAL INTELLIGENCE AND SMART-SENSOR NETWORKS IN A NETWORK-CENTRIC ENVIRONMENT

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Deborah Goshorn, MOVES Institute (Modeling, Virtual Environments, and Simulation)

Second Reader: Eugene Paulo, Department of Systems Engineering

The implementation of network-centric warfare (NCW) and network-centric operations (NCO) is of paramount importance to the Department of Defense. Fundamentally, the key to implementing NCW and NCO is to accurately obtain and analyze information critical to the warfighter. Additionally, the proliferation of sensors, in both type and number, makes it apparent that there will simply not be enough military personnel to monitor, analyze, and synthesize all pertinent data. It is apparent that a smart-sensor network, or a network of sensors with data analyzed by artificial intelligence (AI), is needed to attain full realization of network-centric operations.

This thesis presents a survey of the information required for individuals who will be involved in the design and acquisition of smart-sensor networks, with a focus on systems engineering. The foundations of smart-sensor networks are in artificial intelligence (AI), distributed AI, multiagent systems, sensor basics, and data fusion. In addition to an examination of the previous topics, this thesis examines what must be done to further the preparedness of systems engineers to better understand and design smart-sensor networks.

KEYWORDS: Smart Sensor Networks, Artificial Intelligence, Distributed Artificial Intelligence, Multiagent Systems, Network-Centric Warfare, Network-Centric Operations, Systems Engineering, Network-Centric Systems Engineering, System of Systems

A RECOMMENDED FRAMEWORK FOR THE NETWORK-CENTRIC ACQUISITION PROCESS

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Second Readers: Greg Miller, Department of Systems Engineering

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Network-centric warfare (NCW) is a theory of war in the information age that hypothesizes that forces which exploit networked conditions better than their adversaries will achieve tactical advantage. Understanding how network-centric systems (NCS) that support NCW are acquired is essential for the continued development and delivery of systems that are affordable, meet end-user requirements, and can be fielded quickly.

The network-centric acquisition process (NCAP) will enable the Department of Defense to deliver NCS that are quickly fielded and that leverage the use of leading-edge technologies.

The NCAP incorporates the systems-engineering approach for system design and also maximizes the use of industry best practices. The envisioned NCAP will use, among other things, a central repository of design information (including software, system drawings, etc.) that can be accessed, or pulled, by system-development teams and modified to support specific system needs. The NCAP will use an electronic business (e-Biz) marketplace portal where developers and consumers can be matched-up in order to share their products or make needs known, and where NCS evaluations are available for review by interested consumers.

This thesis clarifies network-centric systems acquisition and explores the benefits that the NCAP would provide.

SYSTEMS ENGINEERING

KEYWORDS: Network-Centric, Network-Centric Acquisition, Net-Centric Acquisition, Netcentric Acquisition, Network-Centric Acquisition Process, NCAP, Systems Engineering, Systems Engineering Processes, SE, Network-Centric Systems, Netcentric Systems, Network Centric Warfare, Netcentric Warfare

MASTER OF SCIENCE IN SYSTEMS ENGINEERING MANAGEMENT

INTEGRATING TEST AND EVALUATION INTO THE ACQUISITION PROCESS FOR NAVAL AVIATION

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Test and evaluation is incorporated throughout both the systems engineering and Department of Defense (DoD) systems-acquisition processes. It is the mechanism for accomplishing verification in the systems-engineering process and characterizing the technical risk of achieving a proper final-design solution. Test and evaluation is a critical and continuous activity throughout the DoD systems acquisition process; it ensures that cost, schedule, and performance requirements are satisfied with acceptable levels of risk.

Guidance for the integration of test and evaluation into the systems acquisition process for naval aviation flows from federal law, to the Department of Defense, to the Department of the Navy, to the Naval Air Systems Command, to be implemented through Naval Air Systems Command policy and guidance.

This thesis analyzes this test and evaluation-related guidance, along with interview results from senior acquisition professionals, to identify areas of weakness that exist regarding integrating test and evaluation into the systems acquisition process for naval aviation. Ten specific recommendations for improving test and evaluation policy and guidance, training, and tool development are provided.

KEYWORDS: Test and Evaluation, Naval Aviation, Acquisition, NAVAIR, Policy, Guidance

A STUDY ON IMPROVING DEFENSE ACQUISITION THROUGH THE APPLICATION OF THE DEFENSE ACQUISITION WORKFORCE IMPROVEMENT ACT (DAWIA) CONCEPT TO THE DEFENSE-INDUSTRY WORKFORCE

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The Department of Defense believes that the acquisition workforce is the most important asset in assuring long-lasting reform of the defense acquisition system and optimizing the expenditure of ever-decreasing acquisition resources. The Defense Acquisition Workforce Improvement Act (DAWIA) is the basis of defense acquisition-workforce policy. As a part of the FY1991 National Defense Authorization Act, the DAWIA requires the DoD to establish and manage career development through the establishment of education and training standards, requirements, and courses for the DoD civilian and military acquisition workforce.

Defense-acquisition leadership in general recognizes that cross-organizational collaboration and disciplined communication are pivotal to successful program acquisition. However, they have not yet completely grasped the control and management of defense industry establishments and activities. The DoD and the defense industry have yet to recognize how much they know and do not know each other. This thesis evaluates the DAWIA principle, investigates the adaptation of the DAWIA concept to the defense-industry establishment, and provides recommendations to the defense-acquisition community.

