Compilation of thesis abstracts,
September 2006

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Compilation of

Thesis Abstracts

September 2006

Office of the Associate Provost and Dean of Research
Naval Postgraduate School
PREFACE

This publication contains abstracts of unrestricted or unclassified theses submitted for the degrees doctor of philosophy, master of business administration, master of science, and master of arts for the September 2006 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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Summary of Research, an annual compilation of research projects and publications, is also available online, at http://www.nps.edu/Research/SummaryRes.html.
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.
INTRODUCTION

Programs of graduate studies at NPS are grouped as follows:

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

**Graduate School of Engineering and Applied Sciences**
- Applied Mathematics
- Combat Systems Science and Technology
- Electrical Engineering
- Electronic Systems Engineering
- Engineering Acoustics
- Mechanical and Astronautical Engineering
- Meteorology
- Meteorology and Oceanography
- Oceanography
- Operational Oceanography
- Space Systems Engineering
- Systems Engineering
- Systems Engineering and Analysis
- Undersea Warfare
- Systems Engineering Management, Product Development
- Undersea Warfare, International

**Graduate School of Business and Public Policy**
- Acquisition and Contract Management
- Defense Systems Analysis
- Defense Systems Management, International
- Executive Management
- Financial Management
- Information Systems Management
- Leadership Education and Development
- Logistics and Transportation Support Management
- 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
- Defense Decision Making and Planning
- Homeland Security
- Security Studies: Stabilization and Reconstruction
- National Security and Intelligence:
  - Europe/Russia/Central Asia
  - Far East/Southeast Asia/Pacific
  - Middle East/Africa/South Asia
  - Western Hemisphere

**Students**
The student body consists of U.S. officers from all branches of the uniformed services, civilian employees of the federal government, and military officers and government civilian employees of other countries. The resident degree/subspecialty student population for September 2006 is shown in Figure 1 on the following page.
Academic Degrees
Curricula are tailored to meet defense requirements within the framework of traditional academic degrees. All curricula lead to a master’s, while 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
- Contract Management
- Defense Analysis
- Electrical Engineering
- Engineering Acoustics
- Engineering Science
- Human Systems Integration
- Information Operations
- Information Systems and Operations
- Information Technology Management
- Leadership and Human Resource Development
- Management
- Mechanical Engineering
- Meteorology
- Meteorology and Physical Oceanography
- Modeling, Virtual Environments, and Simulation
- Operations Research
- Physical Oceanography
- Physics
- Product Development
- Program Management
- Software Engineering
- Space Systems Operations
- Systems Engineering
- Systems Engineering Management
- Systems Technology
- Astronautical Engineer
- Electrical Engineer
- Mechanical Engineer
- Applied Mathematics
- Applied Physics
- Astronautical Engineering
- Computer Science
- Electrical Engineering
- Engineering Acoustics
- Information Science
- Mechanical Engineering
- Meteorology
- Modeling, Virtual Environments, and Simulation
- Operations Research
- Physical Oceanography
- Physics
- Software Engineering
- Astronautical Engineering
- Engineering Acoustics
- Mechanical Engineering

In September 2006, 259 degrees were conferred. Figure 2 indicates distribution by type, Figure 3 by degree area.
INTRODUCTION

Figure 2. Distribution by Degree Type
(259 Degrees Conferred)

* Advanced Degrees and Other: Ph.D. Computer Science (1), Ph.D. Astronautical Engineering (1), Ph.D. Electrical Engineering (1), Electrical Engineer (3), MS Aeronautical Engineering (1), MS Applied Physics (1), MS Information Operations (2), MS Information Systems and Operations (1), MS Management (2), MS Meteorology (1), MS Physical Oceanography (1), MS Physics (1), MS Software Engineering (1)

Figure 3. Degrees Conferred in September 2006
(259 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.

![Classification of Theses](image)

*Figure 4. Classification of Theses*
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Doctor of Philosophy
Electrical Engineer
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DESIGN, IMPLEMENTATION, AND TESTING OF A COMMON DATA MODEL SUPPORTING AUTONOMOUS-VEHICLE COMPATIBILITY AND INTEROPERABILITY
Duane T. Davis-Commander, United States Navy
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M.S., Naval Postgraduate School, 1996
Doctor of Philosophy in Computer Science-September 2006
Advisor: Donald P. Brutzman, Department of Information Sciences

Current autonomous-vehicle interoperability is limited by vehicle-specific data formats and support systems. Until a standardized approach to autonomous-vehicle command and control is adopted, true interoperability will remain elusive. This work explores the applicability of a data model supporting arbitrary vehicles using the Extensible Markup Language (XML). An exemplar, the Autonomous Vehicle Command Language (AVCL), encapsulates behavior-scripted mission definition, goal-based mission definition, inter-vehicle communication, and mission results.

Broad applicability is obtained through the development of a behavior set capturing arbitrary vehicle activities and automated conversion of AVCL to and from vehicle-specific formats. The former uses task-level behaviors suitable for mission scripting and goal decomposition. Translations use the Extensible Stylesheet Language for Transformation, XML data binding, context-free language parsing, and artificial-intelligence machine learning-and-search techniques. Translation capability is demonstrated through mappings of AVCL to and from multiple vehicle-specific formats.

A final demonstration of the power of a common autonomous-vehicle data model is provided by the implementation of a hybrid control architecture. The model’s vehicle-independence and the ability to generate vehicle-specific data are leveraged in the design of an architecture that provides increased autonomy by augmenting a vehicle’s existing controller. The utility of the architecture is demonstrated through implementation on the Naval Postgraduate School’s ARIES unmanned, underwater vehicle.

KEYWORDS: AUV, UUV, USV, UAV, Robotics, Autonomy, Control Architecture, Hybrid Control, Autonomous Vehicle Behaviors, State-Based Control, Data Model, Ontology, XML, XSLT, XML Data Binding, Context-Free Grammar, Data Translation

REACTIVE SHEAR-LAYER MIXING AND GROWTH-RATE EFFECTS ON AFTERBURNING PROPERTIES FOR AXISYMMETRIC ROCKET-ENGINE PLUMES
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M.S., Air Force Institute of Technology, 2001
Doctor of Philosophy in Astronautical Engineering-September 2006
Advisor: Knox T. Millsaps, Department of Mechanical and Astronautical Engineering
Supervisor: Christopher M. Brophy, Department of Mechanical and Astronautical Engineering

A semi-empirical model is developed for predicting the afterburning ignition location of film-cooled rocket engines. The model is based on two characteristic distances, the distance required for turbulent mixing to generate a combustible mixture with the reactive film layer and the distance traveled during the ignition delay. The mixing length is affected by the mass flow, composition of the film-cooling layer and the fuel-rich air-to-fuel ratio required to support combustion. The ignition delay is determined by the composition directly through the auto-ignition reaction time. Both distances are affected by the velocity and temperature of the rocket core and air. This model is experimentally verified over a range of co-flow air velocities using a liquid rocket engine of approximately 440 N thrust, varying amounts of reactive film cooling and compositions of film coolant, and a co-axial annular airflow generator producing airflow at
velocities up to nearly 200 m/s. Mean ignition locations experimentally observed are between 3.8 and 9.8 centimeters from the nozzle lip, and vary due to airstream velocity and film-coolant composition and mass flow. All model predictions are within the standard deviation of the experimentally observed ignition points.

KEYWORDS: Rocket Exhaust Plume, Afterburning, Compressible Shear Layer, Turbulent Mixing

LOW-POWER FAULT TOLERANCE FOR SPACECRAFT FIELD-PROGRAMMABLE GATE ARRAY (FPGA)-BASED NUMERICAL COMPUTING
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B.S., Stanford University, 1995
M.S., Stanford University, 1996
Doctor of Philosophy in Electrical Engineering-September 2006
Advisor: Herschel H. Loomis, Jr., Department of Electrical and Computer Engineering

Fault tolerance is explored for spacecraft computers employing field-programmable gate arrays (FPGAs). Techniques are investigated for tolerating single-event upsets (SEUs) caused by radiation in the space environment. A new architectural approach is proposed for achieving SEU tolerance that minimizes power and size overhead costs by reducing the precision with which error checking is done. This reduced-precision redundancy (RPR) approach is compared to the traditional triple modular redundancy (TMR) method. A methodology is presented for quantifying the costs and benefits of various performance factors, and thereby determining optimal design solutions. This methodology considers reliability as a performance factor that can be traded off against factors such as power, size, and speed.

An SEU simulation system is developed for studying the effect of SEUs on actual FPGA circuits. Live proton radiation testing and computer-controlled fault injection simulations demonstrate the effectiveness of RPR and TMR. Computer simulations of power usage demonstrate the savings achieved with RPR. RPR is as reliable as TMR, while requiring 1/3 to 1/2 as much power. The effect of imprecise computations that may be produced by an RPR system is studied. An image-processing application illustrates the type of problems for which RPR can be applied effectively.

KEYWORDS: FPGA, Computer, Fault Tolerance, Power, Single Event Upset, Reliability, Spacecraft, Space Radiation
TRAFFIC-MANAGEMENT ALGORITHMS IN WIRELESS-SENSOR NETWORKS
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Wireless-sensor networks are one of the fastest developing technologies and have many military and commercial applications. Traffic management in wireless-sensor networks is a crucial issue, and an open research area. This thesis investigates new fusion methods based on the fuzzy-logic theory for traffic management. The fuzzy-logic theory requires low computational and processing power. This thesis explores two different data-fusion methods using Mamdani and Tsukamoto fuzzy-inference systems. The simulation shows that the Mamdani fuzzy method is an appropriate technique for data fusion in wireless-microsensor networks. Based on the results, this thesis provides a new reliable and low-cost data-fusion method for the more effective handling of data in wireless-sensor networks.

KEYWORDS: Data Fusion, Aggregation, Queuing Models

WIRELESSLY NETWORKED, DIGITAL, PHASED ARRAY: DESIGN AND ANALYSIS OF A 2.4 GHZ DEMONSTRATOR
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The wirelessly networked, opportunistic, digital-array radar (WNODAR) system combines opportunistic phased array and aperstructure concepts. The array elements contain standalone transmit-receive (T/R) modules with no hardwire connections other than prime power and are wirelessly networked to a central controller and processor unit. A full-scale WNODAR operating in the VHF/UHF frequency bands (300 MHz) exhibits many favorable properties, which make the system suitable for ballistic-missile defense (BMD) early warning radar (EWR) applications.

In order to validate the WNODAR concepts, demonstration arrays consisting of T/R modules realized using field-programmable gate-array (FPGA) technology are developed. The demonstration units are frequency scaled from the projected VHF/UHF frequency range to S-band (2.4 GHz) to make use of the abundance of commercial, off-the-shelf (COTS) wireless-communication components.

This research primarily relates to the development of a demonstration T/R module and the evaluation and characterization of component devices. Design, analysis, and simulation of an eight-element demonstration array using MATLAB and CST Microwave Studio are conducted to examine expected array-beam patterns.

KEYWORDS: Phased Array, Opportunistic Phased Array, Aperstructure, Radar, Transmitter, Receiver, COTS, Quadrature Modulator, Quadrature Demodulator, T/R Module, Demonstration Array
MASTER
OF
BUSINESS ADMINISTRATION
Assigning human-resource management (HRM) resources in an efficient and effective way, while also considering multiple criteria, is a difficult task for human beings to execute. In these situations, there are typically many attributes to be taken into account, some of which contradict each other. The mind has very finite limitations when dealing with multi-attribute problems and the associated set of multiple tradeoffs. Providing a mathematical solution to the problem, with the ability to evaluate tradeoffs, can provide useful insight to decision makers and help reduce bias in the overall HRM assignment process. Design and implementation of such a system is the purpose of this thesis.

This thesis focuses on the design principles for a decision-support system (DSS) to facilitate HRM job-assignment decisions for the Hellenic navy. A mathematical, multi-criteria optimization model is designed, and an Excel software environment is implemented employing this model to specify, and subsequently evaluate, job-assignment decisions. The rationale behind this system is to develop a turnkey standalone software solution to assist detailers in assigning officers to new positions.


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**NAVAL EXPEDITIONARY LOGISTICS: A HANDBOOK FOR COMPLEMENTING AND SUPPORTING LAND FORCES**

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Master of Business Administration-September 2006  
Advisors: E. Cory Yoder, Graduate School of Business and Public Policy  
Keebom Kang, Graduate School of Business and Public Policy

This purpose of this MBA professional report is to provide a portfolio for U.S. Navy logistics professionals who are members of, or whose primary function is to support, U.S. naval expeditionary forces. The report consolidates and clarifies existing planning and logistics publications, guidance, instructions, and deployment procedures, and adds elements of the aforementioned from other armed services and government agencies that are lacking in current U.S. Navy documents. The report augments the joint-operational logistic-planning process as it pertains to operational and tactical-level planning. The report also provides guidance based on anecdotes and opinions of the author that are pertinent in developing unit or deployment-specific logistic-support plans for naval expeditionary forces. Research is accomplished by reviewing numerous documents of military units and federal agencies whose principal responsibility is expeditionary warfare and supporting expeditionary forces.

Conclusions and appendices address shortfalls in doctrine that are specific to logistics support of naval expeditionary forces and training of expeditionary logistics professionals. The appendices consist of a boilerplate operation order (OPORD) that provides an understanding of how to write and understand a basic order, checklists for pre-deployment preparation and deployment sustainment, and an overview of contingency contracting and host-nation support, which are all combined to create a working logistics handbook.

**KEYWORDS:** Naval Logistics, Navy Logistics, Naval Expeditionary Logistics, Navy Expeditionary Logistics, Expeditionary Logistics, Logistics, Logistics Planning
This thesis approaches the topic of Hispanics in the military, utilizing both qualitative and quantitative methods to identify their role in meeting the military’s future manpower needs. The qualitative portion of the study begins with an examination of the historical record of diversity in the military. Contemporary information is derived from interviews with active-duty Hispanic personnel, high-school counselors, and Junior Reserve Officer Training Corps (JROTC) instructors. The results of the interviews suggest positive views of diversity and reinforce the strong influence of family members and friends in the career decision-making process for Hispanics. The high-school dropout rates of Hispanics are attributed to nontraditional family lifestyles and poor English-language skills. The quantitative portion of the study undertakes econometric analysis of military attrition, promotion, and retention of Hispanic enlistees. Enlisted cohort data for all services from 1992-2005 is used to estimate the multivariate attrition, promotion, and retention models. The results of the statistical analyses suggest that Hispanics have lower predicted rates of first-term and early attrition, and higher rates of retention beyond the first term and of promotion to E-4. The authors recommend additional studies focusing on JROTC, Hispanic officers, marketing, and diversity-management training.

KEYWORDS: Hispanics, Diversity, Attrition, Retention, Promotion

WITHIN THE WALLS: AN ANALYSIS OF SEXUAL HARASSMENT AND SEXUAL COERCION AT NAVAL CONSOLIDATED BRIG MIRAMAR

This thesis explores sexual harassment and sexual coercion among prisoners and staff at Naval Consolidated Brig (NAVCONBRIG) Miramar, per the request of the commanding officer, NAVCONBRIG Miramar. The data come from two surveys (one for staff and one for prisoners), which were administered in June and August 2006. This thesis begins with a review of relevant literature, a discussion of reporting procedures, and an overview of the fear of reprisal. Rates of sexual harassment and coercion experienced by the staff and prisoners are compared, as are perceptions of the percentage of prisoners who experience sexual harassment and coercion, as estimated by the staff and prisoners. Findings are compared with studies conducted in civilian prisons in 1996 and 2000. Write-in responses provide insight regarding what the staff and prisoners believe constitutes sexual harassment, ways to prevent sexual harassment at the facility, and actual incidents of sexual harassment and coercion experienced while in a prison. Compared to civilian prisons, NAVCONBRIG Miramar prisoners experience lower rates of sexual harassment than all but one facility. The rate of sexual coercion reported by prisoners is approximately equal to that reported by all military-prison facilities.

KEYWORDS: Harassment, Sexual Harassment, Sexual Coercion, Brig, Prison, Prisoners, Reprisal
This study explores the Jewish experience within the American military. Information sources include a review of literature, interviews with nineteen Jewish service members, and data files of officers and enlisted personnel who were on active duty as of October 2005. Data files were provided by the Defense Manpower Data Center in Monterey, California. The history of military service by persons of the Jewish faith corresponds roughly to that of persons from many other ethnic or religious groups: military service has been a patriotic calling (especially in periods of war) as well as a path (during earlier times) toward full assimilation into American society. This study concludes that Jewish military personnel, overall, have consistently performed well in service, given current measures of success and this trend is likely to continue. Further research should seek to examine additional measures of success in the military for Jewish personnel. More generally, research should examine the possible relationship between military performance and a person’s religious faith, since religion is such an important part of individual identity. This information would add to existing knowledge of the various background and demographic factors of military members that help shape a diverse and highly effective force.

**KEYWORDS:** Jewish, Religious Minority, American Jewry, Orthodox, Conservative, Reconstructionist, Reformed, First-Term Completion, Reenlistment, Promotion

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This study examines the knowledge, skills, and abilities (KSA) represented by U.S. Navy subspecialty (SSP) codes assigned to human-resource officers (HRO) and the qualitative fit to human-resource (HR) billets. The HRO-designator subspecialty-code assignment process and the process of assigning SSP codes to HR billets is examined, along with the current process used by major manpower claimants (MMC), subject-matter experts (SME), and resource sponsors to assign SSP codes to HR billets. A researcher-developed survey of 183 HROs and/or supervisors found that a) there is a reality-driven trend (insufficient inventory) whereby HR assignment and placement officers respond to end-user demands and “mismatch” HROs to billets without requisite KSAs; and b) many of these officers compensate for KSA-billet incongruence through coping behaviors, i.e., taking outside courses, on-the-job training (OJT), and a “can-do” culture. One way to mitigate the mismatch phenomenon for obtaining SSP codes is to establish a consistent approach, i.e., HR community leaders could ensure that all relevant HR SSP codes are obtained through the Naval Postgraduate School. Additional controls and oversight are needed to ensure that Navy policy (push-driven) is not short circuited by end-user demands (pull-driven), i.e., compounding costs and degrading missions, functions, and tasks.

**KEYWORDS:** Human Resource Officer, HRO, Navy Subspecialty System, NSS, Manpower, Personnel, Job Matching
THE AFFECTS OF RELOCATION OF YONGSAN GARRISON ON LABOR-COST SHARING

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Frank T. Skrypak-First Lieutenant, United States Air Force
Master of Business Administration-September 2006
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Master of Business Administration-September 2006
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Randall B. Howard, Graduate School of Business and Public Policy

The objective of this thesis is to formulate a forecasting model to estimate the labor-cost-sharing amount for the U.S. and the Republic of Korean governments. This essential tool will allow leadership in the peninsula to make decisions ahead of time in order to prevent demonstrations and mass layoffs, which can affect the mission and the objective of the U.S. presence in the Republic of Korea. With the planned move of the Yongsan Garrison from Seoul to the Pyeongtaek region in 2008, there will be a mass consolidation in supporting units. The consolidation will result in fewer Korean nationals being needed in the region. With the forecasting model, leadership can anticipate the labor-cost-sharing amount needed to make critical decisions ahead of time. The model is also useful for forecasting future labor-cost-sharing amounts.

KEYWORDS: Yongsan Garrison, Relocation, Labor Cost Sharing, United States Forces Korea, Republic of Korea, Osan Air Base, Korean Peninsula, Demilitarized Zone, Korean Labor Union, Land Partnership Plan, Special Measurements Agreement

ANALYSIS OF HORIZONTAL INTEGRATION WITHIN THE PROGRAM EXECUTIVE OFFICE, INTEGRATED WARFARE SYSTEMS

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Mary Malina, University of Vermont

The Program Executive Office, Integrated Warfare Systems (PEO IWS) was stood up in October 2002. Since then, the organization has had to change the way it delivers warfare systems to the fleet. This reorganization could be compared to a merger or major transition in the private sector. The organization is still in a state of change.

The purpose of this MBA project is to describe PEO IWS and analyze its implementation of organizational change. Issues that stem from how the change was approached are identified and compared to leading organizational-change theories.

Conceivably, PEO IWS must coordinate and communicate within themselves to field these warfare systems. The term for this is horizontal integration, which can be defined as integrating multiple warfare systems within and across platforms to achieve maximum warfighting capability through enterprise program management, systems engineering, performance measurement, lifecycle management, and processes, as related to acquisition, contracts, financial-requirements allocation, systems development, and integration, test, and certification.

KEYWORDS: Horizontal Integration, Organizational Transformation, Organizational Change, Warfare Systems Engineering

WHAT ISSUES DOES THE CZECH REPUBLIC FACE CONCERNING OFFSETS IN THE CONTEXT OF MILITARY PURCHASES?

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Jomana Amara, Defense Resource Management Institute

This study briefly discusses the history of the Czech Republic’s participation in offsets and its current policy towards using offset practices. As the provider of the biggest offset program in the Czech Republic,
the Gripen Industrial Cooperation provides an overview of how the offset practices are implemented in the Czech Republic and what the government’s goals are in this area. Similarly, the Polish example of the F-16 is introduced. The Czech Republic is a member of both NATO and the EU and is therefore obliged to follow policies implemented by these institutions. The existence of any connections between Czech government policy and NATO/EU policies is also examined. The complexity of offset programs creates room for mistakes and hidden agendas. The most significant issues are described in Chapter IV and summarized in the final chapter.

KEYWORDS: Offsets, International Trade, Industrial Cooperation Program, Public Procurement, Transparency.

OPERATIONAL-MANNING CONSIDERATIONS FOR SPARTAN SCOUT AND SEA FOX UNMANNED SURFACE VEHICLES
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Advisors: William D. Hatch, Graduate School of Business and Public Policy
Cary Simon, Graduate School of Business and Public Policy

This research is conducted in association with Naval Warfare Development Command (NWDC) requests to update unmanned-vehicle tactical memorandum TM-3-22-5-SW. The research identifies and discusses significant unmanned-surface-vehicle (USV)-manning considerations, such as source ratings and manpower qualities to pilot, operate sensors, support USV electronics, and the manpower implications associated with various weapons-systems alternatives. In addition, this research describes several existing and notional USV tactics, and discusses the existing N75 and N76 primary and secondary mission areas USV operations may support.

The methodology consists of a literature review of USV test reports; USV advanced-concept-technology demonstration briefs; USV concept of operations; fleet lessons learned; the USV tactical memorandum; naval-manpower instructions and manuals; weapons tactical, -field, and -training manuals; military-utility assessments; and a search of books, magazines, and manpower theses.

The research finds that determining manpower qualities and standard operating procedures will remain a dynamic process until USV equipment is standardized. The research also shows that USV launch and recovery is more manpower intensive than that of a standard, rigid-hull, inflatable boat (RHIB). Gunners mates (GM) and aviation ordnancemen (AO) are potential source ratings to support USV Hellfire and Javelin missile modules. The Navy should establish a GM Navy- enlisted classification (NEC) to support Hellfire and Javelin or add these weapons to existing GM NECs. Electronics technicians (ET), fire controlmen (FC), and fire-control technicians (FT) are potential source ratings for USV electrical/electronic support. FC and FT are potential source ratings to support the remotely operated small-arms mount. This research finds that additional war-fighting capabilities can be gained by equipping surface-warfare vessels with USVs without any negative effects to primary or secondary warfare missions. Overall, USVs enhance designed capabilities of naval warships and directly support a capabilities-based Navy.

KEYWORDS: Manpower, Personnel Requirements, Unmanned Surface Vehicles, USV, Unmanned Surface Vehicle-Small, USV-S, Spartan Scout, Sea Fox, Knowledge, Skills and Abilities, KSA, USV weapons modules, USV Tactics

REAL-ESTATE SITE SELECTION: AN APPLICATION OF ARTIFICIAL INTELLIGENCE FOR MILITARY RETAIL FACILITIES
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Advisor: Becky Jones, Graduate School of Business and Public Policy
Second Reader: Joe San Miguel for John Shank (deceased), Graduate School of Business and Public Policy

The purpose of this MBA project is to investigate and provide a comprehensive overview of the current real-estate site-selection industry while showing applications of how artificial intelligence can improve the
selection process. The goal is to identify and document both the industry practices primarily utilized and the principal uses of artificial-intelligent algorithms for site selection and sales forecasting.

The results of this project can be applied to military retail facilities (exchanges and commissaries). The current business model for military retail facilities may not be optimized based upon current trends’ market data. Optimizing the location and allocation of goods and services through artificial-intelligent algorithms can provide previously unrealized cost savings to the Department of Defense.