KEYWORDS: Defense Acquisition, Defense Acquisition Workforce, Defense Acquisition Workforce Improvement Act, Certification, Professionalization, Workforce, Defense Industry Workforce, Program Management, Project Management

AN EXPLORATORY ANALYSIS OF THE U.S. SYSTEM OF MAJOR DEFENSE ACQUISITION UTILIZING THE CLIOS PROCESS

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For decades, the United States' major defense-acquisition system has been under scrutiny and has undergone significant reform. Groups have researched the issues, publishing hundreds of reports identifying various problems and solutions. Yet many major weapon systems continue to be well over budget and schedule. Major weapon systems are increasing in size, scope, and complexity. Technology is rapidly changing. Customer expectations are rising. Societal concerns, such as workforce and economic development, are playing a bigger role. Politics are rampant in this system. This system qualifies as a CLIOS system—complex, large-scale, interconnected, open, and sociotechnical in nature.

This thesis explores and analyzes the decades of research concerning U.S. major weapon-systems acquisitions and applies the CLIOS process. Of the three stages within the CLIOS process, this research applies the representation stage to the U.S. major defense-acquisition system. The observations afforded from the analysis are that long-term decisions are made with short-term information, and multiple stakeholders and decision makers facilitate little accountability. Three strategic alternatives are identified: 1) create an integrated process team to make joint, long-term decisions, 2) mandate a federal systems-engineering organization, and 3) create a hybrid between the first two for instilling accountability at all levels.

KEYWORDS: Acquisition, Military Expenditures, Major Weapon Systems, CLIOS, Major Defense Programs

COLLABORATIVE, ONLINE COMMUNITIES FOR INCREASED MILSATCOM PERFORMANCE

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The Department of Defense and the U.S. Navy have embraced a strategy of exerting influence through information dominance versus amassing a large presence. This philosophy, called net-centric warfare, uses sensor and network technology to leverage naval platforms towards realizing effects previously achievable only by a larger force.

In adapting this strategy, the U.S. Navy has realized many benefits, but has also increased its reliance on the technologies implementing net-centric warfare. One such technology is the Navy's future military SATCOM terminal, the Navy multiband terminal (NMT), which will provide the critical, off-ship bandwidth required for these leveraging effects. The Navy plans to sustain the NMT system using the same methods as previous systems.

When considering operational availability, these legacy methods do not adequately address attributes affecting system performance, creating a risk that the NMT system will not perform as needed to successfully execute net-centric warfare. This risk can be managed by transitioning away from traditional methods to those utilizing online, collaborative technologies. These technologies, coined "Web 2.0," center around member participation to foster communities. Much like the philosophy of net-centric warfare, these communities leverage the experience of individuals to the benefit of the entire community.

KEYWORDS: Operational Availability, Net-Centric Warfare, Communities, Online, Web 2.0, Sustainment, Military SATCOM, NMT

SYSTEMS ENGINEERING MANAGEMENT

RISK QUANTIFICATION OF SYSTEMS-ENGINEERING DOCUMENTS IMPROVES PROBABILITY OF DEPARTMENT OF DEFENSE PROGRAM SUCCESS

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A frame-transition problem exists between project systems engineers (SE) and Department of Defense (DoD) program managers (PMs). Systems-engineering organizations, operating in a rational frame, must produce systems-engineering documents required for the PM operating in a political frame of constrained resources. These artifacts, required for milestone reviews, are the result of extensive technical effort that must be accounted for and adequately resourced during project planning by the PM. Programs cannot progress through the DoD acquisition framework if these statutory and regulatory documents are not completed on time and of acceptable technical quality, which is determined during a complicated, multi-organization review process. By providing the PM and DoD decision makers with a quantified risk-assessment methodology during project planning, these key artifacts can be included in initial-program, risk-assessment activities. This thesis provides the methodology for developing a comprehensive risk model for DoD milestone documentation and presents recommendations for changes to the Capability Maturity Model Integration (CMMI) project-planning and risk-management process areas. The intent is to use risk as the common ground between the DoD PM and SE, so that each can operate within their environments with a common and consistent understanding of risk.

KEYWORDS: Risk Quantification, DoD Milestone Documentation, Project Planning, Rational Frame, Political Frame, CMMI Project Planning Process Area, CMMI Risk Management Process Area, Information Support Plan, ISP

IMPROVING AND INCREASING THE EFFICIENCY OF THE P-8A TEST WORK DESCRIPTION PROCESS

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This purpose of this study is to identify opportunities to improve the P-8A test working description (TWD) process in support of the P-8A test program. This study researches other NAVAIR test programs that use a contractor and government integrated test approach. This study determines the proper balance of improvements to support the approval of TWDs to keep pace with the testing. The process is functionally decomposed to look for process redundancies, choke points, and out-of-sequence subprocesses. Two changes are identified and implemented that reduce the process from five phases to four.

Corel's iGrafx software is selected to model the process. The model varies TWD development time and test-team resource level to analyze alternative TWD development-process concepts. Alternatives examine excursions from a baseline condition that is limited by the existing team resource level (the lower bound) to an upper bound that assumes unconstrained resources. The upper-bound conditions represent the earliest time the TWDs could be completed. Additional alternatives are analyzed until an "optimal" resource level is found that would support the test program.

It is recommended that this type of modeling be applied to other test programs and systems-engineering processes to improve their efficiency.

KEYWORDS: Test Working Description, Modeling, Test Team Resource Level, Process Redundancies, Process Efficiencies

SYSTEMS ENGINEERING MANAGEMENT

ELECTROMAGNETIC-COMPATIBILITY REQUIREMENTS FOR MILITARY AND COMMERCIAL EQUIPMENT

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Until approximately 1970, radio-frequency (RF) requirements were driven by military use, and electromagnetic-compatibility (EMC) efforts were conducted by the military and a few select industries. This was largely due to the fact that limited applications and high costs had kept the use of consumer electronics to a minimum.

The past three decades, however, have seen a fundamental shift in the status quo. Starting with the emergence of the microprocessor in the mid-70s, commercial applications began to take the lead in technology development, and the consumer market has grown exponentially.

Widespread use of electronics in both the military and private sectors has impacted the available use of the RF spectrum. As the demands for connectivity continue to grow, wireless capabilities are competing for the bandwidth necessary to handle the expanding flow of information society has come to expect. As consumer usage has come to drive electronic development, the military also finds itself in the position of adopting and adapting commercial technology.

This study examines the origins of the military and commercial requirements that regulate EMC, evaluates the adequacy of these requirements with respect to current spectrum demands, and investigates the potential for harmonizing military and commercial EMC assessments.

KEYWORDS: Electromagnetic, Interference, Compatibility, EMC, EMI, Spectrum, RF, Frequency, COTS, MIL-STD-461, MIL-STD-464, Vulnerability, Electric Field, Radiated Emissions, Radiated Susceptibility, Radiated Immunity, CFR 47, Part 15

DEVELOPMENT OF A COST-EFFECTIVE ORGANIZATIONAL MODEL FOR THE SHIPBUILDING-WELDER LABOR WORKFORCE

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For the past twenty-five years, the United States shipbuilding industry has experienced a slow decay in both hiring and retaining critical-skilled professionals. One of the most critical skills required to fabricate a ship is welding, as welders play a major role in shipbuilding, from prefabrication to delivery. Many factors can be identified with the cause of this reduction in the welder workforce, including technology enhancement, outsourcing, growth of optional career opportunities, and family pressure. The latter factor is identified as playing a role in reducing initial accessions within the Department of Defense. Military recruiters have been required to alter their tried-and-true recruitment strategies. Parents who do not wish to see their children subjected to the violence of war or to serve within what they perceive to be a low-return-on-investment career are pushing their children away from military service in favor of continued education or careers in the private sector. This phenomenon is not unlike the pressures that potential welders receive from within their own families.

Shipbuilding is a demanding profession, requiring a level of mental and physical toughness not found in most manufacturing industries. Under the best conditions, commercial welding is challenging; it requires manual dexterity, mental visualization skills, and years of experience. Given the existing conditions in most shipyards, marine welding is even more challenging. These skilled craftsmen work in hot, tight, poorly lit spaces, often working around corners with no clear line of sight to their work. The expectation of first-time, “perfect” quality is hard to meet. For years, shipyards around the country have relied upon third- and fourth-generation welders to replace losses in the ranks caused by attrition. Due to the factors presented in this research, it is clear that these companies must employ new strategies to combat losses in the workforce.

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One such strategy is to better define requirements traceable to period and cumulative scope of work. Formulate a more responsive organizational structure to meet this need so that the right number and the right skill sets can be targeted for recruiting and retention goals. This thesis identifies attributes within military organizations that could aid in the development of a similar organizational model for use in shipbuilding.

KEYWORDS: Manpower, Marine Welder, Organizational Structure, Labor Workforce Development, Requirements Management, Marine Labor Crafts, Trade Union, Gap Analysis

AN INVESTIGATION OF NETWORK-ENTERPRISE, RISK-MANAGEMENT TECHNIQUES TO SUPPORT MILITARY NET-CENTRIC OPERATIONS

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System security and information-assurance requirements and specifications incorporated into the architectural design of a network enterprise must be driven by an adaptable and evolving network-enterprise, risk-management plan. Network risk management must start at concept design and relate to the network's concept of operations. The purpose of this thesis is to examine some of the essential elements necessary in a network-enterprise, risk-management plan for a complex, global, networked system similar to the Global Information Grid (GIG). It compares the current Department of Defense (DoD) framework for risk management with other popular network-risk-management process models. An important but difficult part of risk-management processes is determining the value of network assets. Another important, but overlooked element of risk-management processes is evaluating the network for resiliency—the ability to return to normal in time to prevent the compromise of a mission. The contention is that risk-management planning must include planning for network survivability and resiliency. Selected elementary network architectures are analyzed for attributes of the architectures that promote the information-assurance qualities of confidentiality, integrity, and availability. Finally, recommendations are made for applying important elements of network risk management into the conceptual architecture of a global network.

KEYWORDS: Network Enterprise, Risk Management, Global Information Grid, Network Survivability, Network Resilience, Network Architecture, Attack Tree

MASTER OF ARTS

Security Studies

MASTER OF ARTS IN SECURITY STUDIES

HOW TO PREPARE THE NATIONAL GUARD'S LEADERSHIP FOR A SUCCESSFUL VENTURE IN HOMELAND SECURITY

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The National Guard (NG) will be the first military forces on disaster scenes in the United States. If the NG is to respond as efficiently as possible, NG leadership must be educated on preparation for and response to disasters. Research questions include: to overcome the gap in disaster-response knowledge, what are the topics on which the Department of Defense (DoD) should specifically educate NG leadership? What has caused this education gap and how can NG leaders overcome it? Survey and interview responses reveal that gaps exist in what the NG knows about the state response process and knowledge of what the civilians expect from the military. A review of the existing education opportunities available to the NG shows that none covered the state process. Using the military decision-making process, courses of action are developed to correct this education shortfall. Recommendations include the development of a one-week course to address the state response process, DoD acknowledgment of the civil-support mission, and the assigned and funded ability of the NG to educate and train on civil-support missions.

KEYWORDS: National Guard, Homeland Security, Civil Support, Defense Support for Civil Authorities, Military Support for Civil Authorities, Defense Support to Civil Authorities, Military Support to Civil Authorities, Training, Education, State Mission, National Guard Leadership, Nebraska National Guard

ISLAMIST TERRORIST NETWORKS IN BOSNIA AND HERZEGOVINA

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After the attacks on the United States in September 2001, Bosnia and Herzegovina acquired a reputation as a country that supports international terrorism. This perception was mostly a result of the 1992–1995 war, when foreign fighters tied to Islamist terrorist groups came to support the Bosniaks and spread radical Islam.