KEYWORDS: Real Estate, Site Selection, GIS, Geography, Optimization, Retail, Genetic Algorithm

A FACTOR-BASED EXAMINATION OF UNITED STATES NAVY HUMAN-RESOURCE OFFICERS’ WORK ACTIVITIES BY COMMERCIAL-ACTIVITY ASSIGNMENT CODES TO SOCIETY FOR HUMAN RESOURCE MANAGEMENT (SHRM) BODY OF KNOWLEDGE STANDARDS

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This research examines the relationship between United States Navy Human Resource (HR) officers assigned work activities as described by Total Force Manpower Management System (TFFMS) commercial activity (CA) function codes with Society for Human Resource Management (SHRM) body-of-knowledge standards. A review of the current HR officer career field and HR competencies is performed. A total of (N=661) cases are drawn from TFMMS and comprise the data set used in factoring HR officers' CA function codes with the body of knowledge standards prescribed by the Society for Human Resource Management. This study enumerates HR officers working in HR-related work activities as defined in the SHRM body of knowledge and those who are performing non-HR related work in the Navy.

KEYWORDS: MPTE, MSA, Manpower, Human Resources, 1200 Officers, Commercial Activities, SHRM, Competencies

PROGRAM MANAGERS’ COMPETENCIES: A CONSIDERATION OF PROJECT MANAGEMENT COMPETENCIES ON THE SPECIFIC CASE OF THE LAND RESERVE MODERNIZATION PROJECT AT MEAFORD, ONTARIO, CANADA

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Project management has passed through various stages over time, evolving to meet the needs of particular projects. At present, the scope of program management covers a significant number of situational and sequential activities, necessitating a series of specific project-manager competencies in order to implement projects successfully in terms of cost, schedule, and performance. Several studies have been conducted in this field, resulting in various outcomes. Among them, Dr. Owen Gadeken’s research (published in 1997 in the Army R&D magazine) summarizes the competencies of outstanding program managers based upon preceding studies analyzing successful defense-program managers. The present report uses the case of the Land Reserve Modernization Program (LRMP) at Meaford, Ontario, Canada, to explore the competencies identified in the aforementioned research. The LRMP was a large infrastructure program consisting of four projects, the first of which was the implementation of a militia training-support center at Meaford. This report analyzes the LRMP project at Meaford in terms of the program manager’s competencies and explores them by highlighting the events that necessitated those competencies.

KEYWORDS: Program Management, Program Managers Competencies, Dr. Gadeken’s Research, Land Reserve Modernization Project
MASTER OF SCIENCE

Astronautical Engineering
Computer Science
Defense Analysis
Electrical Engineering
Human Systems Integration
Information Operations
Information Systems and Operations
Information Technology Management
Management
Mechanical Engineering
Meteorology
Meteorology and Physical Oceanography
Modeling, Virtual Environments, and Simulation
Operations Research
Physical Oceanography
Physics
Program Management
Software Engineering
Space Systems Operations
Systems Engineering
Systems Engineering Management
Systems Technology
Thermomechanical modeling and simulation of a satellite and intercontinental ballistic missile assumes importance due to the increased interest in assessing the potential of such attacks. Effective and innovative methods are sought in assessing the structural integrity of such structural components. In this study, modeling and simulation aspects of two generic models loaded by high-energy laser beam are presented. An application of MSC software in modeling thermomechanical behavior, both steady state and transient behavior of satellite and missile structures, is presented. Thermal energies used for simulation correspond to high-energy laser flux available at low earth orbits as reported in literature. A brief review of the concepts involved is outlined. The analysis is performed under several scenarios that include thermal failures due to steady state as well as transient thermal exposures. The thermal exposure times and locations are varied to assess typical failure modes of the structure. Analysis is conducted in order to define suitable material thicknesses that will make a satellite or a ballistic missile hardened enough to withstand these specific amounts of energy. Other parameters of interest pertaining to this study are the pulse width and resulting transient phenomena affecting the behavior. Temperature gradients and resulting thermal stresses and thermal deformations are reported in this study.

**KEYWORDS:** Thermo Mechanical Analysis, Satellites, Intercontinental Ballistic Missiles, Thermal Analysis, Structural Analysis, Stress Analysis, Transient Thermal, Structural and Stress Analysis, Ground Based Lasers, Atmospheric Propagation Losses, Failures, Pulse Width, Material Thicknesses
MASTER OF SCIENCE
IN
COMPUTER SCIENCE

ENVIRONMENT BEHAVIOR MODELS FOR REAL-TIME, REACTIVE SYSTEM TESTING AUTOMATION
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The effectiveness of using attributed event grammars (AEG)-based environment behavior models as a method for testing and analyzing real-time, reactive, software systems is explored. The AEG specifies possible event traces and provides a uniform approach for automatically generating and executing test cases. The approach is demonstrated through a case study (Paderborn Shuttle System Control Software) and by performing three kinds of experiments: software-correctness testing, system-performance analysis, and study of design alternatives.


XML TACTICAL CHAT (XTC): EXTENSIBLE MESSAGING AND PRESENCE PROTOCOL FOR COMMAND-AND-CONTROL APPLICATIONS
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Don McGregor, Department of Computer Science
Second Reader: Terry Norbraten, MOVES Institute (Modeling, Virtual Environments, and Simulation)

Current chat and instant messaging (IM) solutions within the Department of Defense have created problems with information security and interoperability. Though Extensible Message and Presence Protocol (XMPP) is the only mandated chat and IM protocol in the DoD, the majority of the military still operates alternative, non-standard solutions that prevent interoperability and lack appropriate security assurances.

XMPP is a streaming Extensible Markup Language (XML) protocol used for multi-user text chat and IM. XMPP supports a large set of administrative and user features, valuable to military chat and IM users. As an open standard, XMPP is also extensible to allow for development of military-specific chat and IM requirements. XMPP protocol also provides significant extensibility to allow for greater command and control and other operational capabilities.

This work demonstrates the use of XMPP to route XML-expressed Distributed Interactive Simulation (DIS-XML) data to conduct distributed modeling and simulation. This work also demonstrates the use of XMPP as a generalized XML message-routing framework in conjunction with XML-expressed military data models, such as the Joint Consultation, Command-and-Control, Information-Exchange Data Model. Also presented in this thesis is an XML-document-based chat data logger, designed to support persistent operations using distributed chat architecture. Experiments conducted with Navy exercise Trident Warrior 2006 demonstrate the value of such a framework, as well as the value of XML-document-based chat data logging. Results indicate that implementation and extension of XMPP has significant value for enhancing command and control. These features, along with the benefits of the adoption of open-standard solutions, make XMPP an essential technology for adoption in today’s operational command-and-control suites.
Phishing is a form of crime in which identity theft is accomplished by use of deceptive electronic mail and a fake site on the World Wide Web. Phishing threatens financial institutions, retail companies, and consumers daily, and phishers remain successful by researching anti-phishing countermeasures and adapting their attack methods to the countermeasures, either to exploit them or completely circumvent them. An effective solution to phishing requires a multifaceted defense strategy. A model is proposed for phishing. This research includes reports on a survey conducted of user detection of phishing and on experiments to assess the success of automated methods for assessing clues to phishing email. Recommendations are presented for a defense-in-depth strategy to prevent phishing.

KEYWORDS: Phishing, Social Engineering, Pharming, Fraudulent Web Site, Anti-Phishing Working Group

IMPLEMENTATION AND ANALYSIS OF A THREAT MODEL FOR INTERNET PROTOCOL VERSION 6 HOST AUTOCONFIGURATION
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Advisors: Geoffrey Xie, Department of Computer Science
John Gibson, Department of Computer Science

Internet protocol version 6 (IPv6), the successor of IPv4, introduces the stateless auto-configuration feature as a convenient alternative to the dynamic host configuration protocol (DHCP). However, the security implications of this new approach have only been discussed at the conceptual level.

This thesis research develops software based on the open-source packet capture library Jpcap to capture and build appropriate Internet control message protocol version 6 (ICMPv6) auto-configuration messages. The developed Java software is used to implement two Denial of Service (DoS) threats to the IPv6 auto-configuration procedure in a laboratory IPv6 network. The results indicate that these threats are real, and further studies are required to identify suitable countermeasures. During this work, compliance defects are also identified for the Linux operating system’s IPv6 implementation.

KEYWORDS: IPv6, Stateless Host Autoconfiguration, Duplicate Address Detection, Neighbor Discovery, Jpcap, Denial of Service
The implications of this research are far ranging. On one hand, the techniques can be used to implement innovative new features in wireless intrusion-detection systems (WIDS). On the other, they can be used to target link layer device driver attacks with much higher precision.

**KEYWORDS:** 802.11, Fingerprinting, Wi-Fi

**SAMPLE ENTROPY AND RANDOM FORESTS: A METHODOLOGY FOR ANOMALY-BASED INTRUSION DETECTION AND CLASSIFICATION OF LOW-BANDWIDTH MALWARE ATTACKS**

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Sample entropy examines changes in the normal distribution of network traffic to identify anomalies. Normalized information examines the overall probability distribution in a data set. Random Forests is a supervised learning algorithm that is efficient at classifying highly imbalanced data. Anomalies are exceedingly rare compared to the overall volume of network traffic. The combination of these methods enables low-bandwidth anomalies to be easily identified in high-bandwidth network traffic. Using only low-dimensional network information allows for near-real-time identification of anomalies. The data set is collected from the 1999 Defense Advanced Research Projects Agency (DARPA) intrusion-detection evaluation data set. The experiments compare a baseline f-score to the observed entropy and normalized information of the network. Anomalies that are disguised in network-flow analysis are detected. Random Forests prove to be capable of classifying anomalies using the sample entropy and normalized information. This experiment divides the data set into five-minute slices and finds that sample entropy and normalized information metrics are successful in classifying bad traffic with a recall of .99 and an f-score .50, which is 185% better than the baseline.

**KEYWORDS:** Intrusion Detection, Malicious Anomalies, Data Mining, Random Forests, Machine Learning, DARPA IDE

**CLEARED HOT: A FORWARD AIR CONTROL (AIRBORNE) CONCEPTS TRAINER**

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Master of Science in Computer Science-September 2006  
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Master of Science in Modeling, Virtual Environments, and Simulation-September 2006  
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With the aim of creating a skill trainer of conceptual knowledge, what is the development process for ensuring the correct set of objectives are determined, matched to appropriate technology, and implemented? Months and years prior to the first instance of trainer use, the initial steps of the developer determine the end product’s success. Computer-based trainers fielded for use by the military are rife with poorly matched tasks to technology, often the product of contracts that begin with a list of high-level objectives imitating a detailed requirements document. In those cases, software developers are forced to make best guesses about how to meet those objectives. Is there a better method? The authors embark on a project to create a trainer for the military aviation mission of Forward Air Control (Airborne) using a development process that first identifies critical tasks, then matches technology to facilitate training those tasks, and finally allows expert evaluation of positive transfer. It is not assumed that this methodology, which foregoes a comprehensive transfer study, is the preferred approach; rather, in cases where such a study is not feasible, authors assert that a good development process, reinforced with subsequent expert evaluation, is a comparable alternative.
There are two main purposes to this thesis study. First, the authors deploy the principles of software development learned at the Naval Postgraduate School and test their validity through the development of a real-world system. This system is a completely self-sustaining prototype of a web-based, interactive, military uniform regulation manual. Second, the authors conduct a study of human-computer interaction (HCI) through the design and usability testing of the new interactive uniform-regulations manual. All military services currently possess their own individual uniform regulations specific to each service. This system, although specifically designed for the United States Marine Corps, can be used as a model for any other service and any international military desiring a similar solution to the inherent problems associated with current manuals. The new system addresses all aspects currently outlined in the regulations. This regulation will be used by all U.S. civilians and military-service members to whom the current manual is now relevant. Although the authors fully intend to deliver a finished product to the Marine Corps for their official use, the true value to them as students is in the process of developing and testing this new system. The knowledge learned here will benefit the authors in any future system design or development projects.


A Database management system (DBMS) is system software for managing a large amount of data in secondary memory. The standard DBMS used today in both industry and the military is the relational DBMS (RDBMS). The RDBMS is based upon the relational paradigm, whereas modern software development technologies that interact with the RDBMS are based upon the object-oriented paradigm. This difference in paradigms presents a conceptual mismatch that greatly reduces programmer and developer productivity.

Additionally, wireless handheld devices have become ubiquitous both in the military and in the community at large. These handheld devices provide a convenient means of information access. To date, the military has failed to capitalize on the use of handheld devices as a convenient means of information access with respect to the large amounts of information stored in its databases.

This thesis investigates various database application architectures and proposes an architecture that will not only overcome the conceptual mismatch between the relational and object-oriented paradigms, but also allows handheld device access to the database. A proof-of-concept prototype database application that
provides handheld device access to a military personnel database is built to show the viability of the proposed architecture.

**KEYWORDS:** Object-Relational Mismatch, Relational DBMS, 3-Tier Database Architecture, Mobile Devices

**IMPLEMENTATION OF A DISTRIBUTED TIME BASED SIMULATION OF UNDERWATER ACOUSTIC NETWORKING USING JAVA**

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Master of Science in Computer Science-September 2006  
Advisor: Geoffrey Xie, Department of Computer Science  
Second Reader: John Gibson, Department of Computer Science

Underwater acoustic networks (UAN) have two immutable obstacles to overcome; the hostile environment in which they must operate; and the combination of the propagation speed of sound in water, the latency in communication that this produces, and the dynamic nature of the water column with respect to its attenuation of the sound signal. These combined issues make it very costly and time consuming to set up a UAN just to test new protocols that may or may not be able to mitigate the limitations of this environment. There exists, then, a need for an ability to test a new protocol without the overhead of creating a physical UAN. The goal of this thesis is to provide a more hospitable, adaptable, flexible, and easily useable tool with which to test new protocols for UANs, and to provide the ability for the physics field to test new physical layer encodings. This simulation environment provides the glue, or bridge, between the two disciplines by working as a common tool for both.

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

**INTERNET PROTOCOL VERSION 6 (IPV6) HOST FINGERPRINT**

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This thesis explores ways of using probe packets to identify the type and version of operating system (OS) that is run by a remote Internet protocol version 6 (IPv6) host. Such a probing technique can be effective because developers of different OSs often interpret the guidance provided by the RFCs slightly differently, and consequently, their network-protocol stack implementation may generate responses bearing unique markers to certain probing packets. The key challenge is to find suitable probing packets for different OSs. Using a real IPv6 testbed, this thesis evaluates both existing user-datagram protocol (UDP) or transmission-control-protocol-based and new IPv6-extension-header-based probing packets against a selected set of eight popular OSs. Results show that the UDP/TCP methods are also effective in an IPv6 environment and the extension header approach is worthy of further study. There is also evidence that OS fingerprinting is harder with IPv6. This might be due to the fact that given the experimental nature of IPv6, similar OSs tend to reuse IPv6 code. This conjecture requires further study. Finally, the thesis also develops a method of crafting arbitrary IPv6 packets using the SmartBits system.

**KEYWORDS:** IPv6, Fingerprint, OS Detection
The S-boxes used in the AES algorithm are generated by field extensions of the Galois field over two elements, called GF(2). Therefore, understanding the field extensions provides a method of analysis, potentially efficient implementation, and efficient attacks. Different polynomials can be used to generate the fields, and the set of polynomials $x^2 + x + \alpha'$ over GF(2n) where $\alpha'$ is a primitive element of GF(2n) is explored.

The results of this work are the first steps towards a full understanding of the field that AES computation occurs in—GF(28). The charts created with the data gathered detail which power of the current primitive root is equal to previous primitive roots for fields up through GF(216) created by polynomials of the form $x^2 + x + \alpha'$ for a primitive element $\alpha$. Currently, a C++ program will also provide all the primitive polynomials of the form $x^2 + x + \alpha'$ for a primitive element $\alpha$ over the fields through GF(232). This work also led to a deeper understanding of certain elements of a field and their equivalent shift register state. In addition, given an irreducible polynomial $f(x) = x^2 + \alpha'x + \alpha'$ over GF(2n), the period (and therefore the primitivity) can be determined by a new theorem without running the shift register generated by f(x).

KEYWORDS: Field, Galois Shift Register, Primitive, Field Extensions, Exponential Algorithm

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PATH CALCULATION AND PACKET TRANSLATION FOR UNMANNED AERIAL VEHICLE (UAV) SURVEILLANCE IN SUPPORT OF WIRELESS-SENSOR NETWORKS

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Wireless-sensor networks (WSNs) are a relatively new technology with many potential applications, including military and homeland-security surveillance operations. Accurate classification of WSN contacts has been attempted using various sensor combinations over the past few years, yet video and photographic imagery remain the only choices for attaining context-specific contact classification. While cameras have been successfully installed within some WSNs, there are serious limitations to this solution, stemming primarily from the scarce power resources, immobility, and small form factor common among conventional WSN nodes. An efficient, low-cost answer to this problem involves the use of unmanned aerial vehicles (UAVs) to acquire imagery of WSN contacts. For this system to scale to the wide expanses that WSNs deploy over, UAV contact surveillance operations must be controlled autonomously. The objective of this thesis is to research and implement an autonomous UAV-WSN system, where an optimized two-dimensional flight plan is produced in response to WSN contact detection. Flight plans autonomously guide the UAV on a course to either an estimated interception point with the WSN contact or to the instigated WSN cluster, depending upon user input. The event-driven application produced in this study functions in the periphery of the Kestrel autopilot system, communicating flight plans to the UAV through properly crafted Kestrel packets.

KEYWORDS: Wireless Sensor Network, Contact Interception, Mote, MMALV, Unicorn, Kestrel Autopilot System, Procerus, UAV Path-Planning
OFFLINE FORENSIC ANALYSIS OF MICROSOFT WINDOWS XP PHYSICAL MEMORY

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The rise of cyber crimes combined with the recent use of computer viruses and malicious programs that reside only in volatile main memory demand further development of appropriate forensic tools. Existing forensic tools that analyze non-volatile memory are not capable of analyzing volatile memory, and the few tools that are capable of detailed analysis of volatile memory are not openly available to the public. In this thesis, an open-source tool is developed to analyze images of physical memory originating from the Windows XP and Windows 2003 Server operating systems. The tool, named Windows Physical Memory Offline Analyzer (WPMOA), scans the memory image and, utilizing input from the user, extracts relevant data from the various structures maintained by the Windows operating system. The WPMOA program automatically generates reports about the image and provides key information necessary for a user to perform additional manual investigation of the image beyond what is done automatically. This thesis details instructions on the preparation and use of the program, initial testing results of the program with actual physical memory images, and C-language code for the program itself.

KEYWORDS: Forensics, Computers, RAM, Physical Memory, Cyber Crime

DEPLOYABLE COMMAND-AND-CONTROL SYSTEM FOR OVER-THE-HORIZON SMALL BOAT OPERATIONS

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The deployable navigation system (DeNS) is a prototype system designed to facilitate command and control during over-the-horizon small-boat operations. It is designed to allow small boats to deploy from their host ships with a Bluetooth global-positioning system (GPS) receiver and personal digital assistant (PDA) running the appropriate software, which provides a real-time navigational picture in terms of position and relation to a predetermined track. This same data is shipped immediately back to the control ship via a wireless network and displayed on a laptop computer to allow the mission commander to monitor the small boat’s progress and position, also in real time. The small boat’s relation to the track is compared on every received fix and appropriate indicators are displayed to inform both users if a predetermined distance from track (track tolerance) has been exceeded. It utilizes JPG-formatted maps that are derived directly from the digital nautical chart (DNC) library overlaid with track information. Positions received from the GPS are converted to pixel coordinates that correspond to their original positions on the JPG chart. The positions are then plotted, providing an electronic display that is very similar in appearance to the traditional plot maintained on paper charts.

KEYWORDS: Command and Control, Digital Nautical Charts, DNC, Geospatial Information System, GIS, Global Positioning System, GPS, Small Boat Operations, Over the Horizon
COMPUTER SCIENCE

A NEW FRAMEWORK FOR SOFTWARE VISUALIZATION: A MULTILAYER APPROACH
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This thesis explores the status of software-visualization research and proposes for a new taxonomy and framework. We first review the history of software visualization, presenting terms involved and noting the confusion among definitions; we then describe competing taxonomies and their limitations, and critique a number of software-visualization tools. The challenges in adapting software visualization to the real problems faced by software engineers and computer scientists are also discussed.

We finally propose a multilayer approach for the field, based on our view of software visualization as an interface between man and computer. This new approach can be used as a research framework as well as a taxonomy of related concerns. We argue that under the prism of this novel approach, new research questions are revealed and avenues for tool integration are opened, potentially boosting the acceptance of software visualization beyond the academy.

KEYWORDS: Software Visualization, Taxonomy, Framework, Multi-Layer Approach, Tools’ Integration, Software Visualization Definition

A MEASUREMENT STUDY OF BGP BLACKHOLE ROUTING PERFORMANCE
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In this thesis, the performance of the basic BGP Blackhole routing methods in real testbed networks is evaluated. By using the response time, the central-processing unit (CPU) load, and the link load as performance metrics, the performance of those methods in networks where the routers’ CPU load was the limiting factor is first evaluated. Then the effect of the high link load and the effect of the routers’ preconfiguration on the BGP Blackhole routing’s performance are examined. Results show that the BGP Blackhole routing may not be effective under stressful situations, that is, a high link load, because of its dependence on transmission-control protocol (TCP) and the underlying routing protocols. Of the three basic Blackhole routing methods, the best method is the destination-based, followed closely by the source-based. The third method, customer-triggered Blackhole routing, had very degraded performance in all cases.

KEYWORDS: BGP, Blackhole Routing, Null Routing, DDoS Attacks, Network Security
IDENTIFYING SUPERVISING CONTROL AND DATA-ACQUISITION SYSTEMS ON A NETWORK VIA REMOTE RECONNAISSANCE
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Presidential-decision directive (PDD) 63 calls for improving the security of supervisory control and data acquisition (SCADA) and other control systems that operate the critical infrastructure of the United States. In the past, these industrial computer systems relied on security through obscurity. Recent economic and technical shifts within the controls industry have increased their vulnerability to cyber attack. Concurrently, their value as a target has been recognized by terrorist organizations and competing nation-states.

Network reconnaissance is a basic tool that allows computer security managers to understand their complex systems. However, existing reconnaissance tools incorporate little or no understanding of control systems. This thesis provides a conceptual analysis for the creation of a SCADA network exploration tool. Several reconnaissance techniques are researched and reviewed in a laboratory environment to determine their utility for SCADA system discovery. Additionally, a framework application using common non-SCADA security tools is created to provide a proof of concept. Development of a viable tool for identifying SCADA systems remotely will help improve critical infrastructure security by improving situational awareness for network managers.

KEYWORDS: Supervisory Control and Data Acquisition, SCADA, Critical Infrastructure Protection, CIP, Network Reconnaissance, Industrial Control System Security
Bosnia and Herzegovina has recently emerged from a disastrous war. After a decade of international presence and reduced sovereignty, the unified elements of national power are reclaiming all elements of national power. The last of these to be assumed is the sovereignty of the national airspace. This work analyzes the legal basis, requirements, and costs associated with Bosnia and Herzegovina assuming full responsibility for controlling its air space and enforcing that control. By shouldering this responsibility on its own, Bosnia and Herzegovina will not only become fully sovereign, but will also fulfill its future requirements of membership in NATO and the European Organization for the Safety of Air Navigation (EUROCONTROL).

**KEYWORDS:** Air Sovereignty, Air Policing, Air Force, Bosnia and Herzegovina, F-5E, Air Defense, CAOC-5, NATO, EUROCONTROL, Airspace, Airspace Surveillance, Airspace Control

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The objective of this research is to define and demonstrate a concept by which task force-level commanders and below can obtain a persistent, over-the-horizon surveillance capability for the purpose of target development and other missions without tasking national or theater-level assets. The goal is to increase the ISR capacity of units who normally would not rate the priority to task a Predator, Global Hawk, or U-2. There are two guiding tenets in developing this concept. First, the equipment and its control should be organic to the Special Operations Forces (SOF) unit or task force. Second, utilizing this capability should not require the soldier to carry any additional equipment into the field. Initial research led to the idea of using networked unmanned aerial systems (UASs) to generate an over-the-horizon surveillance capability for SOF. Authors demonstrate the concept by forming a network comprised of a forward ground team, an inexpensive, test-bed UAS equipped with an off-the-shelf video camera, a manned aircraft, and a tactical-operations center. Connectivity is attained through an ITT Mesh structure at 2.4 GHz, amplified to 1W. Researchers are from the Defense Analysis, Mechanical and Astronautical Engineering, and Information Sciences departments. Successful experiments are conducted through the U.S. Special Operations Command-Naval Postgraduate School (USSOCOM-NPS) Cooperative Field Experimentation Program.