This thesis investigates three theories about the development or support of terrorist networks and the radicalization of society and assesses each theory's explanatory power in the case of Bosnia and Herzegovina.

The main research findings include the following: Islamist vanguards have succeeded in attracting some young Bosniaks, who abandoned their traditional beliefs, accepted a more puritan and less tolerant form of Islam, and became potential manpower for Islamist extremists; constant political confrontations among Bosnian and Herzegovinian politicians representing different ethnic groups led to political instability; the country has neither the coercive nor the administrative capacity to provide a safe and stable environment, permitting the development of terrorist cells and affiliates; and even though Bosnia and Herzegovina has a permissive environment where extremist

vanguards promote radical ideologies and call for jihad, the Muslim population generally does not support these groups or extremist violence.

KEYWORDS: Bosnia and Herzegovina, Islamist Terrorism, Islamism, Islamic Radicals, Islamist Extremists, Wahhabism, Alija Izetbegovic, Bosniaks, Active Islamic Youth, Mujahedeen, Jihad

FINDING THE SWEET SPOT FOR CATASTROPHIC-INCIDENT SEARCH AND RESCUE

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This thesis examines the national preparedness for conducting catastrophic-incident search and rescue (SAR) using organization-specific doctrine, concept plans, congressional research reports and testimonies, after-action reviews, periodicals, federal-government plans, interviews, a focus group, and two benchmark studies. The research indicates that individual organizations conduct SAR activities well, but combined-, joint-, and interagency- catastrophic search-and-rescue preparations are lacking. Should another catastrophic incident occur tomorrow, the SAR results will likely exhibit the same unacceptable inefficiency as was found during Hurricane Katrina. It is necessary to find the sweet spot for response to catastrophic incidents. There are three major findings. First, a national strategy for SAR is needed. This epic effort will help improve the interagency coordination between equity holders of the search-and-rescue mega-community and set the conditions for improving catastrophic-incident SAR. Second, a joint air-ground coordination center (JAGCC) is critical to effective response operations. Two benchmark studies suggest a framework for developing a SAR coordination center using experiences of the wildland firefighting community and the United States Secret Service. Finally, domestic and international interagency coordination through integrated strategy development, planning, training, and exercises is needed to improve response operations.

KEYWORDS: Search and Rescue, Catastrophic Incident, Catastrophic Planning, National Search and Rescue Advisory Committee, Integrated Planning, NIFC, National Interagency Fire Center, MAC, National Multiagency Coordination Center, MACC, Multiagency Communications Center, Interagency Coordination, Sweet Spot, USNORTHCOM, United States Northern Command, CI SAR, Catastrophic Incident Search and Rescue, Air Force Rescue Coordination Center, Joint Personnel Recovery Center, Personnel Recovery

LEARNING FROM OUR PAST: HOW A VIETNAM-ERA PACIFICATION PROGRAM CAN HELP US WIN IN AFGHANISTAN

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Weak, failing, failed, and post-conflict states pose one of the greatest national and international security challenges of our day. The stabilization and development of faltering states is in both the short- and long-term interests of the United States because stable states pose fewer security challenges. Afghanistan is a failed state that presents security challenges on a global scale, as well as a classic case study on an insurgency that needs a strong counterinsurgency response.

A successful counterinsurgency needs an explicit strategy for winning the trust and confidence of the local population. Ultimately, the biggest problem is recognizing the importance of human terrain and understanding the population. Currently, operations in Afghanistan are managed at the provincial level. Only operations pushed down to the district and village level can capture these intricacies. This is where and how lessons from the Civil Operations and Revolutionary Development Support (CORDS) program used in Vietnam apply.

CORDS combined the previously separate civilian and military pacification efforts in Vietnam into one program and resulted in what may have been the only truly integrated civilian–military command in U.S. history.

This thesis assesses the lessons learned from fighting a counterinsurgency in Vietnam via CORDS and how they apply in Afghanistan.

KEYWORDS: Civil Operations and Revolutionary Support, Vietnam, Pacification, Afghanistan, Provincial Reconstruction Teams, Counterinsurgency, Stability Operations

COLLECTING AND CONNECTING THE DOTS: LEVERAGING TECHNOLOGY TO ENHANCE THE COLLECTION OF INFORMATION AND THE DISSEMINATION OF INTELLIGENCE

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Developing a national strategy to effectively coordinate information sharing and the subsequent dissemination of intelligence is paramount in domestic efforts to thwart future acts of terror and suppress crime. Past failures illustrate the need for strong and trustworthy partnerships not only between federal, state, local, and tribal law enforcement, but also with relevant partners in the private sector, foreign allies, and other government agencies. Standardizing operations and better utilizing technology will improve the efficacy of this effort and will draw upon the domestic law enforcement community as key players in this endeavor.

The findings and recommendations proffered in this research identify policies and practices that effectively integrate information sharing into all aspects of policing and provide for technological solutions to enhance capabilities for collecting information and disseminating intelligence. Integrating intelligence-led policing into existing community policing strategies also illustrates the utility of both public and private partners in this effort. Ultimately, the enhanced collection of information and the dissemination of intelligence will greatly augment the ability of law enforcement and the myriad of relevant stakeholders to prevent both crime and acts of terrorism.

KEYWORDS: Suspicious Activity Reporting, SAR, Information Sharing, Intelligence-Led Policing, D.C. Metropolitan Police Depart, eGuardian, Federal Bureau of Investigation, Dissemination of Intelligence, Program Management Information Sharing Environment, PM-ISE, Information Sharing Environment, ISE, British Police Service, Joint Terrorism Task Force, JTTF, Joint, Terrorism Analysis Center, JTAC, Domestic Intelligence

BIOWATCH: A CASE FOR A CHANGE OF TRADITIONAL LEADERSHIP TO IMPROVE PERFORMANCE

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An air-monitoring system, Program BioWatch, was introduced in the civilian United States in 2003 to detect an intentional release of a biological agent in a major metropolitan area. As an ambient-air program, BioWatch was assigned to the U.S. Environmental Protection Agency (EPA) to administer at the local level though the state equivalent of the U.S. EPA. Since the BioWatch program is testing for biological agents that can cause illness and death in the human population, there is an obvious roll for public-health involvement in the program. However, over time, the EPA leadership has struggled with the administration of the program, as well as the state EPA programs and efforts with local public-health agencies.