**KEYWORDS:** UAS, UAV, Network Control, Tactical UAS/UAV, Beyond Line of Site, Mesh Networks, ISR
This thesis attempts to convince Air Force leadership to shift its approach to expeditionary airpower in counterinsurgency (COIN) from one that emphasizes advanced technology for striking targets to one that focuses on airmen to influence indigenous populations. Judging from history, airpower will certainly play a supporting role in any effort to quell insurgency through reconnaissance, airlift, and close air support. Thus, wherever the American military deploys for COIN, the Air Force will not only operate, but will also deploy substantial numbers of expeditionary airmen. This forward presence of American airmen at expeditionary air bases enables the Air Force to participate in pacification where it most counts-on the ground, in the surrounding community, and among the indigenous population. To contribute more fully, airmen must comprehend the nature of insurgency to reveal the unique challenges it poses for airpower. To meet these challenges, airmen must develop an appropriate strategic framework for waging COIN so as to correctly shape the expeditionary Air Force by exploiting its own human capital to solve human problems. By bolstering its combat aviation advisors and security forces and creating its own cadre of civil affairs airmen, the Air Force can most significantly improve its effectiveness in COIN.

KEYWORDS: Airpower, Air Expeditionary Force, Insurgency, Counterinsurgency, Small War, Irregular Warfare, Unconventional Warfare, Low Intensity Conflict, Strategy, Coercion, Pacification, Combat Aviation Advisor, Security, Civil Affairs

THE MAYAGUEZ INCIDENT: AN ORGANIZATIONAL THEORY ANALYSIS

Applying selected concepts of organizational theory to the Mayaguez incident of 1975 leads to a more comprehensive understanding of events and more accurate lessons learned. Application of organizational theory to the Mayaguez incident demonstrates the decision processes at the executive level left the military operation vulnerable to failure. Henry Mintzberg’s structural contingency model and Lee Bowman and Terrence Deal’s frames model are used and applied to executive-level decisions. The rationale behind focusing on the executive level is twofold: first, it is where final critical decisions are made, and second, military operations cannot take place without executive-level authorization. The Mayaguez crisis was rife with potential pitfalls, and though President Ford was equipped with an organization of intelligent, competent personnel, the result was unnecessary loss of life. Publicly, the operation was a success and President Ford the savior of the Mayaguez crew. To the military, the operation was an embarrassment because of failures in organizational structure and decision making. Application of organizational theory provides an avenue for analysis of the military operation within the Mayaguez rescue.
EXPLOITING TRIBAL NETWORKS THROUGH CONFLICT
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In the current fight against Islamic extremism, the United States is challenged in its ability to isolate and target specific individuals and groups in select regional environments—efforts that are arguably symptomatic of broader shortfalls in U.S. global influence and strategic reach. These particularly troublesome environments are characterized by a lack of state control and are populated with fiercely independent, largely Muslim, and decidedly anti-western communities.

Unable to consistently penetrate and influence these “ungoverned” regions, operational intelligence remains sporadic and opportunities limited. No broader, structural change has yet been made that would weaken or sever the links among Islamic extremists and their regional hosts over a sustained period, or enable greater cooperation between the U.S. or its allies and indigenous tribal populations. Accordingly, these regions continue to provide ideal locations for terrorist sanctuary, bases of support and operation, and freedom of movement. A supplemental U.S. policy option is required.

The challenge thus becomes one of how to create more effective opportunities to gain influence and control over these select tribal regions while countering the influence of competitors over a sustained period. A policy of manipulating tribal fractures and rivalries in order to induce or heighten internal conflict could provide these opportunities.

KEYWORDS: Colonial North America, Creating Opportunities, Developing Dependencies, Disruption, Divide-and-Conquer, Factionalism, Global War on Terror, Influence and Control, Northwest Frontier, Supplemental Policy Options, Tribal Conflict, Tribal Manipulation

SERVARE VITAS: POLITICAL CONSEQUENCES FOR THE ROMANIAN NATIONAL GOVERNMENT AND MILITARY OF HOSTAGE DEATHS IN A ROMANIAN SPECIAL-OPERATIONS FORCES HOSTAGE-RESCUE OPERATION
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Human conflict has reached a point where the use of terrorism continues to be viewed as an acceptable and valuable instrument to pursue political goals. Because Romanian forces have encountered little action in the terrorism arena, one can say that the Romanian counter-terrorism and anti-terrorism arrangements within law enforcement and the military are immature.

This paper attempts to shed light upon current crisis management procedures and how those arrangements can affect the effectiveness of the state response in hostage situation crises, both in country and abroad. The paper analyzes five hostage rescue operations conducted by German, British, Peruvian, and Russian forces, and focuses on three critical procedures that led to hostage deaths: security measures, negotiations, and handling the media. The analysis exposes that the effectiveness of these procedures will minimize the civilian casualties and will act as prerequisites for successful hostage-rescue operations.

In light of the results of the case studies, a general-based model provides the Romanian authorities with critical tasks faced by either military or law enforcements assets that are required in order to accomplish rescue operations. The project concludes with a number of suggestions for immediate and long-term alleviation of current development problems faced by Romanian special-operations forces.
The airbase has long been a potential target of attack for enemy planners. An effective way to attack the United States Air Force (USAF) is to avoid its usual dominance in the air and use an asymmetrical approach, attacking airbases with ground forces inserted into the joint rear area.

The history of airbase ground attacks from 1942 to 1994, documented in the book *Snakes in the Eagle’s Nest*, shows that the dominant strategy employed by airbase attackers has been the standoff attack. Roughly 75% of all airbase attacks have been through the use of rockets or mortar fire from outside the airbase’s perimeter defenses. In Vietnam, where the defenses against penetrating ground attacks were emphasized, this percentage rose to 96%.

Historically, robust main-operating bases with passive defensive measures, such as hardened facilities and redundant systems, have been able to withstand standoff attacks. The relative inaccuracy of the attackers’ standoff systems and their limited ability to sustain fire on the airbase minimized damage.

Times have changed, and the USAF finds itself operating in an expeditionary mode across the globe. Expeditionary air forces cannot depend on the luxury of operating off airfields with the robust infrastructure of main operating bases. In addition, the emergence of man-portable guided munitions for mortars and guided anti-tank missiles has increased the accuracy of potential standoff weapons. Finally, the sophistication of improvised explosive devices in Iraq and of modern radio-controlled model aircraft even suggest the potential for attackers to build their own guided standoff weapons. The potential for a “one shot, one kill” standoff weapon is here today, negating the effectiveness of passive hardening measures.

Disrupting these attacks will take new strategies. Understanding current joint and USAF doctrine is the first step. Areas for further study, including disrupting the enemy forces before they launch a standoff attack, intercepting the standoff round in flight, and mitigating the damage on impact, are discussed.

**KEYWORDS:** Airbase Defense, Air Base Defense, Asymmetric Attack, Joint Rear Area, Standoff Attack, Expeditionary Air Forces, Unmanned Aerial Vehicles, Improvised Explosive Devices, Homeland Security
Due to increasing demands for security and authentication applications, a considerable amount of research has recently been conducted on face recognition tasks. Recent technological developments in uncooled infrared (IR) imagery technology have boosted IR face recognition research applications. This study is part of ongoing research initiated at the Naval Postgraduate School that considers an uncooled low-resolution and low-cost IR camera used for face-recognition applications. This work investigates a recent approach which approximates nonlinear kernel-based methods at a significantly reduced computational cost. This research is applied to an IR database. Results show that this scheme may perform sufficiently close to its “kernelized” version considered in a previous study, at a fraction of the computational cost, provided that the associated parameters are well tuned. The thesis considers a relative comparison between the two algorithms, based on identification and verification experiments, and considers a statistical test to investigate whether classification performance differences may be considered statistically significant. Results show that, from a cost perspective, a low-resolution uncooled IR camera in conjunction with a low computational-cost classification scheme can be embedded in a robust face recognition system to efficiently address the issue of authentication in security-related tasks.

KEYWORDS: Face Recognition, Pattern Classification, Infrared, FVS, Distances, Feature Vectors

Wireless-sensor networks are one of the fastest developing technologies and have many military and commercial applications. Traffic management in wireless-sensor networks is a crucial issue, and an open research area. This thesis investigates new fusion methods based on the fuzzy-logic theory for traffic management. The fuzzy-logic theory requires low computational and processing power. This thesis explores two different data-fusion methods using Mamdani and Tsukamoto fuzzy-inference systems. The simulation shows that the Mamdani fuzzy method is an appropriate technique for data fusion in wireless-microsensor networks. Based on the results, this thesis provides a new reliable and low-cost data-fusion method for the more effective handling of data in wireless-sensor networks.

KEYWORDS: Data Fusion, Aggregation, Queuing Models
WIRELESSLY NETWORKED, DIGITAL, PHASED ARRAY: DESIGN AND ANALYSIS OF A 2.4
GHZ DEMONSTRATOR

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The wirelessly networked, opportunistic, digital-array radar (WNODAR) system combines opportunistic phased array and aperstructure concepts. The array elements contain standalone transmit-receive (T/R) modules with no hardwire connections other than prime power and are wirelessly networked to a central controller and processor unit. A full-scale WNODAR operating in the VHF/UHF frequency bands (300 MHz) exhibits many favorable properties, which make the system suitable for ballistic-missile defense (BMD) early warning radar (EWR) applications.

In order to validate the WNODAR concepts, demonstration arrays consisting of T/R modules realized using field-programmable gate-array (FPGA) technology are developed. The demonstration units are frequency scaled from the projected VHF/UHF frequency range to S-band (2.4 GHz) to make use of the abundance of commercial, off-the-shelf (COTS) wireless-communication components.

This research primarily relates to the development of a demonstration T/R module and the evaluation and characterization of component devices. Design, analysis, and simulation of an eight-element demonstration array using MATLAB and CST Microwave Studio are conducted to examine expected array-beam patterns.

KEYWORDS: Phased Array, Opportunistic Phased Array, Aperstructure, Radar, Transmitter, Receiver, COTS, Quadrature Modulator, Quadrature Demodulator, T/R Module, Demonstration Array

TIME-FREQUENCY, BI-FREQUENCY DETECTION ANALYSIS OF NOISE TECHNOLOGY RADAR

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Enemy integrated-air-defense systems (IADS) using low-probability-of-intercept (LPI) emitters can cause significant problems for suppression of enemy air defense (SEAD) techniques. New threat-emitter configurations using low-power random-noise modulation have a significant processing gain unavailable to non-cooperative intercept receivers. Consequently, the detection of these emitters cannot be accomplished with conventional intercept-receiver-detection methods.

This thesis examines the use of time-frequency, bi-frequency signal-detection techniques to identify the parameters of the four types of continuous waveform-noise radar recently reported. These include a) random noise, b) noise plus frequency-modulation continuous wave (FMCW), c) noise FMCW plus sine, and d) random binary-phase modulation. Quadrature mirror filtering for wavelet decomposition is used to investigate the four types of noise signals in order to extract the signal parameters. The FFT accumulation method for estimating the spectral correlation-density function is also used to examine the cyclostationary bi-frequency properties of the waveforms. In addition, the periodic-autocorrelation function and periodic-ambiguity function are studied to determine the waveform properties in the delay-Doppler offset domain. Results show that non-cooperative intercept receivers can increase their processing gain using these types of signal-processing techniques, providing a more efficient response time to the threat.

Automated, guided vehicles (AGVs) use different techniques to help locate their position with respect to a point of origin. This thesis compares two approaches that utilize a binary track laid on the floor for the AGV to follow. Both approaches use equally spaced n-tuples on the track that the AGV can use to compute its position. Both approaches also have the special feature that every n-tuple on the binary track is unique and can be used to designate the position of an AGV. The first approach, developed by E.M. Petriu, uses a pseudo-random binary sequence (PRBS) as a model for the binary track. In the second approach, a greedy DeBruijn sequence (GDBS) is used as a model for the binary track. Unlike the PRBS model, the GDBS model has natural ordering, which can be used to determine the position of the AGV more quickly and efficiently than the PRBS model.


Trellis-coded modulation (TCM) is a known technique to increase data rate without increasing the channel bandwidth when implementing error-correction coding. TCM is a combination of M-ary modulation and error-correction coding. This thesis investigates the performance of a low-spectral-efficiency TCM system, which is compared with three alternative systems having comparable bandwidth. The three alternative systems are all non-TCM systems and consist of quadrature phase-shift keying (QPSK) with independent r=1/2 error correction coding on the in-phase and quadrature components, 8-ary biorthogonal keying (8-BOK) with r=2/3 error correction coding, and 16-BOK with r=3/4 error correction coding. The effects of both additive white Gaussian noise (AWGN) and pulse-noise interference (PNI) are considered. The TCM system shows much-better-than-expected performance and significant resistance to PNI, and performance improves as the number of memory elements increases. The alternative QPSK system with soft decision decoding (SDD) experiences significant degradation with PNI. The 8-BOK with r=2/3 error correction and 16-BOK with r=3/4 error correction systems occupy approximately the same bandwidth as the TCM system and show better performance in PNI than the alternative QPSK system.

KEYWORDS: TCM, Trellis Coded Modulation, Hard Decision Decoding, Soft Decision Deciding, Pulse-Noise Interference, BER, Set Partition, M-BOK, QPSK, AWGN
In this thesis, a multiple-hypotheses-tracking (MHT) algorithm is developed to successfully track multiple ballistic missiles within the boost phase. The success of previous work on the MHT algorithm and its application in other scientific fields enables this study to realize an efficient form of the algorithm and examine its feasibility in tracking multiple crossing ballistic missiles even though various accelerations due to staging are present. A framework is developed for the MHT, which includes a linear assignment problem approach used to search the measurement-to-contact association matrix for the set of exact N-best feasible hypotheses. To test the new MHT, an event in which multiple ballistic missiles have been launched and threaten the North American continent is considered. To aid in the interception and destruction of the threat far from their intended targets, the research focuses on the boost-phase portion of the missile flight. The near-simultaneous attacks are detected by a network of radar sensors positioned near the missile launch sites. Each sensor provides position reports or track files for the MHT routine to process. To quantify the performance of the algorithm, data from the National Air and Space Intelligence Center’s IMPULSE intercontinental ballistic missile (ICBM) model is used and demonstrates the feasibility of this approach. This is especially significant to the U.S. Missile Defense Agency since the Impulse model represents the cognizant analyst’s accurate representation of the ballistic threats in a realistic environment. The results show that this new algorithm works exceptionally well in a realistic environment where complex interactions of missile staging, non-linear thrust profiles, and sensor noise can significantly degrade the track-algorithm performance, especially in multiple-target scenarios.

**KEYWORDS:** Multiple Hypotheses Tracking, Boost-Phase, Ballistic Missile, Impulse Modeling, IMPULSE, Kalman Filtering, RF Sensors, Association, Simulation, Linear Assignment Problem, LAP

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**IMPLEMENTATION OF A QUADRATURE-MIRROR FILTER BANK ON AN SRC RECONFIGURABLE COMPUTER FOR REAL-TIME SIGNAL PROCESSING**

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This thesis describes the design and implementation of a quadrature-mirror filter bank on a high-performance, reconfigurable computer implemented with field-programmable gate arrays. The physical connections and signaling specifications for connecting an analog to digital converter to the reconfigurable computer system manufactured by SRC Computers, Incorporated, are discussed. Design and implementation of a fully functional prototype quadrature mirror filter bank is detailed, with a discussion for extending the functionality to larger more practical designs. Performance and device utilization results between the quadrature mirror filter bank implemented in VHDL, design elements implemented in the C programming language, and calculations made using high precision mathematical tools are compared, along with relative effort levels required to achieve results using the different hardware instantiation methods.

**KEYWORDS:** Quadrature Mirror Filter, QMF, Reconfigurable Computer, Field Programmable Gate Array, FPGA, Signal Processing, VHDL, Analog to Digital Converter, ADC
A genetic algorithm is used to optimize the power output of multi-junction solar cells. Solar cell operation is modeled using the Silvaco Atlas software. The output of the Atlas simulation runs serves as the input to the genetic algorithm. The genetic algorithm is run as a diffusing computation on a network of eighteen dual processor nodes. Results show that the genetic algorithm produces better power output optimizations when compared with the results obtained using the hill climbing/gradient approach.

**KEYWORDS:** Multi-Junction Solar Cells, Distributed Computing, Genetic Algorithm, Optimization, Silvaco Atlas

This thesis studies the feasibility of utilizing Zigbee standard devices to create a shipboard wireless sensor network. Two primary methods are used to demonstrate feasibility. The first method demonstrates initial feasibility using a series of laboratory tests. The tests include range, reliability, and battery life tests. In the second portion, a prototype pressure sensor is created by matching a reliable, low-power, pressure transducer to a Zigbee-enabled mote via an integrated data-acquisition unit. Supporting software is generated (using LabVIEW 6.0) to act as a server program and allow a remote Integrated Condition Assessment System (ICAS) program workstation to log-in via a Transmission Control Protocol/Internet Protocol (TCP/IP) connection and monitor sensor data.

The expected contribution from the research effort is a completely wireless sensor network, which would result in a net savings in man hours required to maintain and monitor. The sensor network would be reliable, relatively inexpensive, and entirely commercial, off-the-shelf (COTS) available. With an extended battery life of 18 to 24 months, even the battery replacement could be fit into a standard annual or biannual product maintenance and service cycle, minimizing the workload to maintain the network.

Initial feasibility testing is completed satisfactorily and the prototype sensor is successfully created and integrated to interface with the existing sensor infrastructure.

**KEYWORDS:** Zigbee, Wireless Sensor Network, IEEE 802.15.4, Shipboard Sensor Network, ICAS, Pressure Sensors, LabVIEW
SLEEP PATTERNS OF NAVAL AVIATION PERSONNEL CONDUCTING MINE HUNTING OPERATIONS

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Detailed research conducted over the past forty years has conclusively determined that varying degrees of sleep loss, shifts in sleep cycle, increased stress, and even changes in time zone with respect to daylight transition result in a myriad of physiological and psychological degradations (Helmreich, 2000). Fatigue affects human performance adversely, resulting in predictable changes, not only on the individual level, but also on the system as a whole.

This descriptive study investigates the amount and quality of sleep received by aviation personnel assigned to an operational squadron conducting mine hunting operations. Wrist activity monitors (actigraphs) are used to determine objective assessments of sleep quantity and quality. Demographic variables and additional measures, such as reported sleepiness, fatigue ratings, caffeine and alcohol use, are also collected. Despite a number of factors that altered the original study design, significant differences in amount of sleep, sleep quality, and predicted effectiveness of personnel by officer-enlisted status are identified.

KEYWORDS: Sleep, Mine Hunting, Actigraphy, Fatigue, Aviator Performance
MASTER OF SCIENCE
IN
INFORMATION OPERATIONS

TRANSITIONING TO UNMANNED COMBAT AERIAL VEHICLES
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The Air Force is currently developing Unmanned Combat Aerial Vehicles (UCAV). The UCAV is projected for initial testing by 2010. However, after reviewing the Office of Secretary of Defense’s Unmanned Aircraft Systems Roadmap for 2005-2030, it is found that obtaining squadrons of UCAVs will cost billions of dollars and decades to produce. The United States cannot afford to wait decades for unmanned weapons. Technology is spreading fast. Third world countries without stable economies and non-state actors are able to obtain/develop sophisticated weapons that are capable of easily destroying tactical aircraft. With sophisticated weapons easily obtainable, the risk of losing people in air combat is increasing significantly, and that in turn is creating a level playing field for U.S. opposition to challenge American freedoms. Unmanned weapons technology can help America retain its military edge. However, since unmanned warfare capability is still decades away and is a multi-billion dollar project, America needs a quick fix. This study argues that the most effective way to decrease risk-of-life and budget costs is to introduce F-16 unmanned aerial system (UAS) aircraft for combat. This thesis answers the question of how the government can seize the unmanned aircraft advantages and decrease defense spending until the UCAV is operational. The answer to this question illustrates how an effective F-16 UAS force can synchronize resources to properly complete UCAV development while instantly reducing risk of life.

KEYWORDS: UAV, Unmanned Aerial Vehicles, UAS, Unmanned Aerial Systems, Drone Implementation, Drone, UCAV, F-16, F-22, F/A 22

MODELING TOOLKIT AND WORKBOOK FOR DEFENSE ANALYSIS STUDENTS
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The purpose of this thesis is to provide a workbook to accompany the current textbook, A First Course in Mathematical Modeling. The workbook offers basic reviews of each lesson, followed by detailed examples of how to work each model. Topics covered include difference equations, systems of difference equations, Lanchester equations, graphical analysis, proportionality, geometric similarity, model fitting, Monte Carlo simulation, and probabilistic and deterministic behaviors. The thesis also provides a modeling toolkit for the defense-analysis student upon graduation. The toolkit provides graduates with simple instructions and multiple modeling templates they can take with them upon graduation and use to solve real-world modeling problems in the field. Templates in the toolkit cover decision theory, discrete dynamic systems, expected value, Lanchester models, and two-person games.
KEYWORDS: Difference Equations, Lanchester Equations, Graphical Analysis, Proportionality, Geometric Similarity, Model Fitting, Monte Carlo Simulation, Probabilistic, Deterministic, Decision Theory, Discrete Dynamic Systems, Expected Value, Lanchester Models, Two-Person Games
WIRELESS SECURITY WITHIN HASTILY FORMED NETWORKS
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One of the main purposes of a hastily formed network (HFN) is to provide immediate access to networked voice, data, and video services for as many users as possible. Following terrorist attacks like those in September 2001, or devastating natural disasters like the December 2004 Indian Ocean Tsunami and Hurricane Katrina in August 2005, users of the HFN will likely include survivors; first responders; local, state, and federal government agencies; non-government organizations; militaries; and others. These varied users will have different purposes for accessing HFN services; some will require their information to remain private, while others will not. These needs for privacy and openness appear to present conflicting requirements: the need to provide unrestricted access for many users but ensure “privacy” or security of at least some information within the network. The purpose of this thesis is three-fold: first, to explore methodologies for securing the HFN; second, to examine commercial, off-the-shelf (COTS) products and accepted best practices that provide the necessary security; and third, to provide a limited implementation example and a more robust target architecture that could provide security on the wireless segments, while maintaining open access to the HFN and minimizing installation, operation, and maintenance complexity.

Assigning human-resource management (HRM) resources in an efficient and effective way, while also considering multiple criteria, is a very difficult task for human beings to execute. In these situations, there are typically many attributes to be taken into account, some of which contradict each other. The human mind has very finite limitations when dealing with multi-attribute problems and the associated set of multiple tradeoffs. Providing a mathematical solution to the problem, with the ability to evaluate tradeoffs, can provide useful insight to decision makers and help reduce bias in the overall HRM assignment process. Design and implementation of such a system is the purpose of this thesis.

This thesis focuses on the design principles for a decision-support system (DSS) to facilitate HRM job assignment decisions for the Hellenic navy. A mathematical, multi-criteria optimization model is designed and an Excel software environment is implemented employing this model to specify, and subsequently evaluate, job assignment decisions. The rationale behind this system is to develop a turnkey stand-alone software solution to assist detailers in assigning officers to new positions.


In this thesis, authors review and analyze the current command-and-control communications used by the New Jersey Department of Health and Senior Services (NJDHSS). Best business practices of Emergency Preparedness and Response Systems capable of responding to all public health emergencies, acts of terrorism, and mass casualty incidents are provided. The authors evaluate disaster response plans from civilian and military entities, focusing on a general skeleton that would provide the NJDHSS (or any other entity) a guide/template to follow to be able to create a unique disaster response plan. The plan would include guiding principles and the lifecycle of incident management activities, always ensuring the privacy of medical information. In addition, as part of an emergency response system, available technologies that will have most or all tools needed to respond to a disaster are researched. The Disaster Management Information System (DMIS) is the system of choice. The DMIS solution has an interoperability platform and a set of basic tools. The interoperability backbone is one of the most important aspects of DMIS. It is the backbone that allows responders to acquire software that best suits their needs without having to worry about their neighbors buying the same software. The backbone enables information sharing among
all systems that develop an automated program interface to it. In addition, the tools provide responders with the basic ability to describe an incident and request specific needs as described in the appendices.

KEYWORDS: Emergency Preparedness, Emergency Response, Disaster Management Information Systems

IMPACT OF RADIO-FREQUENCY IDENTIFICATION ON THE MARINE CORPS’ SUPPLY PROCESS

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The purpose of this research is to determine the impacts of utilizing radio frequency identification (RFID) technology in order to implement in-transit visibility (ITV) into the Marine Corps’ supply process. The author interviews experts and users of the LTMITV/W2W at the Supply Management Unit (SMU), 1st Combat Logistics Regiment, 1st Marine Logistics Group, on the operational implementation of the system as well as benefits and opportunities for improvement. With the information recovered and data collected, the author creates a small simulation of the supply process. The simulation is used to create various scenarios that have been encountered in the past, including possible negative impacts of the lack of ITV at certain portions of the supply process. Recommendations are provided on how to improve the current supply process. Recommendations for future research are also provided.

KEYWORDS: RFID, Radio Frequency Identification, ITV, In-Transit Visibility, Simulation Model, Supply Process, Distributions

JOINT ONLINE THESIS AND RESEARCH SYSTEM

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The purpose of this thesis is to develop a web-enabled database that facilitates research related connections and communication among Naval Postgraduate School students and professors and Department of Defense organizations. The proposed name for the prototype website is the Joint Online Thesis and Research System (JOTARS). The specific functional objectives of JOTARS are to establish standard infrastructure and processes that allow DoD organizations to dynamically propose research topics, view research in progress, and a means to suggest topics for class projects. JOTARS will also enable NPS students to conduct refined searches of proposed research topics.