This thesis explores the current assigned leadership of the BioWatch program, primarily at the state and local levels. By using the experiences of the Missouri BioWatch program in St. Louis, a shared leadership is suggested between the state health department and the state EPA to maximize efforts related to the BioWatch program by use of a memorandum of agreement.

KEYWORDS: BioWatch, Public Health, St. Louis BioWatch Program, Ambient Air Testing, Public Health Preparedness

NO DARK CORNERS: DEFENDING AGAINST INSIDER THREATS TO CRITICAL INFRASTRUCTURE

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This thesis identifies defenses against trust betrayers targeting critical infrastructure. Using a Delphi method, the thesis develops insights of experts from more mature arenas of defense against insider threats, such as workplace violence and counterespionage, in order to assist infrastructure stewards with defending against the insider threat to critical infrastructure. The findings uncover flaws in institutional defenses that adversaries can exploit, with infiltrators posing a greater threat than disgruntled insiders. The resulting recommendations run counter to accepted wisdom. These recommendations shape the contours of a "no-dark-corners" approach that applies and extends seminal theories of Newman's defensible space and Kelling's fixing broken windows. "No dark corners" replaces a laser with a flashlight. The laser is a narrow beam of workplace monitoring by corporate sentinels, or security specialists only. The flashlight is a broader beam of employee engagement and monitoring on the frontlines at the team level. There are no easy answers. "No dark corners" shows promise in filling the gaps in traditional insider defenses to deliver the victory of ownership over surprise.

KEYWORDS: Critical Infrastructure Protection, Insider Threat, Trust Betrayers, Infiltrators, Disgruntled Insiders, Defensible Space, Fixing Broken Windows, Employee Engagement, No Dark Corners

MASS CARE (ESF-6) PREPAREDNESS FOR CATASTROPHIC DISASTERS

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Medical providers, patients, and their families have always been able to enjoy the abundance of U.S. society. When medical resources exceed the demand for care, all necessary medical resources are used to improve the health or save the life of each individual. However, the healthcare system in the U.S. is severely underprepared to care for hundreds to thousands of victims simultaneously from a mass-casualty event (MCE). The influx of patients would severely overwhelm emergency rooms. Although global events indicate that the U.S. must prepare, the medical community has historically been uncomfortable openly discussing standards of care during a mass-casualty event because it is equated with the rationing of care. This thesis demonstrates through four case studies that critical mortality is reduced and a greater number of critically injured survive due to improved triage accuracy, rapid movement to definitive care, implementation of damage-control procedures, and coordinated and collaborative regional preparedness. The medical community must appreciate that altering standards of care during an MCE does not reduce overall care rendered; rather, care is strategically directed and critical mortality is lowered.

KEYWORDS: Mass Care, ESF-6, American Red Cross, ARC, Salvation Army, TSA, Southern Baptist Convention, Convoy of Hope, Sheltering, Disaster Shelter, Mass Feeding, Bulk Distribution, Catastrophic Disaster Response, New Madrid Earthquake, Long-Term Recovery Process, National Shelter System, NSS, Multi-Agency

Coordination, Voluntary Agency, Post-Congregate Sheltering Policies, Missouri State Emergency Management Agency

**TELL ME WHAT I NEED TO KNOW: WHAT MAYORS AND GOVERNORS WANT FROM
THEIR FUSION CENTER**

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Mayors and governors who represent high-threat, high-population-density urban areas need strategic decision-making advantages; as such, they should be significant users of fusion centers. These chief executives desire to understand the operating environment for their jurisdictions, where daily risks and threats emerge from the complexities of an integrated world. Paradoxically, as will be outlined through this thesis, there is a lack of robust engagement between fusion centers and mayors and governors. While this thesis does not suggest that executives know nothing about their fusion centers, the lack of direct and regular engagement is problematic given that top elected officials are responsible for leadership and funding decisions that prevent, mitigate, and respond to threats to their jurisdictions. Without engagement, fusion centers struggle to meet executive expectations, and mayors and governors miss critical opportunities to leverage their fusion centers. By addressing this engagement and expectations gap, fusion centers will be better situated to help these busy chief executives develop adaptive, long-term, strategic approaches for preventing, preparing, responding to, and mitigating threats and all hazards in their jurisdictions, where they ultimately are held accountable by their constituency.

KEYWORDS: Mayors, Governors, Chief Executives, Decision Makers, Policy Makers, Executive Engagement, Fusion Centers, Intelligence, Information Sharing, Trust, Senior Staff, Senior Personnel, Local Government, State Government, Strategic Planning, Accountability, Situational Awareness, Risk Communication, Crisis Communication, All Hazards, All Sources, Classified Information, Urban Area Security Initiative

**THE SOUTHERN PHILIPPINES AND THE POLICY OF THE SECOND FRONT IN THE
GLOBAL WAR ON TERRORISM**

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This thesis analyzes the effects of the United States' policy of the second front in the global war on terrorism (GWOT) on the conflict in the southern Philippines. The policy's reliance on intervention measures that are both "preemptive" and "direct" by military means echoes Mearsheimer's argument that "simply put, great powers are primed for offense." The question may be asked: how effective is the second-front policy in terms of resolving the conflict?