KEYWORDS: JOTARS, Thesis, Web-Enabled, NPS Research, Naval Postgraduate School
WEB-ENABLED DATABASE APPLICATION FOR MARINE AVIATION LOGISTICS SQUADRONs: AN OPERATIONS AND SUSTAINMENT PROTOTYPE
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This thesis analyzes the principles and concepts of Marine Aviation Logistics doctrine at the tactical level and the current information management systems used to execute mission requirements. A web-enabled prototype for Marine Aviation Logistics Squadrons (MALS) is developed to optimize management and decision support for deliberate, time sensitive, and crisis action planning of aviation support operations. The first iteration of the prototype is tested by two Operations (S-3) officers formerly assigned to active-duty Marine Aviation Logistics Squadrons (MALS). The application is also subjected to a usability experiment at the Database and Web Technologies Lab at the Naval Postgraduate School. The results of this research reveal potential benefits for tactical-level aviation logistics planners and sustainers; the prototype is a viable concept, worthy of future development.


EXPANSION OF THE CENTER FOR NETWORK INNOVATION AND EXPERIMENTATION NETWORK TO A WORLDWIDE PRESENCE
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This thesis focuses directly on the enhancement of an established Network Operations Center (NOC) and extends the capabilities of this asset beyond its present scope. By defining the current infrastructure using present network management tools, it provides a better understanding of the present network and enhances management for future field experiments. Finally, extending the CENETIX network via implementation of virtual private networking (VPN) technology allows other experimental labs who currently utilize the Defense Research Engineering Network (DREN), such as the Lawrence Livermore National Laboratory (LLNL), Biometrics Fusion Center (BFC), Defense Threat Reduction Agency (DTRA), Office of Force Transformation (OFT), Coast Guard station (located in Alameda), various other U.S. allied forces (Oversea Partners, etc.), access to current and future field experiments.

KEYWORDS: Virtual Private Network, VPN, CENETIX, L2L, IPSec, Site-to-Site, TNT, NOC, IP Management

REQUIREMENTS ANALYSIS FOR THE DEVELOPMENT OF DIGITAL LIBRARY FOR THE DEPARTMENT OF DEFENSE'S INFORMATION OPERATIONS CENTER FOR EXCELLENCE (IOCFe)
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In a memo from Paul Wolfowitz, Deputy Secretary of Defense, “The Naval Postgraduate School 09is hereby designated the Department of Defense’s Information Operations Center for Excellence. In that capacity, NPS shall facilitate development of Information Operations as a core military competency and innovation.” Commander, U.S. Strategic Command (USSTRATCOM) will serve as operational sponsor for
the center on behalf of the combatant commands. The Secretary of the Navy and Commander USSTRATCOM will develop a charter for the Center on Wolfowitz’s approval, in coordination with the Under Secretaries of Defense for Policy and Intelligence, the Chairman of the Joint Chiefs of Staff, and other DoD officials as appropriate. The charter will address oversight and activities of the Center, including graduate education, research, research opportunities, and transformation. As a tool to enhance the Information Operations Center for Excellence (IOCFE), USSTRATCOM is looking into the development of a digital library that will specifically provide resources for the information-operations community. This thesis conducts a preliminary requirements analysis for the development of a digital library. Successful development of this digital library is expected to effectively enhance the operational areas of information operations and information warfare within the Department of Defense.


FINANCIAL ANALYSIS OF HASTILY FORMED NETWORKS
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One of the common lessons learned from the 11 September terrorist attacks in 2001, Southeast Asia Tsunami in 2004, and Hurricane Katrina in 2005, is that there were major command-and-control (C2) and information challenges during the crisis response efforts. The Department of Defense (DoD) is currently transitioning to face these global threats of terrorism and natural disasters, and to support the goals of the new National Strategy, by developing new plans and procedures to improve the coordination, communications, and operations between DoD and other entities when responding simultaneously to such complex humanitarian disasters (CHD). In searching for a mobile and adoptable communication solution for military operations, the DoD should consider a C2 system that utilizes advanced commercial, off-the-shelf (COTS) technology. Hastily-formed networks (HFN) could provide a global broadband network node with Internet, voice, video, and data capability in a rapidly deployable manner, which offers significant advantages to military and other crisis response activities. The focus of this thesis is the financial aspects of HFNs in support of humanitarian assistance and/or disaster relief (HA/DR) efforts by U.S. armed forces. This research and analysis of HFNs could present prospective benefits to DoD, including cost-savings, enhanced emergency response capabilities, and improved interagency/international relations. Additionally, this study provides a recommended model methodology and iterations for future military use of HFNs in support of the DoD’s vision of “transformation.”

KEYWORDS: Hastily Formed Networks, COASTS, Market Comparables, KVA, Financial Analysis
The theories supporting network-centric warfare (NCW) continue to mold the tactical use of U.S. forces throughout the global warfare environment. This thesis research correlates the four tenets of NCW to the tactical employment of the Naval Postgraduate School's light reconnaissance vehicle (LRV). The four tenets of NCW are:

1. A robustly networked force improves information sharing.
2. Information sharing and collaboration enhance the quality of information and shared situational awareness.
4. These, in turn, dramatically increase mission effectiveness.

The faculty and students at NPS are dedicated to researching methods to leverage science and technology in order to maximize the combat effectiveness of U.S. and allied forces. In teaming with the primary sponsor, U.S. Special Operations Command (SOCOM), NPS has developed the Tactical Network Topology (TNT) series of experiments, which are aimed at providing the warfighter information solutions for the battle space. The NPS LRV was derived from an operational requirement to have a mobile command, control, communication, computers and information/intelligence, surveillance, and reconnaissance (C4I/ISR) platform that provides enhanced real-time information sharing to tactically employed units. Total force combat effectiveness is growing more reliant on agile means of information sharing. Wireless communications and collaborative technologies are essential to ensuring that dynamic, forward-deployed forces have the ability to transmit and receive critical information when and where it is needed. Through past TNT experimentation, the LRV has not demonstrated itself as a stable platform providing a high-bandwidth information sharing capability. This research advances the LRV concept by bridging the multiple wireless technologies and by providing a reliable high-bandwidth communications link.

KEYWORDS: Light Reconnaissance Vehicle, Tactical Network Topology, 802.16(2001), 802.11a/b/g, Command, Control, Communication, Computers and Information/Intelligence, Surveillance, and Reconnaissance, Nomadic Wireless Broadband Access, Wireless Communications

This thesis focuses on the management aspects of the Department of Defense’s IPv6 Transition Plan. It addresses the management required to transition the DoD computer systems from IPv4 to IPv6. The study identifies how computer systems will be affected by the transition from IPv4 to IPv6. The advantages, disadvantages, and risks associated with the transition are analyzed to determine potential areas of improvement. The study provides recommendations that can be used before, during, and after the
transition. This thesis investigates the ramifications of transitioning to IPv6. It compared the Transition Plan to the current state of preparedness by DoD agencies. It determines whether or not IPv6 can be implemented by 2008. When possible, it identifies where the DoD will have to concentrate its efforts to ensure that the transition is smooth and timely.

**KEYWORDS:** IPv6, Transition, IPv4, Features, Risk, Cost, RFC

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**EXTENDING THE TACTICAL WIRELESS INTERNET IN SUPPORT OF THE UNITED STATES MARINE CORPS’ DISTRIBUTED OPERATIONS**

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This thesis researches, examines, and recommends technology solutions that provide the capability to extend the tactical Internet to support the United States Marine Corps’ concept of distributed operations (DO). Distributed Operations doctrinal capabilities are compared to a proposed concept of operations that incorporates the most current state of the art wireless technologies to maximize both capability and interoperability. Specifically, research and analysis focus on the capabilities and performance characteristics of the IEEE 802.16 equipment currently implemented as part of the Marine Corps tactical command-and-control architecture in support of Operation Iraqi Freedom, and provides a thorough evaluation of commercial, off-the-shelf (COTS) wireless-mesh technologies in providing the tactical Internet-access layer required to support DO units. The research culminates with an integration of both these technologies in a simulated employment of DO units dispersed in a tactical environment.

The method for evaluation incorporates COTS products and Marine Corps tactical communications devices installed and operated in both a laboratory setting and a tactical field environment. Although the research captures key performance metrics, such as throughput capacity and transmission range, the primary focus of effort centers on the needs of the DO user by evaluating system performance and operational complexity in support of command-and-control requirements comprising voice, video, data, and situational awareness capabilities.

**KEYWORDS:** 802.16, WIMAX, OFDM, COTS, WLAN, MESH, MANET, Tactical Internet, Distributed Operations, DO, Redline, INTER-4, Tacticomp

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**SMALL, UNMANNED, AERIAL SYSTEM FLIGHT AND MISSION-CONTROL SUPPORT-SYSTEM DESIGN**

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Unmanned aerial systems (UAS) are playing a significant role in the global war on terrorism (GWOT). Until recently, small UASs (SUASs) were an insignificant part of these efforts. Now their numbers exceed those of their larger counterparts by an order of magnitude. Future projections anticipate a growing demand for SUAS, making now the best time to examine the functions they perform in order to make better decisions concerning their future design and development. This thesis provides a brief history of UAS and discusses the current capabilities and mission areas in which they perform. Their relevance to modern warfare and assumptions concerning their future roles on the battlefield is presented. Predominant UAS missions and the technical requirements deemed necessary for their success are identified. A generic UAS functional model is developed to illustrate where the challenges and technology gaps manifest in SUAS
design. Possible technology solutions that could fill these gaps are presented and a field experiment is conducted to demonstrate the feasibility of several possible solutions. The goal of this thesis is to identify existing technology gaps and offer technology solutions that lead to better design of future SUAS flight and mission-control support systems (FMCSS).

**KEYWORDS:** Unmanned Aerial System, Unmanned Aerial Vehicle, UAS, UAV, GCS, Mission Control, Sensor, Camera, Vision Systems

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**RADIO-FREQUENCY IDENTIFICATION FOR NAVAL MEDICAL-TREATMENT FACILITIES**  
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The application of radio-frequency identification (RFID) technology in hospitals is modest primarily due to cost and policy issues. Similar to the evolution of other electronic technologies, unit costs for components have been dramatically reduced within the past few years. Despite the reduction in costs, RFID technology has not yet achieved the tipping point of economic rationality for adoption at most healthcare organizations. Although the technology has been primarily applied to asset management and supply chain applications, Navy Medicine stands to gain tremendous benefit if this technology could be successfully implemented for staff and patient tracking in addition to inventory management.

The purpose of this thesis is to conduct a review of RFID technology and components that could fit into the Navy Medicine’s structure. The study explores the implementation requirements associated with the deployment in other industries that could be used as benchmarks for Navy Medicine implementation. Different technological architectures are described to illustrate the various techniques that could be used for creating the opportunity to automate administration, reduce errors, and improve security for both patients and staff.

**KEYWORDS:** RFID, Implementation, Architecture

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**ESTIMATING THE RETURN ON INVESTMENT ON AN ERP FOR NAVAL AVIATION OPERATIONS USING MARKET COMPARABLES**

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U.S. naval aviation squadrons conduct a variety of flight operations in peace and wartime environments. At the heart of these operations is the flight scheduling that occurs to command and control the squadron’s assets to ensure the actors and processes carry out the squadron’s operations seamlessly and meet the squadron’s mission requirements. This research and case study demonstrates how the knowledge-value-added methodology (KVA) and business-process-reengineering (BPR) can be applied to these processes to analyze the performance and effectiveness of a naval squadron’s operations and maintenance departments. By analyzing the outputs of the sub-processes involved at the squadron level in common units of change, a price per unit of output can be generated to allocate both cost and revenue at the sub-process level. With this level of financial detail, a return-on-investment (ROI) analysis can be conducted for each process and the changes that occur to the processes when reengineering. A determination can then be made as to 1)
what level of reengineering, if any, should occur to the system to maximize ROI, and 2) what types of reengineering are needed, such as reducing costs, increasing value, or implementing IT resources into the processes.

**KEYWORDS:** KVA, Market Comps, ERP, ROI

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**KNOWLEDGE-VALUE-ADDED AS A METHODOLOGY TO EVALUATE THE OFFICE OF FORCE TRANSFORMATION'S WOLF-PAC/STILETTO PROGRAM CONCEPTS**

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With the Department of Defense’s acquisition of programs and projects becoming increasingly more expensive, is it imperative that the method or measure for determining value for a particular project, real or conceptual, be identified and used enterprise-wide. The analytic form of analysis known as the knowledge value added (KVA) methodology is used to evaluate the Office Force Transformation Wolf-PAC/Stiletto concept. This thesis explores two distinctly different areas to demonstrate KVA’s use and benefit. First, the KVA method is used to find the improvements in command-and-control (C2) processes. Second, KVA is used to demonstrate the increased value that the Stiletto ship brings to littoral operations (i.e., mine hunting). The resulting values are compared in varying notional scenarios to assess potential improvements for knowledge processes. This method of analysis demonstrates how reengineered processes enable organizations to maximize knowledge creation and production capacity.

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

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**TESTING TEMPLATE AND TESTING CONCEPT OF OPERATIONS FOR SPEAKER AUTHENTICATION TECHNOLOGY**

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This thesis documents development of a generic testing template and supporting concept of operations for speaker verification technology as part of the Iraqi Enrollment via Voice Authentication Project (IEVAP). The IEVAP is an Office of the Secretary of Defense-sponsored research project commissioned to study the feasibility of speaker verification technology in support of global war on terrorism security requirements. In this phase of the IEVAP, the Naval Postgraduate School develops a generic testing template and testing concept of operations for speaker authentication technology. The intent of this project is to contribute toward the future employment of speech technologies in a variety of coalition military operations by developing a testing template and a concept of operations to conduct such testing.

**KEYWORDS:** Voice Recognition, Speaker Authentication, Speaker Verification, Automated Speech Recognition Technology, Voice Recognition Testing Template
One of the objectives of the Global Information Grid (GIG) is to provide reliable, sufficient, and timely information to the front line war fighters. This thesis attempts to provide the operational requirements set by a boarding team, either from the Navy or the law enforcement community, on information flow from and to the team. The goal is to enhance their situational awareness and decision making capability during maritime interdiction operations. That information flow is provided by several wireless network technologies and collaborative tools, implemented during field trials, as part of the Naval Postgraduate School’s Center for Network Innovation and Experimentation (CENETIX) lab’s maritime subset of experimentation. During these field trials, a wireless extension of the Internet is deployed to the sea, allowing the boarding team to access information and to collaborate with remotely located experts and respective operational commands; the technical aspects, benefits, and shortcomings of the utilized technologies and collaborative tools are screened against the maritime war fighter’s operational requirements.

**KEYWORDS:** Maritime Interdiction Operations, Boarding Party, IEEE 802.16, Mesh, Self Healing, Rapidly Deployable, Wireless Networks, Ultra Wideband Technology, UWB Technology, Operational Requirements, Tactical Network Topology, TNT
HISPANICS IN THE U.S. MILITARY
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This thesis approaches the subject of Hispanics in the military, utilizing both qualitative and quantitative methods to identify their role in meeting the military’s future manpower needs. The qualitative portion of the study begins with an examination of the historical record of diversity in the military. Contemporary information is derived from interviews with active duty Hispanic personnel, high-school counselors, and Junior Reserve Officer Training Corps (JROTC) instructors. The results of the interviews suggest positive views of diversity and reinforce the strong influence of family members and friends in the career decision-making process for Hispanics. The high school dropout rates of Hispanics are attributed to non-traditional family lifestyles and poor English-language skills. The quantitative portion of the study undertakes econometric analysis of military attrition, promotion, and retention of Hispanic enlistees. Enlisted cohort data for all services from 1992-2005 is used to estimate the multivariate attrition, promotion, and retention models. The results of the statistical analyses suggest that Hispanics have lower predicted rates of first-term and early attrition, and higher rates of retention beyond the first term and of promotion to E-4. The authors recommend additional studies focusing on JROTC, Hispanic officers, marketing, and diversity management training.

KEYWORDS: Hispanics, Diversity, Attrition, Retention, Promotion

OFFICER CAREER PATHS AND THE EFFECTS OF COMMISSIONING SOURCES ON THE SURVIVAL PATTERNS OF ARMY OFFICERS
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This thesis analyzes the career paths of U.S. Army officers and evaluates the effect of commissioning source on their survival patterns. Data used in this study are taken from the Active Duty Military Master File provided by the Defense Manpower Data Center (DMDC). The data set contains information on 103,501 officers who were commissioned between 1981 and 2001.

Results indicate that commissioning source, occupation (except for the special occupations and military police), and occupation category have significant effects on the survival curves of U.S. Army officers. Officers graduating from the Reserve Officer Training Corps (ROTC) scholarship program and commissioned through direct commissioning have 10% and 19% greater hazards of leaving than U.S. Military Academy (USMA) graduates; officers graduating from ROTC non-scholarship and officer-candidate School (OCS) have 6% and 8% lower hazards of leaving than USMA graduates. Age, race and ethnicity, gender, marital status, number of non-spousal dependents, and graduate education all have significant effects on the survival function. Higher age at commissioning, being African-American, being married, each additional non-spousal dependent, and having a graduate degree have positive effects on survival patterns, while being female has a negative effect. Being prior-enlisted is not statistically significant in all of the models, but when it is significant, it has a positive effect on the survival function.
Defense Force Recruiting (DFR) is responsible for all ab initio recruitment of full-time and part-time officer appointees and general-entry enlistees into the Australian Defense Force (ADF), to serve in the Australian army, navy, or air force. Despite the merging of single-service selection systems into a tri-service system and the commercialization of significant components of ADF recruitment functions in 2001, recruiting achievement continues to be below the targeted levels essential to maintaining the ADF personnel strength necessary for operations. An assessment of the recruiting system to enable managerial overview and performance evaluation is warranted. Using avant-garde commercial, off-the-shelf (COTS), process-modeling software, a recruiting-system model (RSM) is built that captures the entire recruiting system in three dimensions. This will become a tool for defense and DFR managers at all levels that will enrich their ability to assess, analyze, and improve the recruiting system. Ultimately, this tool will help identify the components of the recruiting system that are functioning in a manner detrimental to achieving ADF recruiting goals.

The purpose of this thesis is to develop an experimental methodology to determine the mechanisms and kinetics of sliding at the interface between a metallic thin film and substrate. A methodology is developed and used to study interfacial sliding of aluminum films on silicon substrates and copper films on fused quartz substrates. The methodology employs a lap shear type of geometry to load the interface between the film and substrate in shear. The results of the studies are inconclusive with regard to interfacial sliding. In the case of Al-Si, the sample fabrication process increases the interfacial amplitude to an extent that the sliding rate is essentially zero. In the case of Cu-fused quartz, chromium film is added to the sample to aid the adhesion of Cu to fused quartz, and as a result, the sliding rate is reduced to below detectable levels.

**KEYWORDS:** Interfacial Sliding, Diffusional Sliding, Interfacial Creep, Thin Film Crawling

This thesis discusses the application of a surface re-engineering method for a nickel-aluminum propeller-bronze material called friction-stir processing. Friction-stir processing (FSP) is currently being developed for applications including as-cast nickel-aluminum bronze (NAB). Fabrication and repair of the United States Navy’s NAB propellers involve fusion welding of as-cast NAB and so it is probable that FSP is likely to encounter as deposited weld metal as well as the more slowly cooled as-cast material. Here, the microstructure and resulting distribution of mechanical properties was examined for a fusion-weld overlay, an FSP stir zone and an FSP stir zone that was placed in fusion-weld metal. As-deposited weld metal exhibited a refined Widmanstätten morphology and higher yield and ultimate strengths as well as increased ductility in comparison to base metal. However, the heat-affected zone (HAZ) exhibited severely reduced ductility. Strength and ductility varied throughout the FSP stir zone. The reduction in ductility in the thermo-mechanically affected zone (TMAZ) and HAZ was less for FSP than for the fusion weld. FSP over a fusion weld resulted in strengths and ductilities similar to those produced by FSP alone, although a region of low ductility was observed at a location where stir-zone weld metal and base metal were all present.

**KEYWORDS:** Friction Stir Processing, Fusion Welding NAB Material
THERMOMECHANICAL CYCLING INVESTIGATION OF COPPER PARTICULATE AND NICKEL-TITANIUM REINFORCED, LEAD-FREE SOLDER

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In today’s flip-chip and ball-grid array (BGA) electronic packages, solder joints provide both the electrical and mechanical connections between the silicon chip and the substrate. Due to coefficient of thermal expansion differences between the chip and substrate, the solder joints undergo thermomechanical stresses and strains as an electronic package is heated and cooled with power on/off cycles. Advances in chip designs result in chips that are larger, run hotter, and demand improved resistance to creep and low-cycle fatigue in the solder joints. In this study, the strengthening of these joints with two different reinforcements is explored: a hard particulate and a shape-memory alloy, single-fiber composite. A baseline is established with a SnAgCu solder that is then compared to test runs on the same solder matrix with copper particles and then the SMA, nickel-titanium wire as reinforcements.

KEYWORDS: Shape Memory Alloy, Thermomechanical Cycling, Lead Free Solder, Particulate Reinforcement, Active Reinforcement

BEAM CONTROL OF EXTREMELY AGILE RELAYING LASER SOURCE FOR BIFOCAL RELAY MIRROR SPACECRAFT

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The concept of controlling optical laser beams on spacecraft for acquisition, tracking, and pointing purposes is quickly becoming a reality. As a result, fine pointing of laser beams is turning out to be an increasingly important research topic. A unique test bed is constructed in order to study and develop new methods for laser-beam control. This test bed, the moving target-source test fixture (MTSTF), hosts a laser source, the extremely agile relaying laser source (EARLS), which has the capability of automatically acquiring and directing a laser beam onto a satellite simulator while in motion. The purpose of this thesis is to make the EARLS platform operational by developing a tracking-control system. The ultimate goal is to point the laser beam at the satellite simulator’s receiving telescope and maintain the laser within the telescope’s limits in the presence of structural disturbance induced by the EARLS motion.

KEYWORDS: Extremely Agile Relaying Laser Source, Moving Target-Source Test Fixture Laser Beam Tracking, Fine Pointing of Laser Beams

MATHEMATICAL MODELING OF A RAIL GUN

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The exit velocity of the launch object along with the values of electric and thermal conductivity at the interfaces between the rails and the armature of a rail gun are critical issues. This thesis, using the finite element method, estimates the former by solving the proper multi-physics governing equations along with exploiting the contact theory between flat surfaces. A parametric analysis in the vicinity of the standard deviation of the normalized distance between the reference planes of the rough surfaces is made for a variety of materials and textures at the interfaces. Furthermore, the amount of ohmic heat that is generated due to the application of the electric potential and the resistance of materials is estimated, along with the average temperature at the interfaces. Finally, thermal stresses are also studied.
EFFICIENT CALCULATION OF EARTH-PENETRATING-PROJECTILE TRAJECTORIES
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Currently, two methods exist to determine trajectory of a ballistic penetrator: the Poncelet analysis and differential area force law (DAFL) methods. An exact solution for the Poncelet equation exists, making for easy computation. However, the one-dimensional nature of the equation fails to capture the intricate three-dimensional nature of real-world, ballistic-penetrator trajectories. The DAFL methods employ empirically derived stress algorithms to calculate the forces acting on a differential area of a projectile. These stresses are then used to determine the forces and moments acting on the differential areas. These forces and moments are then used to solve the equations of motion to determine the trajectory of the ballistic penetrator. The DAFL methods accurately capture the three-dimensional nature of the penetrator's trajectory, but are computationally intensive, which makes them slow.

The integrated-force law (IFL) method combines the computational ease of the Poncelet analysis with the accuracy of the DAFL methods. In IFL, the projectile shape is modeled as a polynomial. The stress algorithms used in the DAFL methods are then numerically integrated over the top and bottom surfaces of the projectile to determine the force and moment acting on the top and bottom half of the weapon. These two forces and moments are then used to solve the equations of motion. J-hook trajectories are solved in less than 40 seconds, and stable trajectories are solved in less than three seconds.

KEYWORDS: Ballistic, Penetration, Simulation

STEADY-STATE AND TRANSIENT MEASUREMENTS WITHIN COMPRESSOR ROTORS DURING STEAM-INDUCED STALL AT TRANSONIC OPERATIONAL SPEEDS
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Steam leakage from an aircraft-carrier catapult is sometimes ingested into the aircraft engines upon launch, which may induce compressor stall. Investigation of this phenomenon is of particular interest to the Navy with its new F35C, the aircraft-carrier variant of the joint strike fighter. The single-engine configuration of the F-35C makes this aircraft particularly vulnerable to steam-induced stall. The present study examines both throttle-induced stall and steam-induced stall in a compressor at 90% and 95% speed, through the use of nine Kulite and two hot-film pressure transducers. The use of fast Fourier transform waterfall plots of the transient data before and during stall prove invaluable in determining stall precursors and the mode of rotor stall.

In addition, a new computational fluid-dynamic model is designed using CFX-5 software to represent a single blade passage of the compressor rotor in order to predict compressor performance. The computed results are compared to experimental results gathered at various throttle settings. An accurate model will enable researchers to predict compressor performance for various and multiple gases.

KEYWORDS: Compressor, Transonic, Steam Ingestion, Turbulence, Stall, CFD, Computational Model
Encounters with turbulence generated by complex topography, convection, or mechanical forcing present a significant threat to military aircraft operations. Properly forecasting the initiation, duration, and intensity of such encounters is a tremendous challenge to forecasters, often resulting in the over-forecasting of turbulence. Over-forecasting the presence or intensity of turbulence can result in unnecessary mission delays, cancellations, and rerouting. The lack of observations and the fact that turbulence is a micro-scale phenomenon that numerical weather prediction (NWP) models currently cannot resolve are what make forecasting turbulence so difficult.

Progress has been made in the last several decades in both the observation of turbulence and the resolution of NWP models. A new turbulence-forecast approach is created based on recent developments in observing turbulence and using automated turbulence diagnostics. The development of an in-situ observation platform, using the eddy-dissipation rate (EDR) and the graphical turbulence guidance (GTG) model, is discussed. A turbulence-forecast approach is derived that includes the synoptic patterns that create or allow the turbulent environment to exist, the use of current tools to observe turbulence, and the use of models to help form the turbulence forecast. A turbulence-forecasting manual is created to give the new forecaster improved guidance to effectively forecast turbulence.

**KEYWORDS:** Turbulence, Clear-Air Turbulence, Mountain Wave, Thermal Turbulence, Mechanical Turbulence, PIREPs, Eddy Dissipation Rate, Integrated Turbulence Forecasting Algorithm, Graphical Turbulence Guidance, Forecasting Turbulence, Diagnostics, Richardson Number
Metrics of the performance and operational impacts of meteorology and oceanography (METOC) support to strike operations conducted on operational-aircraft carriers (CVs) are developed. The goal is to assess that support and make recommendations for improvement. An existing, automated real-time METOC metrics system, which was developed for land-based training missions, is adapted for use on CVs by developing a new data collection form, new metrics, and a new collection, analysis, and reporting architecture for the remote entering of sensitive mission data without compromise. The weather support element of a CV, the OA Division, does not provide strike mission planning support, but does provide situational awareness to pilots. This system allows for situational awareness to be measured and assessed using metrics that quantify the performance of the forecasts, the relationship of the forecasts to the mitigating actions taken by pilots due to adverse weather conditions, and the effects of individual weather phenomena on the execution of strike missions. A key element of the data collection, analysis, and reporting system developed in this study is the collection of METOC-related data from pilots during their intelligence debriefings. This system is readily adaptable for the assessment of METOC support to other warfare areas.

**KEYWORDS:** Meteorology, METOC, Metrics, Quality, Performance Metrics, Operational Impacts, Impacting Phenomena, Situational Awareness, Strike Warfare, Carrier Operations, METOC Support

This study focuses on understanding the development of gap outflow and the air-sea interaction processes during the 26 February 2004 Tehuano event over the Gulf of Tehuantepec, Mexico. The Navy’s Coupled Ocean Atmospheric Mesoscale Prediction System (COAMPS) is used to simulate the gap wind event and to compare satellite, scatterometer, and coincident in situ aircraft and dropsondes measurements collected during the Gulf of Tehuantepec Experiment (GOTEX).

Comparisons between model results and the observations suggest that COAMPS performs the best in simulating the outflow jet within 200 km offshore, although the simulated surface fluxes deviate significantly from the observations. This is the region with dominant dynamical forcing arising from the coastal topography. Larger discrepancies are found in model results further away from the coast, especially to the south and southeast of the gulf, where the air-sea exchange becomes increasingly important. Detailed inter-comparison between COAMPS and the aircraft measurements at 40 m also shows the strong spatial and temporal variations of boundary layer thermodynamics and turbulence that require

**OBSERVED AND SIMULATED TEMPORAL AND SPATIAL VARIATIONS OF GAP OUTFLOW REGION**

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improved characterization of the sea surface temperature, upper air conditions, and initial conditions for COAMPS. The results also point to the need for improved surface flux parameterization, particularly in high wind conditions.

**KEYWORDS:** Gap Wind, Gap Outflow, High Wind Environment, Boundary Layer Evolution, Gulf of Tehuantepec, GOTEX, Ocean Response, COAMPS, Mesoscale, Air-Sea Interaction, Surface Flux

**REMOTE SENSING OF THE REFRACTIVE ENVIRONMENT ABOVE THE MARINE, STRATOCUMULUS-TOPPED BOUNDARY LAYER**

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Electromagnetic propagation paths are subject to refraction as they travel through moisture and temperature gradients found within the inversion layer at the top of the stratocumulus-topped marine boundary layers (STBL). The Naval Postgraduate School Department of Meteorology is developing an automated program called satellite electromagnetic electro-optical (SEMO), which will use remote sensors to estimate the cloud-top height and characterize the ducting conditions over large regions. In addition to estimating the location and strength of elevated ducts, the probability that each duct will reach the surface will also be assigned by the SEMO program. This thesis tests the SEMO program with a unique dataset and provides recommendations as appropriate. Results indicate that the SEMO cloud-top height algorithm has the most success when the inversion layer is greater than 400m, there is a troughing pattern aloft (500mb level), and there is greater than three degrees Celsius difference between the cloud-top and surface temperatures. The SEMO refractive algorithm overestimates the duct strength by ~100% for shallow boundary layer cases (<400m), and overestimates their corresponding trapping layer depth by ~20%. For deeper boundary layer cases, the duct strength is well represented, however, the trapping layer depth is overestimated by ~33%.

**KEYWORDS:** Satellite Meteorology, Atmospheric Boundary Layer, Coastal Meteorology, Radar Propagation

**DUNE EROSION, MEGA-CUSPS, AND RIP CURRENTS: MODELING OF FIELD DATA**

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Sand-dune erosion is highly episodic, occurring only when storm waves coincide with high tides, generating swash that impacts the toe of the dune. Owing to the episodic nature of sand-dune erosion, it is difficult to observe in nature. The removal of a structure and rip-rap seawall from the Stilwell Hall site located in southern Monterey Bay provides a unique opportunity to study erosion processes at an accelerated rate. A 1-D wave-impact-line erosion model (Larson, et al., 2004) is tested against data acquired at this site between April 2004 and April 2005. The model is optimally tuned to the data by a dimensionless coefficient that relates the impact force to the rate of recession. The coefficient values range from 0.7-1.3x10-3 for this field data, compared with values of 1.0-2.5x10-3 previously obtained for lab and field data. Migrating rip currents create a system of mega-cusps, which are nominally 10m in width and 200m in alongshore wavelength (Thornton, 2005).

The presence of mega-cusps is hypothesized to accelerate sand-dune erosion at their embayments where the beach is steeper and narrowest (Short, 1979; Shih and Komar, 1984; Revell, et al., 2002). It is determined that the highest recession occurred at the location of the rip current/mega-cusp embayment.

Changes in the surf climate are of great interest to Naval Special Warfare (NSW) and U.S. Marine Corps (USMC) forces tasked with planning and executing operations in littoral areas. Naval history is replete with operations highlighting the importance of understanding and accurate prediction of nearshore
dynamics. Without the ability to predict nearshore morphologic processes, providing such support is impossible.

**KEYWORDS:** Oceanography, Sand Dune Erosion, Wave Impact Theory, Monterey Bay

**OBJECTIVE IDENTIFICATION OF ENVIRONMENTAL PATTERNS RELATED TO TROPICAL-CYCLONE-TRACK FORECAST ERRORS**

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The increase in skill of numerical-model guidance and the use of consensus forecast techniques have led to significant improvements in the accuracy of tropical-cyclone-track forecasts at ranges beyond 72 h. Identification of instances when the forecast track from an individual numerical model may be in error could lead to additional improvement in the accuracy of tropical-cyclone-track forecasts. An objective methodology is tested to characterize the spread among the three primary, global, numerical, model forecast tracks used as guidance by the Joint Typhoon Warning Center. Statistically significant principal components derived from empirical orthogonal functions of mid-tropospheric height and vorticity forecast fields identify cases of large spread among model forecasts. Cases in which the three-model-average forecast track result in a large error are characterized by a distribution of principal components, such that one component is significantly different than the other two. Removal of the forecast track associated with the outlying principal component results in a reduced forecast error. Therefore, the objective methodology may be utilized to define a selective consensus by removing forecast tracks from consideration based on the projection of forecast fields onto empirical orthogonal functions and inspecting the distribution of the resulting principal components.

**KEYWORDS:** Tropical Cyclones, Consensus Forecast Techniques, Principal Component Analysis, Objective Forecast Techniques

**REFRACTIVITY IN THE ARCTIC REGIONS**

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The purpose of this study is to quantify patterns or trends of electromagnetic-ducting conditions in the Arctic. On average, ducts occurred 5% of the time in the summer months, and 2-3% in the spring, fall, and winter months. This is considered a low approximation due to the vertical resolution of the sounding data. For some local regions, ducts occurred up to 20% of the time, especially in the summer months. In general, local areas near coastlines or near the pole over ice/ocean had a higher frequency of ducts than local areas over a land mass. For the summer and fall months, humidity gradients contributed most to the formation of a duct, while temperature gradients contributed to a lesser degree. For the spring months, temperature gradients contributed most to the formation of the duct, while humidity gradients contributed to a lesser degree. For the winter months, due to the extremely cold surface temperatures and low available humidity, temperature gradients were the dominant contribution to duct formation, and humidity gradients worked against duct formation.

**KEYWORDS:** Arctic, Refractivity, Modified Refractivity, Ducting
During July 2005, Typhoon (TY) Banyan recurved and underwent extra-tropical transition over the western North Pacific. Coincident with the extra-tropical transition of Banyan, a large mid-tropospheric anticyclone developed immediately east of the recurving typhoon. The anticyclone was associated with a high-amplitude, Rossby-wavelike pattern that developed downstream of the anticyclone and extended across the North Pacific. Development of the anticyclone is examined with respect to the interaction between the outflow from Banyan and the mid-latitude jet streak. During the pole-ward movement of TY Banyan, an anti-cyclonically-curved jet stream was forced by the merger of upper-level outflow from Banyan and a jet streak associated with an upstream trough. The anti-cyclonic curvature was accentuated by the presence of a mid-tropospheric cyclone east of Banyan. The anti-cyclonic curvature increased as Banyan moved pole-ward and the mid-tropospheric cyclone moved equator-ward. Thermodynamic forcing of the mid-tropospheric anticyclone is examined with respect to the pole-ward movement of warm moist air that ascends as it is advected around the eastern side of the decaying typhoon. The combination of dynamic and thermodynamic factors is examined in a potential vorticity framework to identify the development of the anticyclone east of Banyan and the transformation of Banyan into a mid-latitude cyclone.

**KEYWORDS:** Tropical Cyclones, Extratropical Transition, Banyan, Advanced Microwave Sounding Unit, AMSU, Potential Vorticity, Polar-Orbiting Satellites
A COMPUTER-GRA PHICS BASED TARGET-DETECTION MODEL
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Modeling of visual perception for computer-generated forces and intelligent software agents is usually fairly feeble in computer games and military simulations. Most of the time, tricks or short cuts are employed in the perceptual model. Under certain conditions, these shortcuts cause unrealistic behavior and detract from military training and user immersion into the simulated environment. Many computer games and simulations trace a ray between the target and observer to determine if the observer can see the target. More complex models are sometimes used in military simulations. One of the models used in Army simulations is the ACQUIRE model. This model may still produce debatable results. The ACQUIRE visual perception model uses a single value for the target’s contrast with its background. This can cause unrealistic results in certain conditions, allowing computer generated forces to see targets that should not be seen and not see targets that should be seen. Testing of these more complex models needs to be completed to determine the conditions under which the model gives questionable results. Testing ACQUIRE against human subjects helps determine when ACQUIRE behaves reasonably. The study consists of multiple scenes with a target in many positions, multiple postures, and many different lighting and fog conditions. Now that testing and analysis is complete, modifications can be made to the visual perception model, allowing it to give better results in more varied conditions, such as low light, excessive fog conditions, and partially hidden targets.

KEYWORDS: Target Detection, Artificial Intelligence, Synthetic Players, Perceptual Modeling

CLEARED HOT: A FORWARD AIR CONTROL (AIRBORNE)-CONCEPTS TRAINER
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With the aim of creating a skill trainer of conceptual knowledge, what is the development process for ensuring the correct set of objectives are determined, matched to appropriate technology, and implemented? Months and years prior to the first instance of trainer use, the initial steps of the developer determine the end product’s success. Computer-based trainers fielded for use by the military are rife with poorly matched tasks to technology, often the product of contracts that begin with a list of high-level objectives imitating a detailed requirements document. In those cases, software developers are forced to make best guesses about how to meet those objectives. Is there a better method? Authors embark on a project to create a trainer for the military aviation mission of Forward Air Control (Airborne) using a development process that first identifies critical tasks, then matches technology to facilitate training those tasks, and finally allows expert evaluation of positive transfer. It is not assumed that this methodology, which foregoes a
MODELING, VIRTUAL ENVIRONMENTS, AND SIMULATION

comprehensive transfer study, is the preferred approach; rather, in cases where such a study is not feasible, authors assert that a good development process, reinforced with subsequent expert evaluation, is a comparable alternative.

KEYWORDS: Forward Air Control (Airborne), FAC(A), Training, Open Source, Close Air Support, Virtual Environment, Call for Fire

SURVEY OF AVAILABLE ARTIFICIAL-INTELLIGENCE TECHNOLOGIES FOR ADDITION INTO DELTA3D

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This thesis explores the addition of artificial intelligence (AI) capability to the Delta3D gaming and simulation engine developed at the Naval Postgraduate School. An analysis of the types of AI capabilities that exist, and their potential to add value to the project, is presented. This analysis includes the use of specific AI technologies, such as state machines and pathfinding, as well as the potential use of existing open source packages. One growing trend in the commercial game industry is the use of AI middleware packages, allowing developers to buy the technologies they need and reduce development time. This thesis covers the link between AI and animation, specifically comparing how animation is handled by Delta3D and UnrealEngine. One final area covered is the use of scripting to generate behaviors within a game or simulation. Again, UnrealEngine, specifically UnrealScript, is considered as a potential model for a scripting language based on the Python programming language. Python is chosen based on its integration with the underlying C++ base code. By following the game industry’s lead, one has a pool of potential options and avoids attempting to reinvent the wheel.

KEYWORDS: Artificial Intelligence, Animation, Scripting Language, Finite State Machine, Path Search Algorithm, Python, Delta3D, Virtual Environments

APPLICATION OF AVATARS IN DISPLAY DESIGN TO SUPPORT SPATIAL AWARENESS UNDER VARYING WORKLOAD CONDITIONS

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Human performance in spatial orientation tasks is determined primarily by spatial awareness and the skills to transition from the current spatial attitude into the desired spatial orientation and position. Erroneous spatial awareness may lead to degraded task performance, the loss of equipment, serious injuries, or fatal aviation mishaps.

The use of unmanned aerial vehicles (UAVs) is considered beneficial due to the reduction in risk to the human carrying out the “mission.” However, the remote execution of such a mission is extremely demanding for the operator. If extensive use of UAVs is to become routine, a number of concerns that may influence their effective use need to be addressed. When the human-in-the-loop (HITL) is considered, vehicle control and the use of autonomy are important issues for the end user.

Therefore, this thesis investigates the use of a virtual avatar in the flight simulator software (Weber Box) and conducts experimental proof of concept (conduct of experiments and analysis, evaluation and validation of the data of the concept using actual flight simulation software). Results of a study (conducted by Weber, 2006) indicated that the proposed design (Weber Box) seemed to strongly support spatial awareness in 3D orientation tasks. Time to assess a spatial situation decreases significantly, whereas accuracy of this spatial judgment at least maintains its level.
This study investigates human orientation performance in relation to display designs that support mental models of the user's spatial situation under varying workload conditions. The main goal is to support the pilot/operator with intuitive, 3D-based information that improves their spatial awareness and supports the mental model of spatial position he/she is operating under, even with varying workload conditions. A follow-up study has to be identified, determining whether varying workload affects performance between the two display designs, and if there is a significant difference to a set of properties that are essential for linking virtual avatars and spatial awareness.

**KEYWORDS:** Spatial Awareness, Situation Awareness, Situational Awareness, Flight Instrument Design, Human Factors Design, Human Systems Integration, Weber Box, Spatial Disorientation, Human Performance

**EVALUATING THE EFFECTIVENESS OF WATERSIDE SECURITY ALTERNATIVES FOR FORCE PROTECTION OF NAVY SHIPS AND INSTALLATIONS, USING X3D GRAPHICS AND AGENT-BASED SIMULATION**

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The individuals charged with the task of planning, developing, and implementing force protection measures both at the unit and installation level must consider numerous factors in formulating the best defensive posture. Currently, force protection professionals utilize multiple sources of information regarding capabilities of systems that are available, and combine that knowledge with the requirements of their installation to create an overall plan. A crucial element missing from this process is the ability to determine, prior to system procurement, the most effective combination of systems and employment for a wide range of possible terrorist attack scenarios.

This thesis is inspired by the work done by James Harney, LT, USN (2003). The thesis expands the Anti-Terrorism Force Protection (AT/FP) tool developed during the original thesis by including the capability of testing force protection measures in multiple scenarios by utilizing models of force protection equipment and forces, virtual worlds of existing naval facilities, and terrorist agents that exhibit intent and behavioral characteristics that can test the effectiveness of the force protection equipment used. The result of this work is a scalable and repeatable methodology for generating large-scale agent-based simulations for AT/FP problem domains providing 3D visualization, report generation, and statistical analysis.

**KEYWORDS:** Virtual Environments, X3D, Discrete Event Simulation, Simkit, Force Protection, Anti-Terrorism, Extensible Markup Language, XML, Java, DIS-Java-VRML, Extensible Modeling and Simulation Framework, XMSF, SAVAGE, Distributed Interactive Simulation

**THE IMPORTANCE OF ARTIFICIAL INTELLIGENCE FOR NAVAL INTELLIGENCE TRAINING SIMULATIONS**

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Artificial intelligence (“intelligent agent”) technology is widely deployed in numerous commercial areas, such as networking, modeling, and software; however, this technology remains under-utilized by operational organizations within the United States Navy. This thesis investigates the importance of artificial intelligence (AI) for military training simulations, particularly in the training of intelligence personnel in the Navy.

The computer-generated Forces (CGF) of the current intelligence team trainer’s (ITT) system initiate actions as a result of rigid scripted programming. Forces will execute the same actions regardless of what
the user decides to do, resulting in highly unrealistic scenarios. For instance, in a scenario where an amphibious ready group (ARG) transits the Strait of Hormuz, the response of an Iranian P3 or an incoming dhow would be the same whether the battle group utilized frigate escorts or not.

This thesis produces very simple but less rigid AI, which can easily be made more complex and “intelligent” in later phases. Demonstrations and assessments validate the importance of AI integration for the ITT. Furthermore, this analysis of the requirements for the AI will assist training commands and combat information centers fleet-wide with the range of realistic combat-related possibilities needed in order to ensure a fully capable “combat ready” watch team.

**KEYWORDS:** Multi-Agent Systems, Artificial Intelligence, Naval Simulations, Combat Information Center, Air-Defense Simulation, AEGIS, CG, Human-Computer Interface, HCI, Watchstander Training, Naval Air Defense, Threat Assessment, Decision Making, Interactive Training Systems

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**DESIGN OF AN OBJECT-ORIENTED AND MODULAR ARCHITECTURE FOR A NAVAL TACTICAL SIMULATOR, USING DELTA3D’S GAME MANAGER**

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The author proposes an architecture based on the dynamic actor layer and the game manager in Delta3D to create a networked virtual environment that could be used to train Navy officers in tactics, allowing team training and doctrine rehearsal. The developed architecture is based on object oriented and modular design principles, while it explores the flexibility and strength of the game manager features in the Delta3D game engine. The implementation of the proposed architecture is planned to be conducted in standard personal computers running the Windows operating system (OS), but as Delta3D is a multi-platform tool, the generated code can be easily ported to Linux or even Mac platforms. The designed architecture also includes a proposal for fast scenario creation and modification based on Extensible Markup Language (XML) technology.

**KEYWORDS:** Virtual Reality, Virtual Environment, Surface Warfare, Computer Simulation, Computer Graphics, Open Source, Division Tactics, Fleet Maneuvers, Surface Tactics, Delta3D, Game Manager, Dynamic Actor Layer, Distributed Simulation
PROMOTING MISSION SUCCESS FOR THE U.S. MARINE CORPS’ DISTRIBUTED-OPERATIONS SQUAD THROUGH EFFICIENT EQUIPMENT SELECTION

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The Marine infantryman is carrying too much weight in combat. This thesis analyzes the tradeoffs between individual load weights and the value that a distributed-operations squad receives from the equipment its members carry. Multiple-objective decision-analysis principles are used to help determine the coefficients for an integer linear programming model. The optimization model prescribes equipment assignment to individual positions that maximizes squad mission success while meeting target weights for the individual Marine. Findings indicate that significant improvements can be made to the Marine’s combat load weight and equipment composition. The optimization model provides the squad with a more efficient combination of equipment while reducing the average weight of the combat load by more than 19 percent for both the assault load and the approach march load. Also, by balancing the loads across the members of the squad, the model reduces the variation of weight across the squad positions from as much as 38 percent to less than two percent for all loads. Examining the trade space between equipment weight and equipment value assists in the creation of future Marine Corps doctrine by providing senior Marine leaders with a starting point analysis for addressing this difficult problem.

KEYWORDS: Value-Focused Thinking, Multiple Objective Decision Analysis, Multiple Attribute Utility Theory, Decision Analysis, Equipment Selection, Distributed Operations, Squad Equipment

FORECASTING U.S. MARINE CORPS REENLISTMENTS BY MILITARY OCCUPATIONAL SPECIALTY AND GRADE

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Each year, manpower planners at Headquarters Marine Corps must forecast the enlisted force structure in order to properly shape it according to a goal, or target force structure. Currently, the First Term Alignment Plan (FTAP) model and Subsequent Term Alignment Plan (STAP) model are used to determine the number of required reenlistments by Marine military occupational specialty (MOS) and grade. By request of Headquarters Marine Corps, Manpower and Reserve Affairs, this thesis and another, by Captain J.D. Raymond (Raymond, 2006), begin the effort to create one forecasting model that will eventually perform the functions of both the FTAP and STAP models.

This thesis predicts the number of reenlistments for first- and subsequent-term Marines using data from the Marine Corps’ Total Force Data Warehouse (TFDW). Demographic and service-related variables from fiscal year (FY) 2004 are used to create logistic regression models for the FY 2005 first-term and subsequent-term reenlistment populations. Classification trees are grown to assist in variable selection and modification. Logistic regression models are compared based on overall fit of the predictions to the FY2005 data.
Combined with other research, this thesis can provide Marine manpower planners a means to forecast future force structure by MOS and grade.

**KEYWORDS:** Reenlistments, Marine Corps Manpower, Total Force Data Warehouse

**EVALUATION OF FLEET OWNERSHIP VERSUS GLOBAL ALLOCATION OF SHIPS IN THE COMBAT-LOGISTICS FORCE**

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Military Sealift Command (MSC) introduced its new dry cargo and ammunition ship (T-AKE) in June 2006, to replace its retiring ammunition and fast combat stores supply ships. MSC seeks new ways to use T-AKEs, fleet replenishment oilers, and fast combat support ships to better support the U.S. Navy. Two alternate ways to manage these ships are evaluated, one where each ship operates under a particular “fleet ownership,” and another where these ships are “globally allocated,” serving any fleet customer as needed worldwide. An optimization-based scheduling tool is introduced and used to evaluate an expository 181-day peacetime scenario. Daily inventories of 13 battle groups—carrier strike groups, expeditionary strike groups, and a littoral combat ship squadron—to gain insight into how to best employ combat logistics force (CLF) ships. It is determined that, in this scenario, global allocation provides significantly better service to fleet customers.