The ongoing violence in the southern Philippines, since the policy's inception in early 2002, suggests its ineffectiveness in addressing the root causes of the conflict. This thesis investigates the history of the Moro and the Mindanao conflict to determine the conflict's root causes. On the foundation of the existing theory of conflict resolution, the thesis performs an analysis of past peace processes and provides recommendations for future policy and peace negotiations: a comprehensive peace policy that clearly distinguishes armed terrorists from Islamic separatists with legitimate political grievances and applies direct and indirect approaches accordingly. For future peace negotiations, it is recommended that both the GRP and the MILF concentrate their efforts on building trust and consensus at all levels of society. The thesis concludes with recommendations for future studies.

KEYWORDS: Philippines, Mindanao, Moro, MNLF, MILF, ASG, Terrorism, Muslim Separatism, Conflict Resolution

WAHHABISM: IS IT A FACTOR IN THE SPREAD OF GLOBAL TERRORISM?

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What is the role of Wahhabism in the rise of global terrorism? Is Saudi Arabia and its Wahhabi ideology a contributing factor in the spread of violent radicalization in the Muslim world? What are the possible causal mechanisms linking Wahhabism to violence? How is it possible to ascertain these mechanisms and disentangle them from other sources of radicalization in the Muslim world? Three potential hypotheses may provide answers to these questions: 1) Wahhabism provides passive ideological support for extremism, but is not a sufficient cause of violent radicalization, 2) Wahhabism provides indirect support through the establishment of networks that give material facilitation to extremist groups, and 3) Wahhabism provides direct support to extremists with the approval of the Saudi government. The major finding of this study is that the first hypothesis—Wahhabism is a facilitator but not a direct contributor to violent extremism—is best supported by the evidence. Those who claim that Wahhabism has nothing to do with terrorism underestimate the extent to which the core principles of Wahhabism overlap with the extremist ideology of takfir, and its inherent intolerance toward other creeds can create fertile minds ready to demonize foreigners and even fellow Muslims who are non-Wahhabists. The second hypothesis receives hardly any evidential support, while the third hypothesis has no support at all and amounts to guilt by association.

KEYWORDS: Wahhabism, Saudi Arabia, Terrorism, Jihad, Jihadism, Salafism, Islamism

PRIVACY PROTECTION STANDARDS FOR THE INFORMATION-SHARING ENVIRONMENT

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Created in response to findings of the 9/11 Commission concerning the lack of information sharing as a primary factor in the failure to stop the September 11, 2001, attacks, the Information Sharing Environment (ISE) was mandated by the Intelligence Reform and Terrorist Prevention Act of 2004 (IRTPA). The ISE was intended to build on existing information-sharing systems and promote increased information sharing through the creation of a collaborative culture among a diverse group of participants. Another goal of the ISE is to protect information privacy.

ISE efforts to meet the goal of information privacy protection are stymied by a lack of uniform privacy standards that are equally applicable to all ISE participants. The thesis compares two policy options—voluntarily adopted mandatory standards and federally imposed mandatory standards—to the status quo system of voluntary guidelines. These policy options are evaluated in terms of their effect on collaboration and information sharing, their constitutionality, their consistency and enforceability in application, and political acceptability. Based on projected relative outcomes, this thesis recommends that the ISE adopt a privacy protection system consisting of voluntary standards that, once adopted, become mandatory in application.

KEYWORDS: Information Sharing Environment, Privacy, Collaboration, Constitutionality, Transportation Security Administration, Program Manager Information Sharing Environment, Information Sharing

**RELIGIOUS EDUCATION AND THE PREVENTION OF ISLAMIC RADICALIZATION:
ALBANIA, BRITAIN, FRANCE, AND THE FORMER YUGOSLAV REPUBLIC OF
MACEDONIA**

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This thesis examines the potential contribution of religious education to preventing Islamic extremism in Albania, Britain, France, and the Former Yugoslav Republic of Macedonia (FYROM). The existence of large Muslim populations in each of these four countries, combined with the fact that a growing number of young Muslims have become members of terrorist networks, constitutes a security threat to the whole Western world. In recent years, several terrorist incidents have taken place in all four of these countries. Governments tend to deal with terrorism by adopting counterterrorism policies, which necessitate the use of force. This thesis suggests that religious education, if properly formulated as a preventive measure, may effectively counter Islamic extremism. European institutions, such as the European Union, the Council of Europe, and the Organization for Security and Cooperation in Europe, have provided a substantial legal framework and general principles on how to establish a constructive and socially beneficial religious-education curriculum. If Albania, Britain, France, and FYROM take into account the recommendations provided by these European institutions and implement them along with other positive innovative measures, they may set up an efficient mechanism to prevent Islamic radicalization.

KEYWORDS: Albania, Britain, France, Former Yugoslav Republic of Macedonia, Islamic Radicalization, Religious Education, Terrorism

**HOMELAND SECURITY COLLABORATION: CATCH PHRASE OR PREEMINENT
ORGANIZATIONAL CONSTRUCT?**

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Since September 11, 2001, numerous documents addressing homeland security issues have been produced by various governmental agencies and the private sector. Many of these publications identify a need to create multi-discipline, multi-agency, cooperative environments at all levels of government and within the private sector in order to resolve homeland security problems. Although these cooperative environments are deemed collaboration, a common definition of collaboration is missing from the literature. More importantly, guidance on how to achieve collaboration is also missing from the literature.

This project identifies a common, measurable definition for collaboration. The research identifies existing organizations that address homeland security issues that do not meet the definition of collaboration, but are successful in addressing current problems. Conclusions of this project include: organizations can effectively manage homeland security issues although they have not reached true collaboration; collaboration is the most efficient and therefore the desired organizational structure dealing with homeland security concerns; and future homeland-security publications need to include a definition of collaboration and guidance for achieving collaboration.