**KEYWORDS:** Global Allocation, Fleet Ownership, Combat Logistics Force, Optimization, Mixed Integer Program, Global Sea Route, T-AKE, T-AO, T-AOE, Station Ship, Shuttle Ship, Logistics Planning Factors, Underway Replenishment, Consolidation

**OPTIMIZING DAYTIME SHORT-SLEEP EPISODES TO MAXIMIZE PERFORMANCE IN A STRESSFUL ENVIRONMENT**

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This study provides the baseline and initial assessment of the napping habits of the United States Military Academy (USMA) class of 2007. This portion of a four-year longitudinal study examines data collected on 62 Cadets over 32 days from 4 October 2004 to 4 November 2004 using actigraphy data and sleep logs. Data are stratified and cleaned in accordance with nap infrastructure, a term used to differentiate between naps of different duration and times of day based upon the phases and waves with which they tend to be associated. A total of 607 naps were reported for a total of 73.3 hours of sleep in addition to primary nocturnal sleep (PNS). Naps ranged from fifteen minutes to six hours in duration and occurred most frequently on weekdays. This finding contrasts with research on other adolescent college students. Weekend naps were shorter in duration, on average, than weekday naps. This finding was also a departure from current nap research findings. Consistent with other research, most naps were between thirty minutes to one and one half hours in length. Frequency and duration of naps was greatest on Wednesdays. The primary type of nap taken was restorative, as opposed to appetitive or prophylactic in nature. Afternoon naps were more prevalent than morning naps, possibly reflecting cadets’ class schedules rather than sleep need. Suggestions for additional research are proposed.

**KEYWORDS:** Actigraphy, Sleep Logs, Nap, Core Body Temperature, Suprachiasmatic Nuclei, Zeitgebers, Circadian Rhythm, Sleep Gates, Forbidden Zones, Biphasic Sleep, Polyphasic Sleep, Slow Wave Sleep, Rapid Eye Movement, Sleep Stages, Sleep Latency, Sleep Duration, Sleep Deprivation, Sleep
Inertia, Sleep Debt, Performance, Mood, Habitual, Non-Habitual, Prophylactic Naps, Restorative Naps, Appetitive Naps, Continuous Work, Sustained Operations

ANALYSIS OF OPERATIONAL PACE VERSUS LOGISTICAL SUPPORT RATE IN THE GROUND-COMBAT ELEMENT OF A MARINE EXPEDITIONARY BRIGADE

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The execution of maneuver warfare by the Marine Air Ground Task Force (MAGTF) places a large amount of stress on the supporting logistics infrastructure. Sustaining the movement of the ground-combat element (GCE) as the battlefield expands becomes increasingly more difficult for the combat-service-support element (CSSE) to accomplish with finite assets. Authors assert that the days of supply the GCE is capable of carrying, the reorder point for inventories carried by the GCE, and the transportation capacity assets within the CSSE dedicated to moving supplies are all significant contributing factors in sustaining the movement of the GCE. This thesis defines a logistics process and develops a simulation where the GCE consumes logistical resources necessary to sustain its movement toward assigned objectives while being supported by a CSSE in an expanding maneuver warfare environment. A successful sustainment of the GCE is defined and using logistic regression, the above three factors are confirmed to contribute significantly to the success rate of sustainment in the simulation. Through relationships to response variables in probability distributions and leverage plots, it is determined which of the three factors contributes significantly more to the responses of success and time. Through a sample means comparison, the combination of factor values that achieve a minimal delay in sustainment for the GCE in the simulation is determined.

KEYWORDS: Combat Service Support, Logistics, Discrete Event Graphs, Discrete Event Simulation, Java Computer Language Programming, Time Criteria Logistics Model, Transportation, Logistic Regression, Regression

IMPROVING CLINICAL EFFICIENCY OF MILITARY TREATMENT FACILITIES

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The Department of Defense is facing medical expenses that are growing at an unprecedented rate. The top leadership is looking for ways to reduce costs and improve efficiency while still providing world-class medical care for its beneficiaries. One option is to implement a relatively new tool called data-envelopment analysis (DEA). This tool uses linear programming to identify efficient entities, called decision-making units (DMU), relative to the other entities in the set.

In the past, DEA studies used military hospitals as DMUs. This study is different in that it uses clinics within hospitals as DMUs. The rational behind this is that administrators have difficulty using data that tells them in general terms that they have too many people or are spending too much money. What they need is a tool that tells them where there are too many people or where they are spending too much money. A hospital is made up of clinics so it is intuitive to begin by improving the efficiency of the clinics, which in turn will improve the efficiency of the whole hospital.

KEYWORDS: Data Envelopment Analysis, DEA, Military Treatment Facility, MTF, TRICARE, Efficiency, Hospital, Obstetrics
OPERATIONS RESEARCH

DETERMINING THE NUMBER OF REENLISTMENTS NECESSARY TO SATISFY FUTURE
FORCE REQUIREMENTS
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The Manpower and Reserve Affairs Department (M&RA) of Headquarters Marine Corps currently uses
two models to assist in determining the optimal number of reenlistments each Military Occupational
Specialty (MOS) should record in each year. One is called the First Term Alignment Plan (FTAP) and the
other, the Subsequent Term Alignment Plan (STAP). As their titles suggest, the FTAP calculates
reenlistment numbers for first-term Marines, while the STAP performs the calculations for all other
Marines. M&RA requested that these models be examined in an effort to combine the functionality of each.
This thesis builds a model that does just that.

The fundamental concept of the model involves taking the current inventory of Marines (by MOS and
grade) and applying transition rates to each of them in order to determine how many are in what state at the
end of the upcoming year. The necessary number of reenlistments is then calculated by subtracting the
forecasted inventory from a desired force structure known as the Grade Adjusted Recapitulation.
Manpower planners can use the results of this model to establish the number of boat spaces for each of the
first-term MOSs as well as recommended reenlistment goals for the subsequent-term MOSs.

KEYWORDS: FTAP, STAP, Determining Reenlistments, Shaping Force Structure, Manpower, USMC
M&RA

OPTIMAL STATIONING OF RADAR PICKETS AND ANTI-BALLISTIC MISSILE
DEFENDERS FOR LONG-RANGE SURVEILLANCE AND TRACKING AND BALLISTIC-
MISSILE DEFENSE OPERATIONS
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Major enhancements to the missile-defense-planning aid “Joint Defender” (JDEF) are described. JDEF is
the first system that shows how to evaluate and exploit new and anticipated improvements in interceptors,
long-range surveillance and tracking capabilities, networked communications, and the ability to detect
platforms to cue intercepting ones downrange. The goal is to improve system-wide effectiveness, gauged
here by the reduction of expected damage inflicted. An asset list (DAL) of targets, characterized by their
locations and values to us, is defended. Defenders include pure “LOOKERs,” radars and sensors of enemy
missile launches, and “SHOOTERs,” platforms with means to both detect and intercept enemy launches.
JDEF optimally positions platforms that can be moved, and prescribes what each platform should do. JDEF
can estimate the value to either opponent of secrecy, deception, or intelligence. JDEF is the only missile
defense planning system using formal optimization. Among the many advantages this conveys, JDEF is
able to unambiguously quantify the difference among disparate plans. Although the JDEF planner can
manually control any detail, the planner is well advised to let optimization suggest where to start.

KEYWORDS: Optimization, Math Programming, Theater Ballistic Missile Defense, Joint Missile Defense
Several models for the spread of two opposing ideologies in a closed population based on epidemic models are developed. Based on different interaction rules for the mechanism of how the ideologies are spread, the results of deterministic and stochastic models are studied. The goal of this work is to provide a tractable analytical framework for each hypothesized set of social interactions, and to analyze the effect of different initial conditions on the proportion of the population affiliated with each ideology after a large time interval. The models developed herein are designed to give decision makers an insight into a complex process.

**KEYWORDS:** Epidemiology, Diffusion Process, Daley-Kendall Model, Rumors

**EFFECTIVENESS OF NONLETHAL CAPABILITIES IN A MARITIME ENVIRONMENT**

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The attack on the USS *Cole* within a civilian port and the increased threat of pirating and terrorism on the high seas underscore the immediate need for a maritime non-lethal capability. This research uses modeling and simulation to explore the requirements and tactical use of non-lethal capabilities in a maritime force protection mission. Specifically, a multi-agent simulation emulates a tactical-level mission in which a U.S. naval vessel returning to Naval Station, Norfolk, Virginia, encounters a variety of maritime surface threats. Data farming is the method used to address the research questions by applying high performance computing to the simulation model, with the intent of examining a wide range of possibilities and outcomes. The non-lethal capabilities are analyzed in their effectiveness to 1) determine intent, 2) deter inbound surface vessels, and 3) engage targets identified as hostile through the continuum of force.

**KEYWORDS:** Non-Lethal Capabilities, Anti-Terrorism, Maritime Force Protection, Port Security, Agent Based Model, Multi-Agent Simulation, Pythagoras, Data Farming, Design of Experiment, Distributed Simulation

**QUANTIFYING THE PROBABILITIES OF SELECTION OF SURFACE-WARFARE OFFICERS TO EXECUTIVE OFFICER**

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This thesis seeks to identify factors affecting the probability of selection of a surface-warfare officer (SWO) to executive officer (XO) in the U.S. Navy. Selections to XO are made by a board that meets annually. Because a candidate is considered for selection in up to three consecutive boards, the possible outcomes in this process are selection to XO in one of three annual boards, failure to be selected to XO in the third board, or attrition from the process between boards. Using data on the board’s selections over a three-year period (2002–2004), a hazards-based logistic regression model is developed to estimate the probabilities associated with a candidate’s disposition based on his or her career profile. The model confirms that a candidate’s recent fitness and evaluation report (FITREP) is the single-most-important
factor affecting selection. Additionally, officers who have completed a tour in Washington D.C. or at the Bureau of Naval Personnel have higher probabilities of selection than do those who have completed other shore tours. When an officer receives a poor FITREP, the probability of selection is low, regardless of other factors. A nonparametric statistical analysis is used to confirm these findings.

KEYWORDS: Surface Warfare Officer, Promotion, Probability Modeling, Logistic Regression, Nonparametric Statistics

AN ANALYSIS OF THE JOINT-STRIKE FIGHTER AUTONOMIC-LOGISTICS SYSTEM
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Traditionally in the Navy and Marine Corps, to proactively prevent failures, maintenance and inspections are performed at fixed intervals independent of aircraft status. The current preventive maintenance strategy services and replaces certain components on a pre-determined schedule. Additionally, the current Navy/Marine Corps aircraft-repair process is reactive. First failures occur, then the logistics system (maintenance and supply) responds. The Joint-Strike Fighter Autonomic-Logistics System (ALS) is proposed to be better than the logistic system in place. Under the ALS, maintenance is performed only as needed. The idea is to decrease the logistics infrastructure and simultaneously improve logistic performance by performing maintenance only as needed. Additionally, parts are ordered “autonomously,” without human intervention. The logistics system prepares for an impending failure. In this thesis, simulations are developed to compare the traditional repair system and the ALS. An analysis is conducted to show differences in performance in respect to aircraft availability, failures per mission, and maintenance-hour-per-flight-hour. The ALS maintenance model dominates traditional maintenance under the study assumption.

KEYWORDS: Autonomic Logistics, Autonomic Logistic System, ALS, Conditioned Based Maintenance, F414-GE-400, Joint Strike Fighter, JSF, Operational Availability, Simulation

EXPLORATION OF FORCE TRANSITIONS IN STABILITY OPERATIONS, USING MULTI-AGENT SIMULATION
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Stability operations have become the most prevalent mission for U.S. forces in the current global security environment. This research explores new methods to assist in determining when it is acceptable to downsize a force in a stability operation. The methodology developed provides insight into this problem by quantifying force protection risk, mission failure risk, and time in the context of the operational threat environment.

The Pythagoras multi-agent simulation and data-farming techniques are used to investigate force-level comparisons in a theoretical threat continuum based on a peacekeeping scenario similar to the Bosnian operation. The data from the simulation is used to construct simple tools for decision makers. These tools are used collectively to find the balance, according to a commander’s priorities, between the conflicting issues of force protection, mission success, and time.

Two areas are identified as significant in achieving success in a stability operation. They are troop posturing and troop employment. The problem is that they are often overlooked or under emphasized. The results of this research demonstrate that posturing and employment should be considered as factors equal to force size in contributing to the goal of maximizing force presence. In addition, this research provides a vehicle to assist military planners with ways in which a stability force can maximize and maintain a near
continuous presence, while simultaneously minimizing the risk to the force and adhering to operational timelines.

Overall, the important conclusion is the significance of troop posture on force size transitions. As a force is downsized, it is crucial to evaluate how to maintain presence with the smaller force. This is evident by the surprising success achieved by the smallest force in the simulation, which was able to project a greater presence by utilizing small, dispersed units, much like the combined-action platoons in Vietnam.

KEYWORDS: Stability Operations, Peace Operations, Data Farming, Pythagoras, Agent-Based Model, Multi-Agent Simulation, Design of Experiments, Project Albert, Force Downsizing, Force Transition, Redeployment

WEAPON–TARGET PAIRING: REVISING AN AIR-TASKING ORDER IN REAL TIME

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Well-publicized lost opportunities for U.S. and coalition air forces to strike enemy leadership targets in Afghanistan and Iraq demonstrate the importance of time-sensitive targeting. How do we “pair” the weapon and weapons-delivery platform with their target? The available platforms (aircraft, manned or unmanned) may be on the ground in an alert status, loitering airborne, or on their way to attack other targets. The problem is compounded by the fact that the actual goals are to a) create multiple strike packages simultaneously, b) recompose existing strike packages that are disrupted by the new plans, c) minimize such disruptions, d) satisfy minimum kill probabilities, and e) avoid the attrition of tasked assets. This thesis develops an automated, optimizing, heuristic decision aid, “RAPT-OR,” that rapidly revises a current air-tasking order (ATO) to meet the requirements above. RAPT-OR identifies verified, near-optimal ATO revisions on a desktop PC (in less than two seconds) for a typical scenario with forty aircraft, four new targets, and thousands of potential strike packages. RAPT-OR allows decision makers the ability to adjust risk acceptance in the formulation of possible courses of action by manipulating friendly-attrition importance in formulating a solution.

KEYWORDS: Time Sensitive Target, Heuristic, Integer Programming, Weapon-Target Pairing, Joint Fire Support, Air Operations Center, Air Tasking Order, Mathematical Programming, Air-Strike, Optimization, Decision Aid
Video-imaging data generated from the Naval Postgraduate School Imaging System (NAPSIS) during November 2004 to June 2006 is analyzed to determine the location of rip channels and track their morphology. During the study period, the rip fields changed constantly in shape, size, and location. Rip channels are found to have a mean migration southward at a rate of 0.16 meters per day with a standard deviation of 7.6 meters per day and maximum rates varying between approximately 30 meters per day north and 30 meters per day south. The migration exhibits a strong seasonal variation with southerly shifts in the fall and winter months, northerly shifts in the late winter and early spring months, and no significant shift in the late spring and summer months.

Directional wave spectra measured every hour at the offshore National Oceanic and Atmospheric Administration (NOAA) buoy are refracted to the 10-meter depth contour at Marina and Sand City and compared with measured spectra at these locations. The significant wave heights at both locations exhibit a correlation of 0.94. Mean wave directions for Marina and Sand City are found to have correlations of 0.83 and 0.34, respectively. These refracted data are then used to calculate sediment transport rates at Stillwell Hall, Fort Ord. Rip-channel migration and calculated sediment-transport rates are correlated at 0.8, qualitatively confirming the hypothesis that the migration rate of rip channels is a function of modeled alongshore sediment transport.

The sometimes-rapid migration of these large-scale morphological features is critical to the successful planning and execution of U.S. Navy and Marine Corps beach assaults and the operation of mine warfare. Because amphibious and special forces operate mainly in shallow areas, the modeling of rip current direction and magnitude contributes greatly to effective mission organization and accomplishment. In addition to causing mines to drift, rip currents transport sediment that can cause the underlying morphology to change, possibly covering bottom mines and creating a potential hazard for military forces operating in the area. Being able to predict where mines may be drifting and how much sediment has concealed them is a necessity in securing a littoral battlespace.

**KEYWORDS:** Nearshore Oceanography, Rip Currents, Sediment Transport, Video Imaging, Undersea Warfare
The characteristics and application of a thyristor (a four-layer semiconductor structure) in a pulse-generating circuit are explored. A thyristor device is used to create a pulse-generating circuit and the pulse-interval duration of this circuit is experimentally measured. The pulse-interval duration is determined to be characterized by a Poisson point process distribution that is dependent on both temperature and applied voltage bias. The adjustable aperiodicity of the pulse intervals is a key characteristic used to design a distributed processing system of micro-robots that are capable of swarming. A micro-robotic swarm platform is simulated using finite element analysis, a JAVA-based swarm model, and three fully operational macro-scale platforms.

**KEYWORDS:** Thyristor, SCR, Pulse Mode Operation, Poisson Point Process, Micro-Robotics, Emergent Behavior, Swarming, COMSOL
AN IDENTIFICATION OF INTERPERSONAL SKILLS FOR BUILDING ARMY CIVILIAN LEADERS

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This joint applied project identifies effective interpersonal skills for four selected leadership levels in the Army civilian workforce. This project expands the findings from the 2003 Army Training and Leadership Development Panel, Communication Task Force initiative, which identified a perceived gap in interpersonal skills exhibited by Army civilian leaders. Thirty-eight Army civilian managers from four leadership levels completed questionnaires and participated in face-to-face interviews describing the important interpersonal skills that were necessary to successfully perform in their jobs. This study illustrates which interpersonal skills were considered most important at the different levels. This study further shows that current education is lacking for civilian leaders to develop these important skills. Recommendations for improving career development and leadership training, which would enable the Army to “grow” better, more effective, Army civilian leaders, are offered.

KEYWORDS: Communication, Interpersonal Skills, Army Civilian Leaders
The U.S. Army is undergoing a substantial departure from its historical underpinnings to adapt and succeed in the emerging arena of asymmetric warfare—i.e., migrating from a traditional “heavy” approach to an agile and responsive capability. Changes are not limited to equipment and doctrine, but are pervasive throughout all aspects of infrastructure and processes, including leadership. Army Transformation is outlined by the Department of Defense’s April, 2003 transformation planning guidance and the subsequent 2004 Army transformation roadmap. One tenet of leadership transformation includes increased capability to develop and sustain innovation. This paper analyzes civilian leadership competencies and capabilities related to the current Army training environment. Leadership competencies and capabilities deemed crucial for civilian leadership transformation are identified. A researcher-developed survey and interviews reveal noteworthy conclusions, including 1) civilian and military personnel share a common view of core leadership competencies required for transformative change; 2) diversity of leadership experiences is widely regarded as a core leadership competency and is generally considered inadequate for civilian leadership; and 3) cultural differences between civilian and military leadership are narrowing, but momentum must be nourished and encouraged to affect positive and permanent leadership improvements for Army civilians.

**KEYWORDS:** Leadership, Transformation, Civilian, Competency

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The investigatory findings of the space shuttle Challenger and Columbia’s accident-investigation boards are analyzed and evaluated relative to one another, with the goal of determining if there are lessons
applicable to organizations that manage technically complex programs. An analysis is conducted of the recommendations from the Challenger investigation and actions taken by the National Aeronautics and Space Administration (NASA) to correct problems in the organization. The effectiveness of both the recommendations and NASA’s response in terms of preventing the Columbia accident are examined. In the intervening years between the Challenger and Columbia accidents, several unofficial analyses of the Challenger accident and investigation have been published. The findings of these independent works are presented in order to determine any relationship to the Columbia accident and the subsequent Columbia investigation. The investigation of the Columbia accident and Challenger accident are compared to determine if any of the investigatory findings indicate that there were common factors in the accidents. An evaluation of the NASA organizational structure and culture is conducted. The impact of the culture on implementing the changes recommended after Challenger, and the relationship to the Columbia accident and investigation, are examined. These analyses and examinations result in several conclusions and recommendations applicable to organizations that manage technically complex programs.

**KEYWORDS:** NASA, Space Shuttle, Challenger, Columbia, Normalization of Deviance, Assumption of Risk, Groupthink, Risk Management, Organizational Culture, Systems Engineering, Columbia Accident Investigation Board, Rogers Commission, Diane Vaughan, Irving Janis
ENVIRONMENT-BEHAVIOR MODELS FOR A REAL-TIME, REACTIVE, SYSTEM-TESTING AUTOMATION
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The effectiveness of using attributed event grammars (AEG)-based environment behavior models as a method for testing and analyzing real-time, reactive software systems is explored. The AEG specifies possible event traces and provides a uniform approach for automatically generating and executing test cases. The approach is demonstrated through a case study (Paderborn Shuttle System Control Software) and by performing three kinds of experiments: software correctness testing, system performance analysis, and study of design alternatives.

A PROPOSED ARCHITECTURE FOR THEATER COORDINATION OF GLOBAL SPACE CAPABILITIES

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This thesis proposes an architecture for the coordination of global space capabilities in a joint force commander’s theater of operations. The current architecture for space capabilities coordination in a geographic area of operations is not standardized, and is instead left up to each theater to develop independently. As dependence on space capabilities proliferates to the lowest levels of operations, while the capabilities and products provided by space systems becomes increasingly complex, ad hoc relationships are no longer sufficient. Purely because of physics, assets on orbit are global rather than theater in nature, and require a global level of control. The interaction of a unified global controlling organization with disparate theater coordination constructs results in confusion, inefficiency, and potentially lost opportunities to influence or support operations. The standardization of space coordination across theaters will ensure that similarly trained and operating organizations are able to interact within their theater, across theaters, and up to the space command-and-control organization. This thesis proposes the establishment of a theater space coordination cell on the staff of the joint force commander in order to provide theater-wide space capabilities coordination and reach-back to U.S.-based space resources.

KEYWORDS: Space, Operations, Space Coordinating Authority, Space Capabilities, Theater Space Coordination

A DEPTH ANALYSIS OF MIDWAY ATOLL USING QUICKBIRD MULTI-SPECTRAL IMAGING OVER VARIABLE SUBSTRATES

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Shallow-water bathymetry is important for both safe navigation and natural-resource management. Extracting depth information from spectral imagery allows identification of benthic features and characterization of coral reef habitats, especially in remote islands. Techniques have been developed to extract water depth from multispectral imagery (Lyzenga, 1978; Philpot, 1989). These techniques can be difficult to apply in optically shallow waters with heterogeneous bottom types and varying albedo, and require tuning of multiple parameters. An improved algorithm to extract water depth from multispectral satellite imagery was proposed by Stumpf, et al. (2003) to generate bathymetric maps with limited a priori information. The algorithm is based on the ratios of transformed reflectance values in the visible bands, retrieving greater depths than previous algorithms and compensating for variable bottom type and albedo. This method requires fewer tunable parameters and can be applied to low-albedo features. Although Stumpf, et al. (2003) conclude that the method is robust and works well over variable bottom types, recent studies have pointed out limitations, mostly attributable to varying albedo (Clark, 2005; Densham, 2005). This research attempts to quantify the contribution of variable benthic substrates to the algorithm’s...
accuracy by classifying the scene into its main bottom types and tuning the coefficients separately. The algorithm is evaluated using a QuickBird high-resolution multispectral image of the remote Midway Atoll, in the northwestern Hawaiian Islands. Classifying the image into two main bottom types and tuning the coefficients separately produces a small improvement in the accuracy of the bathymetric estimates when bottom reflectance is included as a factor. This result indicates that Stumpf, et al. (2003)’s ratio method is not insensitive to variable bottom type, and that knowledge of the distribution and extent of different benthic substrates in optically shallow waters has the potential to improve bathymetric derivation in remote coastal areas, such as coral reef environments in the Pacific.

**KEYWORDS:** Bathymetry, QuickBird, ENVI, Ratio Algorithm, Remote Sensing, Midway Atoll, IKONOS, Satellite, Multi-Spectral, Coral Reef

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**A COMMERCIAL ARCHITECTURE FOR SATELLITE IMAGERY**

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The objective of this research is to determine the possibility of an alternative for government-developed satellites that produce high-resolution imagery. This study focuses on the concept of the U.S. government’s purchasing proven and successful commercial satellites with minimal non-recurring engineering costs to help augment current national systems. The benefit with this alternative is the reliability and affordability of a system that is currently used in space, and therefore reduces a significant amount of risk and production time. A constellation of commercial satellites that are reconstituted on a monthly or quarterly cycle could also invigorate the commercial satellite work force and better produce future systems. Potential limitations with geolocation accuracy and data rate downlink transmission capability are disadvantages associated with an architecture of commercial satellites.

This thesis evaluates constellation design factors, such as orbit types, number of satellites, life-cycle, and ground segment implementation. A coverage capability evaluation is provided to determine how a commercial system would be able to fulfill national imagery collection requirements. Eight different constellation types are created, ranging from one to 12 satellites in size. Orbit analysis settled on a sun-synchronous polar elliptical orbit at 185 km x 700 km, using an existing commercial satellite with a 0.6m optic. This provides imaging with a resolution range between 10-37 inches. The largest constellation of 12 satellites provides a daily area collection of 43,000 km² and 150 point images for a region the size of Iraq and has an estimated $1-2B cost for an annual life cycle cost. Revisit time for mid-latitude targets is approximately one day at 10-inch resolution.

**KEYWORDS:** Space Operations, Commercial Imagery, Commercial Satellites, Space Capabilities, QuickBird, Imagery Requirements
DETECTION AND JAMMING LOW-PROBABILITY-OF-INTERCEPT RADARS
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Second Reader: Orin E. Marvel, Department of Information Sciences

An increasing number of LPI radars are integrated into integrated air-defense systems (IADS) and modern platforms and weapons, such as anti-ship missiles and littoral weapon systems. These LPI radars create a requirement for modern armed forces to develop new techniques, strategies, and equipment.

The primary objective of this thesis is to investigate methods and means to counter LPI radar threats integrated into modern platforms and weapons and to focus on the related techniques, strategies, and technology. To accomplish this objective, both platform-centric and network-centric approaches will be examined thoroughly.

**KEYWORDS:** Detection, Interception, Classification, Jamming, LPI Radar, Low Probability of Intercept Radar

EXTRACTING MATERIAL CONSTITUTIVE PARAMETERS FROM SCATTERING PARAMETERS
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In the frequency domain all materials can be described electrically by their complex permittivity ($\varepsilon$) and permeability ($\mu$). These constitutive parameters determine the response of the material to electromagnetic (EM) radiation. The precise knowledge of complex permittivity and permeability is required for both scientific and industrial applications. Due to the uncertainties in manufacturing processes, often the only way to find a material’s parameters is to measure them.

The concept of metamaterials, exhibiting negative permittivity and permeability, is attracting a lot of attention. Such materials are also termed left-handed materials (LHMs).

This thesis examines several methods to determine the effective permittivity and permeability of both normal materials and metamaterials. CST Microwave Studio is used to model the materials in both free space and rectangular waveguide environments to calculate the S-parameters (S11 and S21) from which the constitutive parameters can be extracted.

**KEYWORDS:** Complex Permittivity and Permeability, Negative Index, Metamaterials, Constitutive Parameters, S-Parameters
State-of-the-art technologies keep generating new ways of improving on the performance of old systems. Array antennas, a continuously improving technologies, have brought many benefits to our life. The superiorities of array antennas removes the disadvantages of the old technology radars, such as great sidelobes, vulnerability to the jammers, and degradation effect of the clutter. Array antennas find many applications in different areas. Today, use of unmanned aerial vehicles is increasingly more prevalent. UAVs prevent pilot loss of life. They carry out a variety of military and civilian missions, such as surveillance and reconnaissance, target recognition, battle damage assessment, electronic warfare, search and rescue, and traffic monitoring. An important use of UAVs is troop support, carrying out reconnaissance and surveillance missions, which requires maintaining a data-link with troops in order to send any data collected, such as video images or audio. During operations it is necessary to continuously maintain a data and control link with the operator. This requires the ground station antenna to track the UAV so the antenna beam is pointed properly. The purpose of this research is to design and build an array to angle-track a UAV and, eventually, to accomplish the data transfer from the UAV to the ground station.

KEYWORDS: Array, Tracking Antenna, Tracking, CST Microwave Studio, Characterization, LabVIEW

A SYSTEMS-ARCHITECTURE APPROACH FOR NEXT-GENERATION MINE-WARFARE CAPABILITY
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Martha J. Hall, Hampton University

When operating in a seaborne environment, sea mines can prevent U.S. Navy vessels from meeting operational objectives. Sea mines have the potential of damaging or destroying ships at sea. The U.S. Navy conducts mine warfare (MIW) operations to meet this threat. Although effective against mining, U.S. countermining operations are currently employing 1960s technology in an attempt to keep pace with new Concepts of Operations (CONOPS).

Today’s legacy MIW processes currently employed by the warfighter, although capable of countering the mining threat, is a reactive process that is slow to engage and employ assets that are cumbersome to operate. With the advent of new technologies, a transformation of MIW capability is on the horizon and has the potential of influencing how the U.S. Navy maintains maritime dominance in the open oceans and littoral environments.

The influence that technologies bring to MIW includes multi-spectral sensors, laser imagery, compact modular systems, unmanned and semi-autonomous weapons, and new communications architectures and tactics. Although these technical innovations present a level of capability superior to the existing legacy systems, developmental barriers and the lack of an overarching systems architecture will hinder or prevent these systems from being effectively integrated into tomorrow’s CONOPS.

This thesis examines the potential of the two competing designs for the littoral combat ship (LCS). The first design is by Lockheed Martin and has been designated USS Freedom, the U.S. Navy’s first LCS. The second design is by General Dynamics. This thesis focuses on the LCS usage concepts in naval capability pillars and information operations.

As a transformation platform, the LCS will be critical in implementing new operational concepts and in providing a focused, littoral mission platform for joint forces. Its superior speed and maneuverability; low radar, infrared, and acoustic signatures; and ability to lay distributed sensor fields are all fundamental to mission success. It will also carry a “squadron” of unmanned vehicles (air, surface, and undersea) that will considerably extend its sensor and weapon coverage, providing substantial Anti-Submarine Warfare (ASW) capabilities.

This thesis also discusses present and future platforms and their concepts of operation in Turkish littoral waters (Aegean Sea, Black Sea, and Mediterranean Sea).

**KEYWORDS:** LCS, Littoral Combat Ship, Littoral Warfare, Force Transformation, Turkish Navy, Surface Combatant, United States Navy, Network-Centric Warfare, Electronic Warfare

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**ELECTRONIC WARFARE: HISTORICAL PERSPECTIVES AND RELATIONSHIP TO INFORMATION OPERATIONS—CONSIDERATIONS FOR TURKEY**  
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Master of Science in Systems Engineering—September 2006  
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Second Reader: Edward L. Fisher, Department of Information Sciences

The purpose of this thesis is the exploration of the relationship and interaction between electronic warfare (EW) and information operations’ (IO) core, supporting, and related competencies. Understanding the definitions of information and its value, information superiority, and the decision making cycle provides the foundations for this thesis. Investigation of the historical transformation of EW from the U.S. Civil War to the first Gulf War, and also learning how the concept of IO was developed and evolved contributes to this study by helping to comprehend the modern day interaction between EW and each IO competency separately. This interaction is constructed upon the guidance and standards provided by the latest U.S. Joint Chiefs of Staff Publication, *Joint Publication 3-13, Information Operations*.

This study concludes that the relationship between EW and IO is increasingly interactive and consists of two aspects: limiting and interfering, and reinforcing and supporting. Also, the relationship between EW and each IO competency is not consistent between the core and supporting competencies. The EW relationship to IO is strongest with the core competencies. In addition to these conclusions, this study expresses some considerations for EW and IO applications with respect to the unique environment and requirements of the Turkish Republic.

**KEYWORDS:** Information Operations, Electronic Warfare, History of EW, Turkey, Elektronik Harp, Bilgi Harekati, Bilgi Destek Harekati, Radar, IO Competency, EW Relationship to IO, Information Superiority, OODA Loop, ASELSAN, MILDEC, PSYOP, Information Technology, Public Affairs, Civil Military Operations, Physical Attack, Computer Network Operations, PSYOP, Harekat Guvenligi, Psikolojik Harp, Turkiye
The aim of the thesis is to analyze India’s nuclear weapons command-and-control dilemma as a consequence of its 1998 nuclear tests. The small size of India’s nuclear weapons does not imply that its command-and-control structure would be simple. It would require the same infrastructure, capabilities, and operating concepts possessed by countries with larger number of nuclear weapons, but possibly on a smaller scale. A small arsenal is easy to control, but it is vulnerable to attack, and hence the issue of command and control becomes more complex. India’s No-First-Use (NFU) policy and the de-mated nuclear posture also make the command and control of nuclear weapons look simple, affordable, and easy to implement. However, the nuclear policy and posture must be examined through the prism of peacetime, crisis, and wartime situations. The smooth transition from peacetime to crisis and, if required, to wartime, demands a robust command-and-control system.

This thesis examines the requirements and then provides recommendations for the command-and-control structure for Indian nuclear operations. The thesis will investigate the U.S. command-and-control model and draws lessons for a suitable option for India. While NFU has many challenges, it can be effective provided that India adopts an operational capability of Launch After Attack (LAA), which would require a significant upgrade of command-and-control structure and procedures. In particular, this thesis demonstrates the role that civilians and military could effectively play to strengthen “minimum credible deterrence” within the established financial, political, and strategic parameters.

KEYWORDS: Nuclear Command and Control, Nuclear Weapons, Civil-Military Relations

THERMOMECHANICAL ANALYSIS OF GROUND-BASED, DIRECTED-ENERGY WEAPONS ON SATELLITES AND INTERCONTINENTAL BALLISTIC MISSILES

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Thermomechanical modeling and simulation of a satellite and intercontinental ballistic missile assumes importance due to the increased interest in assessing the potential of such attacks. Effective and innovative methods are sought in assessing the structural integrity of such structural components. In this study, modeling and simulation aspects of two generic models loaded by high-energy laser beam are presented. An application of MSC software in modeling thermomechanical behavior, both steady state and transient behavior of satellite and missile structures, is presented. Thermal energies used for simulation correspond to high-energy laser flux available at low earth orbits as reported in literature. A brief review of the concepts involved is outlined. The analysis is performed under several scenarios that include thermal failures due to steady state as well as transient thermal exposures. The thermal exposure times and locations are varied to assess typical failure modes of the structure. Analysis is conducted in order to define suitable material thicknesses that will make a satellite or a ballistic missile hardened enough to withstand these specific amounts of energy. Other parameters of interest pertaining to this study are the pulse width and resulting transient phenomena affecting the behavior. Temperature gradients and resulting thermal stresses and thermal deformations are reported in this study.

KEYWORDS: Thermo Mechanical Analysis, Satellites, Intercontinental Ballistic Missiles, Thermal Analysis, Structural Analysis, Stress Analysis, Transient Thermal, Structural and Stress Analysis, Ground Based Lasers, Atmospheric Propagation Losses, Failures, Pulse Width, Material Thicknesses
A CONCEPT OF OPERATIONS FOR THE USE OF EMERGENT OPEN-INTERNET TECHNOLOGIES AS THE BASIS FOR A NETWORK-CENTRIC ENVIRONMENT
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The industrial age spawned a revolution that brought fundamental changes to the business of commerce, the structures of society, and the theories of warfare that are used to this day. With the dawn of the information age, a similar revolution has begun, with the realization of the science of networks and their effects on complex systems, such as command and control and sharing information both internally and externally, of a traditional military organization. Recognizing the power of network-centric warfare, the U.S. military is transforming to develop that means. This has translated into the holistic requirement of agile, interoperable networks to achieve information superiority in fighting future wars and maintaining peace.

The purpose of this thesis is to provide a concept of operations for the use of emergent open Internet technologies as the basis for a network-centric environment. Examining current relevant research on networks and their application in the U.S. military, a system of information systems is presented to demonstrate current and potential capabilities in information sharing. Developing constructs, such as web feeds, portals, blogs, and wikis, are used to create an interconnected framework for use with coalition partners, other government agencies, non-government organizations, and internal communications.


INTEGRATING STAKEHOLDER REQUIREMENTS ACROSS GENERATIONS OF TECHNOLOGY
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Complex defense-acquisition programs, like that for the global-positioning system (GPS), must overcome many requirements engineering challenges in order to deliver capabilities to customers and satisfy other stakeholders. To meet these challenges and stay within cost and schedule constraints, engineers and managers need system requirements information organized in a clear, complete, and efficient manner to support decision making. An effective methodology tailored to the needs of the program decision makers will ensure that important information is correct, organized, and readily accessible. The GPS program is implementing a methodology that includes standardized processes across its segments. However, the GPS program refrained from implementing a better requirements engineering approach and using its current requirements engineering tool to take advantage of this approach.

Trellis-coded modulation (TCM) is a known technique to increase the data rate without increasing the channel bandwidth when implementing error correction coding. TCM is a combination of M-ary modulation and error correction coding. This thesis investigates the performance of a low spectral efficiency TCM system, which is compared with three alternative systems having comparable bandwidth. The three alternative systems are all non-TCM systems and consist of Quadrature Phase Shift Keying (QPSK) with independent $r=1/2$ error correction coding on the in-phase and quadrature components, 8-ary bi-orthogonal keying (8-BOK) with $r=2/3$ error correction coding, and 16-BOK with $r=3/4$ error correction coding. The effects of both additive white Gaussian noise (AWGN) and pulse-noise interference (PNI) are considered. The TCM system shows much better than expected performance and significant resistance to PNI, and performance improves as the number of memory element increases. The alternative QPSK system with soft decision decoding (SDD) experiences significant degradation with PNI. The 8-BOK with $r=2/3$ error correction and 16-BOK with $r=3/4$ error correction systems occupy approximately the same bandwidth as the TCM system and show better performance in PNI than the alternative QPSK system.

KEYWORDS: TCM, Trellis Coded Modulation, Hard Decision Decoding, Soft Decision Deciding, Pulse-Noise Interference, BER, Set Partition, M-BOK, QPSK, AWGN

PROPAGATION MODELING OF WIRELESS SYSTEMS ON SHIPBOARD EXTERNAL DECKS

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Many onboard ship operations demand full radio coverage over the entire ship, not only indoor, but also from the interior spaces to the other decks. On board a ship, specifically in the upper decks, radio-wave propagation is subjected to fading that would impede the quality and reliability of data links and communication. One example is the performance of unmanned aerial vehicle (UAV) data and communications links. The purpose of this thesis is to analyze, model, and simulate some communication scenarios that occur on naval ships using Urbana. Starting from known inputs (frequency, ship compartment geometry, material properties, propagation computation model, and antenna type), analytical results reflecting the propagation mechanisms and coverage area are presented. Variable inputs can then be optimized to achieve a desired signal distribution for a specific shipboard environment. The ship models are created by Rhino, a well known, Windows-based, computer-drawing software. The values of the signals received on the different points in the main deck are computed for different frequencies and powers. The results are used to draw conclusions of the deployment of antennas on the ship, as well as operational aspects, such as UAV flight paths.

In this thesis, the performance of the basic border-gateway protocol (BGP) Blackhole-routing methods in real test bed networks is evaluated. By using the response time, the central processing unit (CPU) load, and the link load as performance metrics, the performance of those methods in networks where the routers’ CPU load was the limiting factor is first evaluated. Then the effect of the high link load and the effect of the routers’ pre-configuration on the BGP Blackhole routing’s performance are examined. Results show that the BGP Blackhole routing may not be effective under stressful situations, that is, a high link load, because of its dependence on transmission-control protocol (TCP) and the underlying routing protocols. Of the three basic Blackhole routing methods, the best method is the destination-based, followed closely by the source-based. The third method, customer-triggered Blackhole routing, had very degraded performance in all cases.

**KEYWORDS:** BGP, Blackhole Routing, Null Routing, DDoS Attacks, Network Security
EVALUATION OF ORGANIZATIONAL SELF-ASSESSMENT TOOLS AND METHODOLOGIES TO MEASURE CONTINUOUS PROCESS IMPROVEMENT FOR THE NAVAL-AVIATION ENTERPRISE
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We live in a time that is alternately confusing and exhilarating. Our nation is fighting a war on terror, while attempting to manage our position as the world’s superpower. The U.S. Navy, including naval aviation, is being required to defend the nation in transformational ways with constrained resources. To support these efforts, the Naval Aviation Enterprise (NAE) was created to improve the lifecycle management of naval-aviation warfare systems. To meet the demands of this vision, the NAE has created a program called AIRSpeed to deliver the efficiency gains of continuous process improvement (CPI). NAE leadership seeks a common self-assessment tool to measure how well AIRSpeed has been implemented, including possible areas for improvement. This thesis studies the origins of continuous process improvement, the value of assessment, and current assessment methodologies. Key concepts are cited for the use of organizational-assessment tools. The objectives are an enhanced body of knowledge for enterprise assessment, to provide a comparison of several approaches, and to recommend a tool for NAE AIRSpeed. The tools to be considered are the Department of Defense’s CPI Transformation Guidebook (DoD CPITG), the Navy’s Performance Excellence Guidebook (NPEG), the Lean Aerospace Initiative’s Government Lean Enterprise Self-Assessment Tool (GLESAT), and the NAVAIR Alignment Assessment Tool (NAAT).

KEYWORDS: Enterprise Ass, Continuous Process Improvement, CPI, Performance Self-Assessment, AIRSpeed, Lean, Capability Maturity Model, DoD CPITG, GLESAT, NPEG, CMMI, LAI

AN ANALYSIS AND COMPARISON OF VARIOUS REQUIREMENTS-MANAGEMENT TOOLS FOR USE IN THE SHIPBUILDING INDUSTRY
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Second Reader: David M. Hicks, Northrop Grumman Ship Systems

Requirements are the cornerstone of all contracts for products and services. If requirements are not well defined and managed, the product or service may fail to meet the customer’s needs and costs may go up. This is especially true in the shipbuilding industry, where the customer has many requirements. Some are clearly defined while many more are undefined. Some requirements have to be generated from the implication of other requirements, while even more have to be pulled from other industry or military standards. This amounts to hundreds or thousands of requirements. Without the proper tools, managing all these requirements would be next to impossible.
This thesis investigates requirements management “best practices” and relates them to the needs of systems engineering in shipbuilding. This thesis also compares and analyzes several requirements-management tools to determine the best fit for the shipbuilding industry in vessel design. Recommendations for a specific requirements-management tool and its suggested use are provided.

**KEYWORDS:** Requirements Management, Requirements Development, Systems Engineering, Shipbuilding, Vessel Design, INCOSE

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**COMMERCIAL, OFF-THE-SHELF SECURITY ISSUES AND APPROACHES**

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Custom-built products do not always meet the new Department of Defense requirements. Their high cost and lengthy development cycle does not suit the information age, where communication information and technology grow quickly. To adapt to this new environment, commercial, off-the-shelf (COTS) products have become the core for military systems. This is the only way to approach the readiness requirements for armed forces. Like any other products, COTS products provide many advantages, but also carry side effects for military systems. One issue of primary concern for military use of a COTS product is security. This thesis provides analysis of approaches to identify the security vulnerabilities and recommends acquisition to minimize the issue. It is not the intent of this thesis to find a universal approach to solve the security issue of COTS products.

**KEYWORDS:** Security, COTS Software, DoD Software, DoD Acquisition Software

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**EFFECTIVENESS OF INTRODUCTORY FLIGHT SCREENING FOR UNITED STATES NAVAL AND MARINE CORPS STUDENT PILOTS**

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LT Henry Phillips, USN, Chief of Naval Air Training

This study examines the effectiveness of introductory flight screening (IFS) for U.S. Navy and Marine Corps student pilots. It compares a non-IFS group to an IFS-complete group to determine if IFS had any effect on primary drop-on-request (DOR) and flight-failure (FF) attrition. It then examines the return on investment (ROI) of the IFS program utilizing T-34 flying-hour costs, active-duty costs, and opportunity cost-savings of IFS-screened students who did not enter undergraduate pilot training. Results suggest that IFS did not have an effect on the DOR rate and may have produced the undesired effect of delaying the DOR-student’s decision until later in the syllabus. IFS had a desirable effect on the FF attrition rate with no significant change in T-34 flight hours per FF. The combined primary DOR and FF rate, although significantly lower, did not achieve expectations. The ROI analysis is completed with both composite-pay costs and individual account costs. In both cases, the IFS-investment costs significantly outweigh the IFS savings, resulting in a net loss and an undesirable ROI. Several alternatives are discussed as possible improvements to the current IFS program.

**KEYWORDS:** IFS, Introductory Flight Screening, Introductory Flight Program, Naval Aviation, Pilot Training, Flight Training, Pilot Production, Primary Flight Training, Navy Pilot, Marine Pilot, Student Pilot, Student Naval Aviator, T-34, T-34 Mentor, Flight Hour, Attrition, Attrition Rate, Undergraduate Pilot Training, Flight Failure, Drop on Request, Effectiveness, Return on Investment
A STUDY ON IMPROVING UNITED STATES AIR FORCE SPACE-SYSTEMS ENGINEERING AND ACQUISITION
Jeremiah B. Stahr-Captain, United States Air Force
B.S., United States Air Force Academy, 1999
Advisor: Thomas V. Huynh, Department of Systems Engineering
LtCol Christopher Forseth USAF, Air Force Space Command

Systems engineering is a vital element of systems acquisition, and yet, as a result of previous Department of Defense and United States Air Force policies and practices, many government systems engineers today lack the systems engineering/management skills required to successfully execute national security space programs. The purpose of this thesis is to study and understand common issues that have impacted the ability of the USAF to cost-effectively acquire satellite systems. The research performed here involves an analysis of the differences between the traditional DoD systems acquisition and the national security space systems acquisition processes and an investigation of previous national efforts to improve these processes. The analysis results, together with the findings from a review of successful and struggling space programs, are then used to discover trends that aid in the formulation of the recommendations in this thesis. Specifically, to improve USAF systems engineering management skills and thereby improve the national security space systems acquisition process, the role of the government systems engineer should be defined as one of risk management, and the government systems engineers should be trained, equipped, and tracked in order to efficiently perform systems engineering in support of the space systems acquisition process. Finally, the research findings provide a foundation for future researchers to expand upon the recommendations and make steady progress toward improving DoD and USAF space systems engineering expertise.

KEYWORDS: Systems Engineering, Space Systems Engineering, Systems Acquisition, Space Systems Acquisition
METHODOLOGY FOR EVALUATING THE EFFECTIVENESS OF COLLABORATIVE TOOLS FOR COORDINATING MARITIME-DOMAIN-AWARENESS EMERGENCY RESPONSE

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Second Reader: Susan Higgins, Department of Information Sciences

The federal government recognizes that collaboration between the various departments and the local, federal, and private sectors can best support maritime security. Of course, the question is how to get these entities to collaborate? Collaborative technology can provide an answer to maritime-domain awareness (MDA) and emergency-response collaboration, but the right tool for this mission must be selected. In order for the right tool to be selected, the right criteria must be used to evaluate the tool for this particular mission. The criteria must not only look at the tool or the network, but the whole picture: cognitive processes, organizational structure, and the doctrine and procedures of the players involved.

This thesis focuses on establishing criteria for evaluating collaborative tools in the tactical environment of MDA and emergency response collaboration. In this environment, an incident commander will need to coordinate military, coalition, federal, state, local entities, and non-governmental organizations. A methodology does exist that meets these criteria, the North Atlantic Treaty Organization’s code of best practice for assessing command-and-control systems.

KEYWORDS: NATO COBP, C4ISR Evaluation, Collaborative Technology, MDA, Emergency Response, Disaster Relief
MASTER OF ARTS

National Security Affairs
Security Studies
POLITICAL SOLDIERS AND DEMOCRATIC-INSTITUTION BUILDING IN BOSNIA–
HERZEGOVINA
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Richard Hoffman, Center for Civil–Military Relations

This thesis seeks to identify if, in the course of the United States’ and NATO’s democratic institution-
building efforts in Bosnia–Herzegovina, the United States and NATO are offering a viable model of how
military professionals interact with a healthy democratic society. Because the understanding of how
military professionals should interact with society as a whole is often flawed in the United States and other
developed democratic states, this study researches how well the United States and NATO are presenting a
realistic model to professional soldiers in Bosnia–Herzegovina. This study begins with a broad look at
civil-military relations theory and examines select historical examples of professional soldiers exceeding
their purview in developed countries, such as the United States and Britain. The Yugoslav People’s Army’s
political history is surveyed to examine the political involvement of professional soldiers in politics in the
former state of Yugoslavia. Lastly, this study examines contemporary Bosnia–Herzegovina and the West’s
democratic institution-building efforts.

KEYWORDS: Bosnia–Herzegovina, Democratization, Civil-Military Relations, Yugoslav People’s Army,
Defense Reform Commission

PERCEPTIONS OF REGIME LEGITIMACY IN MOZAMBIQUE: LEGITIMACY IN
TRANSITION?
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The growth and development of democratic regimes across the globe has been of particular interest to
political scientists over the last several decades. The question of what is an appropriate and relevant regime
depends on various aspects of people’s political ideals. Mozambique is one such nation wherein democratic
developments have been recent and somewhat successful. This thesis focuses firstly on the views and
political ideals of rural dwellers, and secondly on generational differences in political ideals and views on
regime legitimacy at the local level. It suggests youth and the elders have different views concerning how
they should be ruled and what constitutes a legitimate political regime. At the local level, there are
manifestations of the central democratic regime and the historically traditional regime. Rural youth
consider the democratic regime to be legitimate and the traditional regime to be incompatible with their
ideals. In their opinion, the existing traditional regime is outdated and irrelevant. Older adults in rural areas,
in contrast to the youth, are aware of the duality in regime-types at the local level, but believe there is a
place in the community for both to exist. In the opinion of the adults, both regimes are compatible with
their ideals and are thus legitimate. If these two significant segments of Mozambican society—rural youth
and rural elders—hold strongly opposing views concerning what constitutes a legitimate regime, this would
hold important implications for regime legitimacy in Mozambique.