KEYWORDS: Collaboration, Guidance, Smart Practices, Community Based Collaboration, Business Executives for National Security, BENS, ChicagoFIRST, Texas Association of Regional Councils, TARC, Responsibility, Authority, Expertise, RAE

CHINA AND JAPAN'S STRATEGIC NUCLEAR RELATIONSHIP

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While China and Japan individually have been the focus of tremendous study, until recently it was not necessary to compare their nuclear relationship. The advent of Japan's ballistic-missile defenses has offered a unique twist on the traditional study between two nuclear powers. This thesis examines each country's strategic situation in this new light and maintains that the same theories about strategic interaction still hold. Lawrence Freedman's theory of general deterrence is particularly relevant; his theory finds that two actors in conflict will react to opposing actors' force structure and policies despite their belief that there is no military solution to their situation.

KEYWORDS: Deterrence, Japan, China, Nuclear, Missile Defense

THE HOMELAND-SECURITY ENTERPRISE: WHERE DO WE FIT?

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Homeland security is a responsibility to be shared across the nation. Resource demands, differing cultures, and varying motivations result in frustration and confusion that conflict with the nation's need to collaborate and cooperate. As such, the homeland-security enterprise appears to be imploding from turf battles, suspicion, poor communication, competitive funding, and mistrust, which cause stakeholders to wonder where they fit in this complex, interdependent environment.

This study examines reports, literature, and studies, along with interviews of homeland-security executives from the four levels of government. It is argued and supported by the research that enhancing the nation's ability to collaborate involves a hybrid approach, where operational functions are decentralized and intelligence functions are centralized. The operational component encourages growth from the bottom of the enterprise through a decentralized block-grant process that allows jurisdictions to address their unique demands. The intelligence component recommends comprehensive reform and uses the nation's layered system of government as a portal to provide situational awareness at all levels.

Collectively, the study's recommendations create an environment ripe for collaboration, where leaders capitalize on the strengths of interconnectivity and continuously add value so that the synergy of combined efforts positively influences the homeland security enterprise.

KEYWORDS: Homeland Security, Collaborative Capacity, Federalism, Grants, Homeland Security Stakeholders, Australian Security Intelligence Organization, AISO, Domestic Intelligence Agency, Information Sharing, Virginia State Police

U.S. NAVY SEABEES AS A STABILITY ASSET

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Since World War II, the Seabees have both supported the Navy's combat mission and promoted goodwill through construction projects. Given the counterinsurgency and state-building challenges of the 21st century, the Seabees need to be integrated into the pursuit of all elements of U.S. national power projection, including economic development, governance, and establishing the rule of law in developing or war-torn countries.

This thesis proposes that the Naval Mobile Construction Battalion (NMCB) integrate a provincial reconstruction team (PRT) to create a Seabee stability team (SST). This highly mobile and self-sufficient organization designed for an SSTR environment will better meet future challenges of irregular warfare and provide a capacity-building organization in developing countries and conflict environments.

The proposed SST would be scalable and deployable within 48 hours to any global, emergent contingency mission. It can conduct military missions in an insecure environment. It would avoid contractor or contractual delays that, at present, often limit the effectiveness of PRT-led construction projects. An SST would reduce these delays and allow reconstruction to proceed in a timely manner. In an SST, emergent missions could be executed without contractor delays because the construction trades are inherent to the organization.

KEYWORDS: Naval Mobile Construction Battalion, NMCB, Seabees, Stabilization and Reconstruction, Four Pillars, Provincial Reconstruction Team, PRT, Iraq, Afghanistan, Civil Military Operations, Insurgency, Counter-Insurgency, COIN, Seabee Stability Team, SST

PROTECTING SMALL COMMUNITIES THROUGH DOMESTIC POLICING: ADOPTING AN INFORMATION-ANALYSIS SYSTEM TO RECOGNIZE POTENTIAL TERRORIST ACTIVITY

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Throughout history, the role of law enforcement has never been more demanding than it is today. In the aftermath of 9/11, local law enforcement agencies have recognized the need to develop new capabilities to protect their communities. Due to the evolving nature of terrorism, public-safety organizations must modify the way they respond to crime and acts of terrorism. This report seeks to contribute to the debate among law enforcement organizations regarding how to counter the increasing threat of terrorism. The aim of this document is to assist policymakers by providing an alternate response strategy to the growing criminal and terrorist nexus. Due to limited resources, the challenges of implementing a locally driven information system for police agencies are considerable. Outcome-based policing is a promising methodology that is proactive and information driven. It is a comprehensive strategy that addresses domestic policing and homeland security concerns affecting public safety. This thesis examines the challenge that small communities have in combating threats of terrorism through shared intelligence. As a final point, this report outlines how the threat of terrorism and potential terrorist activity has redefined police operations and its impact on small jurisdictions

KEYWORDS: Outcome Based Policing, Intelligence Sharing, Terrorism Prevention, Triangle of Terrorism, Public Safety Assessment Triangle, Domestic Preparedness Performance Model

A MODEL FOR NATIONWIDE PATIENT TRACKING

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The events of Hurricane Katrina raised awareness regarding the need to track patients nationwide. As patients were transferred out of the region quickly, they often could not be located by family members or the evacuating facilities, which caused psychological and operational stress for all those involved. The literature shows that a nationwide patient-tracking system does not exist today, and by putting patient tracking at the forefront of preparedness, challenges during response will be minimized.

The researcher uses grounded theory to gather data through a series of interviews that explore what an ideal nationwide patient-tracking system would look like, when information should be shared, what data is necessary to

ensure a useful system, where data is available, and who will be given access to the data. The interviews result in the development of a national system composed of seventeen localized modules. The individual modules need to be constructed and maintained by individual entities, such as public health, the military, law enforcement, and human services, while the effort itself requires a champion to organize the collaborative undertaking, a role emergency management agencies can readily fill.

KEYWORDS: Patient Tracking, Public Health, Emergency Medical Services, Patient Movement, Evacuation, Public Health Preparedness

WINNING THE BATTLE OF IDEAS THROUGH INDIVIDUAL RESILIENCY: A MULTIDIMENSIONAL APPROACH FOR COUNTERING RADICALIZATION IN THE HOMELAND

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To defeat the terrorist threat facing the U.S., the 9/11 Commission recommended a balanced strategy to attack the terrorists and prevent recruitment, while protecting against future attack. A review of the national strategies related to counterterrorism and homeland security shows that they do not provide a balanced approach. Specifically, they fail to counter the factors influencing individuals to conduct terrorism. Disruption of the radicalization process becomes more significant when considering that the threat is no longer just of foreign origins, it is increasingly from within. Adding to this dilemma, evidence shows that terrorist networks are becoming less centralized and placing greater emphasis on individual actions.

Based on the evolving threat, this thesis explores what strategy offers the most balanced approach. To answer this question, an exploratory study is conducted to define the threat and causes of radicalization. Current U.S. strategies are then evaluated to determine if they adequately address the research findings. Additionally, international approaches are analyzed to determine if any lessons learned could be incorporated into a U.S. strategy.

The recommendation is to complement existing strategies with a counter-radicalization strategy. The proposed multi-dimensional solution offers several options to counter radicalization: traditional and nontraditional educational programs, outreach programs, and community involvement.

KEYWORDS: Community Outreach, Counterradicalization, Counterterrorism, Deradicalization, Education, Extremism, Homeland Security, Internet, Media, Multi-Discipline, Multi-Dimensional, Radicalization, Resiliency, Terrorism

MEASURING EFFECTIVENESS IN CONFLICT ENVIRONMENTS

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Traditional warfare has taken on a new meaning in the wake of the September 11 terrorist attacks. Winning peace has become just as important as winning the war. In the military operations in Afghanistan and Iraq that followed the terrorist attacks, it has become increasingly clear that winning peace is a complicated process. In this regard, the concept of stabilization and reconstruction is no simple task and requires planning in advance of combat operations. Unfortunately, current measures of effectiveness (MOE) are either too narrowly constructed or far too complex for application in the hostile environment that accompanies stabilization and reconstruction. This thesis examines the concept of stabilization and reconstruction and exposes the weaknesses and strengths of MOEs. The underlying goal is to formulate a simplified and effective MOE for successful, post-combat stabilization and reconstruction efforts. It

is the author's position that the success of stabilization and reconstruction depends in large part on the ability to monitor progress and respond to obstacles that arise in the course of stabilization and reconstruction.

KEYWORDS: Measure of Effectiveness, Indicators, Assessment, Post-Conflict Reconstruction, State Building, Quantitative Analysis, Qualitative Analysis, Stability Operations, SSTR, Afghanistan, Iraq

A COMPARISON OF THE DEMOCRATIC SECURITY POLICY IN COLOMBIA AND PROVINCIAL RECONSTRUCTION TEAMS IN IRAQ

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The issue of security and democratic development in Colombia and Iraq are important for them as nations as well as for the international community.

For Colombia, the democratic security policy is a mechanism to establish a government presence throughout the country, reclaim territory and the population from insurgent, paramilitary, and other criminal groups, and so end practically sixty years of internal conflict. Colombia's chronic instability creates tensions in the country, the region, and the United States. The DSP is the latest in a long line of efforts to secure the country and its citizens from the grasp of Colombia's insurgent and criminal groups.

The provincial reconstruction teams (PRT), imported into Iraq from Afghanistan, have adapted to a different stability, security, transition, and reconstruction environment with difficulty. The lack of coordination and resources and the presence and nature of security threats have severely limited their effectiveness.

This thesis examines the strengths and weaknesses of both the DSP in Colombia and the PRTs in Iraq in order to determine their effectiveness and identify which methods, strategies, and practices might be transferable to other SSTR environments.

KEYWORDS: Democratic Security Policy, Provincial Reconstruction Teams, Combined Action Program, Civil Operations and Revolutionary Development Program, Military Support Groups, Colombia, Iraq, FARC, AUC, ELN, Al Qaeda, SSTR, Stability, Reconstruction, Insurgent, Demobilization, Paramilitary, Security

LEVERAGING SOCIAL MEDIA TO ENGAGE THE PUBLIC IN HOMELAND SECURITY

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There seems to be an increase in the occurrence of natural disasters and acts of terrorism, creating an increased dependence on government services and emergency responders. At the same time, public safety budgets are shrinking, and there are fewer resources to address this greater, widespread need. The answer may be what homeland security officials have yet to do—engage the public as a full partner.

A relatively new concept has emerged in which social media or Web 2.0 tools can be utilized to facilitate the timely and accurate exchange of information and better engage the public. This thesis examines the current use of Web 2.0 technologies and crisis informatics and seeks to discover how existing social media can be used to engage the public in homeland security and emergency management.

This thesis concludes that social media connects people and helps build communities. Unfortunately, public-safety officials have not embraced Web 2.0 technologies and are missing a great opportunity to engage the public and harness its collective power. With virtually no capital investment, public-safety agencies can create an innovative partnership by capitalizing on tools the public uses every day.

KEYWORDS: Citizen Engagement, Web 2.0, Social Media, Social Networking, Twitter, Blogs, Emergency Management, Homeland Security, Communications, Crisis Informatics, Preparedness, Response, Recovery, Fear,

SECURITY STUDIES

Panic, California Wildfires, Virginia Tech, OGMA, Trust, Two Way Communications, NIMS, Incident Command, Wikis, Information Sharing, Israel, Networked Homeland Security, Public Information, Emergent Behavior, Crisis, Disaster

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