KEYWORDS: Regime Types, Traditional Authority, Democracy, Youth, Legitimacy, Mozambique
The United States invaded Iraq in 2003 to compel compliance with UN disarmament mandates. The invasion exposed the lack of a standing organization to conduct weapons of mass destruction (WMD) elimination as a serious capability gap in the U.S. military force structure. This thesis demonstrates why it is necessary to establish such a capability. It is argued that the United States cannot rely solely on multilateral, cooperative approaches to eliminate a determined adversary’s weapons program. While non-coercive tactics are preferred, the mixed results of twelve-years of UN verification in Iraq show that a viable threat of force must accompany these approaches in order to induce compliance with UN Security Council disarmament mandates. Additionally, the U.S. elimination effort in Iraq demonstrated that ad hoc approaches inadequately address this capability shortfall. The lack of integrated training, unsecured sites because of inadequate prioritization, and misaligned intelligence assets are just some of the problems that occurred during the ad hoc Operation Iraqi Freedom elimination operation. When cooperative nonproliferation measures fail to rollback aggressor states’ WMD programs, the Department of Defense (DoD) must have the capability to compel compliance if called upon. This thesis provides recommendations to facilitate the development of a viable and sustainable WMD elimination capability.

KEYWORDS: WMD Elimination, SALW Elimination, Combating WMD, 75th XTF, ISG, 20th Support Command, Site Survey Teams, Mobile Exploitation Teams, Counterproliferation, Nonproliferation

Biological weapons have the ability to inflict mass casualties while keeping existing infrastructure intact. They are inexpensive to manufacture, difficult to detect, and have a low signature for attribution. In the 1970s, the Soviet Union began amassing the largest stockpile of biological weapons worldwide. The U.S. intelligence community repeatedly failed to detect the scope and character of this large-scale Soviet development effort despite implausible explanations for outbreaks of unexplained disease, credible ground reports from informants, and strange behavior patterns viewed through reconnaissance efforts. Toward the end of the Cold War, the U.S. intelligence community realized its grave error. Unfortunately, the majority of these weapons are unaccounted for today. By examining the reasons the Soviet Union’s biological weapons program went undetected, the United States may gain a better advantage for future assessments and prevent the large-scale stockpiling and development of biological weapons.

KEYWORDS: Biological Weapons, Soviet Union, Sverdlovsk, Aralsk, Lysenko, U.S. Intelligence, Brain Drain
The Uighur issue is of vital regional- and global-security importance to China. Although minority separatists are not well armed and seem to be largely disorganized, the violence poses a very real threat to China’s ability to develop Xinjiang. The Chinese Communist Party’s (CCP) behavior toward its Muslims has received renewed western attention in the aftermath of 9/11. China’s Uighurs have responded to CCP policies with violence and separatist activity, but the Hui (ethnic Chinese who are Muslim) have reacted with relatively high levels of accommodation. Some have blamed Uighur separatism on external influences (such as transnational terror) and Islam. However, the puzzle is, why do the Uighurs engage in separatism where the Hui do not? This study contributes to existing literature by directly comparing the Uighurs and Hui in order to determine the reasons behind Uighur separatism and Hui accommodation. This thesis argues that the Uighurs and Hui have faced different social and economic realities, which have led to different perceptions of inequality and thus, different reactions to CCP policy. Also, unlike the Uighur ethnic identity, the Hui identity stems from and is compatible with the People’s Republic of China (PRC) and Chinese society. This study uses primary sources, including interviews with Uighurs, Hui, and Han Chinese conducted in western China during June and July 2006.

KEYWORDS: China, Islam, Separatism, Secession, Uighurs, Hui, Minority Relations, Muslims, Xinjiang, Ethnic Identity

PROGRESSIVE RECONSTRUCTION: A METHODOLOGY FOR STABILIZATION AND RECONSTRUCTION OPERATIONS

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The intent of the author is to establish a methodology for future forcible interventions in the affairs of failed, failing, or rogue- and terrorist-sponsoring states in order to stabilize and democratize these nations in accordance with stated United States’ goals. The argument follows closely current and developing United States military doctrine on stabilization, reconstruction, and counterinsurgency operations. Further, the author reviews several past interventions from 1844 to the present. Conducting a survey of colonial, imperialist, and pre- and post-World War II, Cold War, post-Cold War, and post-September 11th interventions to determine the techniques and procedures that proved most successful, the author proposes a program of intervention and reconstruction called Progressive Reconstruction. Progressive Reconstruction incorporates many of the successful activities of these past and present doctrines. The cornerstone of the methodology is the combination of rapid decisive combat and stabilization operations leading to a series of governmental transitions from foreign direct and indirect to indigenous independent rule.

KEYWORDS: Stabilization, Reconstruction, Counterinsurgency, Military Intervention, Martial Law, Military Government
ORGANIZING THE FIGHT: TECHNOLOGICAL DETERMINANTS OF COALITION COMMAND-AND-CONTROL AND COMBAT OPERATIONS
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Despite the political impetus for greater multilateralism in international military operations, recent coalitions including U.S. forces reflect a trend toward increasing U.S. dominance and decreasing allied participation. As the United States continues to invest in its military with research, development, and acquisition budgets at least double that of any other nation, it fields technologies so advanced with respect to its allies as to leave them incompatible for combined operations. Recent coalition operations suggest that there is a close relationship between technological asymmetries created by partner contributions and the structures formed as the coalition assembles. Using Desert Storm and Operation Allied Force as case studies, this thesis identifies a systemic relationship between technological advantage and coalition dominance. As a coalition seeks to reduce aggregate risk, it relies on technologies that offer the greatest effectiveness. This reliance causes the coalition to divert combat burden to the technologically dominant partner, which, in turn, imposes its operational culture. This thesis concludes that the technological transformation currently underway in the U.S. Department of Defense conflicts with U.S. political initiatives to promote greater multilateralism in combat operations by forcing allies to rely on U.S. technologies, thereby creating more unilateral operations.

The state of Utah, like all states and the federal government, has had a longstanding need to improve communication capacity in its emergency-response and public-safety system. As government entities strive to meet this priority in the national strategy for homeland security, it is crucial that communication systems be interoperable. Ironically, the groundwork for establishing an interoperable communication system nationwide is dependent upon effective human communication and coordination among policy makers, homeland security professionals, first responders, and technologists.

Accurate and complete information, in the right hands at the right time, can prevent, deter, or mitigate a terror event or other mass casualty event. As hosts of the 2002 Winter Olympics, Utah understood that communication was critical to incident command and control and created a world-class 800 MHz communication system to support that mission. Since the 2002 Winter Olympics, with the leadership of former Governor Olene S. Walker and hard work and dedication from multiple agencies, Utah has developed that basic Olympic communications blueprint into the Utah Wireless Integrated Network (UWIN). It is the nation’s first statewide, interoperable, wireless, voice-and-data network and it is used every day by Utah’s public-safety professionals.

**KEYWORDS:** Communication System, Interoperability, Information, Wireless, Voice and Data Network, 2002 Winter Olympics

The United States Department of Homeland Security has proposed that the nation’s system of response to terrorism and catastrophic disasters would be more practical and efficient if handled on a regional basis throughout the country. Regionalization is one of three overall priorities under the national preparedness goal. The primary hypothesis is that there is a mismatch between the federal government’s expectations of regionalization and the understanding of it by state and local governments. This lack of understanding will negatively impact the expenditure of federal funds in the future. The author proposes that there are six major reasons regionalization may fail, and that a change of policy by the federal government will be necessary to increase the chance of success. The reasons include a lack of definition for regionalization; the impact of federalism; the influence of risk-based funding on local interest in regionalization; the impact of home rule and local autonomy; risk and liability questions; and the lack of leadership. Three options are considered, including maintaining the same program, creating a Regional Homeland Security Service Agency, and the Regional Council of Governments (RCG) approach.
As the threat of domestic terrorism increases and the demands on emergency responders and the public intensify, a more distributed, efficient, and flexible training and collaboration model is needed to guide future efforts. The current blended learning strategy unintentionally limits collaboration. As learners move away from interactive learning to more static-based solutions, continuing education and collaboration is severely limited.

This research investigates the potential impact of homeland-security “communities of learning” on information sharing, training costs, and innovation. This study reviews current efforts in Internet-based interactive learning through an analysis of networked-based learning. A futures forecast is conducted, identifying trends and events that may influence the future of communities of learning.

The research findings support the creation of homeland-security communities of learning that are designed to include collaborative technologies such that information sharing leads to enhanced capabilities and innovation. A strong correlation ($r = .798$) is attributed to the degree to which networked-based learning contributed to knowledge accumulation.

The study presents a strategic plan, implementation framework, and community of learning pilot. The pilot includes previously excluded participants from non-emergency responder public and private stakeholders. Additionally, the pilot identifies a significant cost savings with communities of learning.

KEYWORDS: Communities of Practice, Communities of Learning, Internet Based Interactive Learning, Networked Based Learning, Nominal Group Technique

A COMPILATION OF NECESSARY ELEMENTS FOR A LOCAL GOVERNMENT

CONTINUITY-OF-OPERATIONS PLAN

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National and state homeland-security strategies call for continuity-of-operations plan development. The 2006 Nationwide Plan Review Phase II report identifies continuity of operations plan (COOP) development as a state and local goal, with a federal goal of providing continuity of operations plan development support. Most local governments do not have a continuity of operation plan or existing plans need to be updated. Continuity-of-operations plan guidance is provided by a variety of international, federal, state, and local documents. Common, unique, and best-practice elements are identified and should be contained in a continuity of operations plan. An identified compilation of continuity-of-operation elements is presented. Planning templates are good for COOP document structure and should contain the compilation of COOP elements (a recommended template is offered). Local government continuity-of-operations plan developers must independently develop and “own” their continuity of operations plan based on the compilation COOP elements. An after action-report is a necessary component for continuity of operations plan maintenance and can be used for continuity of operations plan research. Academia must pursue continuity of operations.
plan research to qualitatively and quantitatively identify effective continuity of operations plans and their respective elements. With the advent of homeland security as an academic pursuit, research opportunity exists and should be supported by the federal government because of the critical nature of an effective COOP for local government in ensuring the continuity of essential functions during and after an event.

KEYWORDS: Continuity of Operations, COOP, Continuity of Government, COG, Delegation of Authority, Order of Succession, Alternate Facility, Essential Functions, Federal Preparedness Circular 65, FPC 65, COOP Template

THE IMPACT OF POLICE AND MEDIA RELATIONS ON A CRISIS
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Effective crisis management and communication is crucial during any catastrophic event, otherwise fear, panic, and mass hysteria can prevail. The public relies heavily on the government (police) and the media for information during a crisis. This thesis focuses on a joint police-and-media response plan and outlines a preparation plan to assist the public during a terrorist attack or similar crisis. Historically, the police and media have had opposing views regarding sharing and disseminating information to the public. This report studies the inherent mistrust between both organizations and proposes strategies to overcome the suspicion and build a partnership. Proven community policing models within the Philadelphia Police Department are examined as a potential template for a police and media partnership. Survey results and focus group responses from the police, media, and the community are presented. This document examines national and international lessons learned and offers best practices on providing timely and accurate information, educating and informing the public and improving communication and trust between the police and the media. The proposed police and media training curriculum breaks down the cultural barriers and develops mutual respect for each individual profession.

KEYWORDS: Police and Media Relations, Police and Media Partnership, Community Policing Model, Community Relations, Fear Management, Mass Hysteria, Crisis Management, Crisis Communication, Philadelphia Police Department, Philadelphia Media

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The Medical Reserve Corps (MRC) was formed to provide a cadre of trained medical volunteers to support and strengthen the public health infrastructure and improve its emergency-preparedness level. Training policies and standards are left to the discretion of the local MRC coordinator so the program maintains its flexibility to meet community needs. Training varies from unit to unit, and there are no protocols in place to measure or evaluate the effectiveness of that training. According to recent studies and surveys, disaster operations are an unfamiliar role for most MRC volunteers and the public health workforce in general. Evidence also suggests that few medical and public health workers receive this important preparedness training. In 2005, MRC working group members developed a list of core competency recommendations to provide training guidance, but specific educational content to satisfy those competencies were not defined. This thesis offers specific training content guidelines and strategies for achieving competency. The MRC
must be able to integrate into the disaster environment while working safely, effectively, and efficiently. Standards will set the mark for success, enabling the MRC to respond in a coordinated manner, and at a consistently higher level, to any public health emergency.

KEYWORDS: Medical Reserve Corps, Citizen Corps, Public Health Preparedness, Training

BORDER PROTECTION AND THE NATIONAL SECURITY OF MONGOLIA  
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Both globalization and the 9/11 terrorist attacks spawned heated debates about border security. It is widely agreed that in a globalizing world, borders should be as open as possible and much has been written in recent years about the value of “soft” borders in maintaining good relations between neighboring states, creating borderland prosperity, and developing successful open-market economies. The reality in many parts of the world is that borders are hardening rather than softening as states, more than ever, seek to protect themselves from perceived external threats and to ensure that their frontiers are secure. Thus, today, managing borders and maintaining their security is a complex and challenging task for states.

The aim of this thesis is to examine the implications of the re-emergence of security as a key dimension of boundary management and to seek answers to questions, such as “Can borders actually be made secure?” and “If so, what border management strategies are available and how are they working in practice?” mostly, in Mongolia.

According to the Mongolian National Security Concept of 1993, one of the nine securities of Mongolia, the security of the Mongolian existence is defined by the guarantee of its independence, sovereignty, inviolability of state borders, and territorial integrity. In the last fifteen years, the need for improvements in state border protection has arisen as a result of changes in foreign policy and socio-economic situations, global military and political circumstances, and trends in relations with neighboring countries.

This thesis explores the effects of the policy options on the prevention of terrorism within Mongolian borders. It also explores the effects of those policy options on the movement of people across international borders. The scope is limited to border security policy, and implications are drawn for Mongolian policymakers. Three case studies are included from the border protection services of the United States, the Russian Federation, and the People’s Republic of China.

It is generally accepted, both practically and theoretically, that secure state borders are an integral part of the national sovereignty, independence, and territorial integrity of any nation. In the information technology-dominated new century, the guarantee of national state borders’ security and protection may be ensured if the specific national traditional ways of ensuring border security are creatively adjusted to modern international standards and to the latest scientific and technological trends.

KEYWORDS: Mongolia, National Security, Border Protection, Boundary, Demarcation, Boundary Delimitation, Territory, Border, Boundary, Border Guard, Border Patrol, Illegal Immigration
Historically, the American governance system, divided into federal, state, and local jurisdictions, does not provide a natural vehicle for discussing public policy issues from a regional, multi-jurisdictional perspective. The autonomy of local jurisdictions and competing priorities within and among them makes regional coordination difficult. Efforts that seek to overcome these challenges to coordinate regionally must take into account the different operational structures and civic traditions of states and municipalities.

The establishment of a Homeland Security Regional Structure will support the Department of Homeland Security (DHS) mission of leading a unified national effort to secure America. The homeland-security regions will enhance the national effort to prepare for threats and hazards to the nation. The regional structure will move DHS support closer to state and local governments that have been overwhelmed by new requirements for homeland security within their jurisdictions. Engaging state and local governments at the regional level provides the best opportunities for the integration of homeland-security efforts across all levels of government.

KEYWORDS: DHS, Region, Homeland Security, NRP, NIMS

Many states do not currently have an intelligence fusion center, and therefore, their ability to prevent and deter a terrorist attack is limited by the lack of information sharing. Wisconsin, in addition to many other states, lacks a central hub for information exchange and currently has no system in place that allows the variety of technologies to gain access to a common database to gather and/or exchange information. The vast majority of public safety agencies currently operate their own systems that are incapable of exchanging information. The inability to exchange and/or access information in a user-friendly format has inhibited many state and local efforts to keep citizens safe from the possibility of a terrorist attack. The ultimate goal is to provide a mechanism where law enforcement, public safety, and private sector partners can come together with a common purpose and improve the ability to safeguard our homeland and prevent criminal activity. Terrorism early warning systems (TEWs) embody the core of collaboration and are an effective tool to maximize available resources and build trusted relationships. The fusion process should be organized and coordinated on a statewide level between the major Urban Area Security Initiative (UASI) areas and the statewide fusion center concept.

KEYWORDS: Information Sharing, Network, Intelligence Fusion Center, Terrorism Early Warning System, Wisconsin, Milwaukee
The aim of the thesis is to analyze India’s nuclear weapons command-and-control dilemma as a consequence of its 1998 nuclear tests. The small size of India’s nuclear weapons does not imply that its command-and-control structure would be simple. It would require the same infrastructure, capabilities, and operating concepts possessed by countries with larger number of nuclear weapons, but possibly on a smaller scale. A small arsenal is easy to control, but it is vulnerable to attack, and hence the issue of command and control becomes more complex. India’s no-first-use (NFU) policy and the de-mated nuclear posture also make the command and control of nuclear weapons look simple, affordable, and easy to implement. However, the nuclear policy and posture must be examined through the prism of peacetime, crisis, and wartime situations. The smooth transition from peacetime to crisis and, if required, to wartime, demands a robust command-and-control system.

This thesis examines the requirements and then provides recommendations for the command-and-control structure for Indian nuclear operations. The thesis will investigate the U.S. command-and-control model and draws lessons for a suitable option for India. While NFU has many challenges, it can be effective provided that India adopts an operational capability of launch after attack (LAA), which would require a significant upgrade of command-and-control structure and procedures. In particular, this thesis demonstrates the role that civilians and military could effectively play to strengthen “minimum credible deterrence” within the established financial, political, and strategic parameters.

KEYWORDS: Nuclear Command and Control, Nuclear Weapons, Civil-Military Relations

The analysis of domestic incidents of terrorism has revealed many gaps in our nation’s capability to effectively manage the multi-jurisdictional response. Although many gaps have been addressed through implementation of measures based on lessons learned, the most pervasive unresolved issue remains the ability to properly identify first response personnel on incident scenes. The nature of incidents of terrorism requires force protection to be a priority because of the threat of a secondary attack. Identity must be established and authenticated to protect responders and prevent infiltration to perpetrate a secondary attack.

This thesis examines and evaluates several options for closing this pervasive identity management capability gap. The current decentralized identity system, a defined and typed response resource for identity management, and the federal identity project initiated under HSPD-12 are examined and evaluated as mechanisms for improving on-scene identity management in the response to incidents of terrorism. The thesis argues that developing a standardized, nationwide responder identity token that can be rapidly authenticated and establishing dedicated identity management response resources are essential to improving the response to multi-jurisdictional and catastrophic incidents of terrorism.

KEYWORDS: Identity Management, Identity Management Team, Credentialing, Terrorism Incident Response, Smart Card, Identity Authentication
Our national security and prosperity depend in part on secure and competitive ports. Effective public and private sector collaboration is needed in a world with myriad security challenges and fierce global competition. Although steps have been taken in the years since 9/11 to realize these twin goals much more needs to be done. The current maritime domain awareness (MDA) paradigm needs to be expanded to provide comprehensive awareness of intermodal operations in our ports. An effective Open Source Intelligence (OSINT) program that succeeds in leveraging intermodal data is fundamental to better port-level MDA. Developing effective port-level MDA and using it to enhance the security of our ports relies on the effective organization of public and private sector resources. The joint operations centers called for in the SAFE Port Act, once broadened to include key intermodal players, provide an excellent organizational model to pursue enhanced port security.

**KEYWORDS:** Homeland Security, Intermodal, Joint Operations Centers, Maritime Domain Awareness, Maritime Security, Open Source Intelligence, Port Security

**THE SANDBOX STRATEGY: THE WHY AND HOW OF FEDERAL LAW ENFORCEMENT INTEGRATION**

This thesis examines the interoperability of federal law enforcement’s Big Six investigative agencies, including the Federal Bureau of Investigation (FBI), Immigration and Customs Enforcement, Drug Enforcement Administration, Alcohol Tobacco Firearms and Explosives, Internal Revenue Service-Criminal Investigative Division (CID), and the United States Secret Service-Investigations. The main issue is whether, in the post-9/11 environment of transnational and terrorist criminal threats, the current administrative and jurisdictional configuration of the Big Six within three executive departments with overlapping duties marginalizes the nation’s investigative work-product. This discussion includes the establishment of metrics used to gauge the functionality of the Big Six and, thus, to determine whether negative characteristics are present that materially affect the “total” mission. Ultimately, the conclusion is drawn that the integration of the Big Six into a single agency, namely the FBI, would better serve the nation’s federal investigative law enforcement needs. This leads into the next area of discussion, which is how to integrate the Big Six. Lastly, an analysis of what the federal investigative mission means and whether it should include a domestic intelligence product is provided.

**KEYWORDS:** Federal Law Enforcement, Criminal Investigations, Policing, Immigration and Customs Enforcement, Federal Bureau of Investigation, Drug Enforcement Administration, Alcohol Tobacco Firearms and Explosives, Internal Revenue Service-Criminal Investigative Division, United States Secret Service-Investigations, Negative Characteristics, Intelligence Community, Merger, Integration
MEASURES OF EFFECTIVENESS: ISRAELI COUNTERTERRORISM STRATEGIES AND TACTICS DURING THE AL-AQSA INTIFADA  
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On September 28, 2000, Israel's Likud party leader, Ariel Sharon, visited the Temple Mount in the Old City of Jerusalem. His visit spawned the al-Aqsa Intifada, a period of significant Palestinian resistance that has never “officially” ended, and whose reverberations continue to be felt to this day. This thesis assesses Israel’s counter-terror strategies and tactics during the al-Aqsa Intifada in light of established scholarly measures of effectiveness. This research focuses on specific Israeli actions aimed at countering Palestinian resistance. These include targeted assassinations, home demolitions, collective punishments, border controls, administrative detention, controls on terrorist financing, and technological advances. These tactics are assessed year by year to determine whether there is a correlation between the tactics and the number of anti-Israeli terrorist incidents. This tactical analysis provides a basis on which to appraise Israeli counter-terror strategy and its long-term effectiveness. The thesis concludes with a consideration of the long-term implications of the Israelis’ experience.


PREVENTING TERRORIST BOMBINGS ON UNITED STATES SUBWAY SYSTEMS  
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In the last three years, major attacks on mass transportation in Moscow, Madrid, London, and Mumbai have left hundreds dead, thousands injured, and the world searching for answers. Subway systems are not only attractive targets, but evidence persists of a continued terrorist interest in conducting attacks on United States subways and railways. An attack on a subway or rail system in the United States could cause substantial loss of life and could have an adverse impact on public confidence, resulting in massive economic loss.

This thesis examines a series of security initiatives that collectively comprise a plan to be used as a template for mass transit systems in the United States that operate a subway. The core goal of these initiatives is to identify ways to increase the probability of early detection to prevent terrorist bombings of all types on United States subway systems.

KEYWORDS: Preventing, Bombings, Mass Transportation, Intelligence Sharing, Behavioral Screening, Subway Systems
CRITICAL INFRASTRUCTURE PROTECTION: HOW TO ASSESS AND PROVIDE REMEDY TO VULNERABILITIES IN TELECOM HOTELS
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America’s open society includes a vast array of critical infrastructure and key resources that are vulnerable to terrorist attacks. While it is not possible to protect or eliminate vulnerabilities of all critical infrastructures in the United States, strategic improvements can be made to harden these assets and mitigate any damaging effects if an attack were to occur. Current network assessment methods and protective measures are inadequate. As a consequence, the need for a scientific methodology for implementation of critical infrastructure protection is required. A standardized vulnerability assessment/risk analysis tool needs to be developed and implemented for the Critical Infrastructure Protection Programs to analyze complex networks and examine critical nodes. This will help to prevent, deter, and mitigate the effects against terrorist attack in accordance with HSPD-7. This thesis examines ways that vulnerability analysis is currently conducted and could be improved to establish an all-encompassing methodology to identify, prioritize, and protect critical infrastructure. Through analysis and research, this thesis recommends that the National Communications System under the Department of Homeland Security (DHS) establish the required policy initiatives to mandate the National Reliability and Interoperability Council’s current and future “best practices,” and set a vulnerability assessment/analysis standard based on Model-Based Vulnerability Analysis (MBVA) and Joint Staff Integrated Vulnerability Assessment (JSIVA) methodologies.

KEYWORDS: Telecommunications, Carrier Hotel, Critical Infrastructure Protection, Telecom Hotel, Joint Staff Integrated Vulnerability Assessment, Model-Based Vulnerability Analysis, Local Exchange Carriers, Inter-Exchange Carriers, Meet-Me-Rooms, Data Center, Central Office, Colocation Facility, Network Access Point

CHEMICAL FACILITY PREPAREDNESS: A COMPREHENSIVE APPROACH
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This thesis proposes that private and public sectors should partner together to improve the preparedness of chemical facilities against acts of terrorism. More specifically, key stakeholders from both sectors need to join together to forge Regional Defense Units (RDUs). Their primary purpose is to effectively reduce the attractiveness of regional chemical facilities as targets for terrorists without unduly hampering their operations. To achieve this goal, a mixture of mandates (“sticks”) and incentives (“carrots”) needs to be regionally developed, implemented, and sustained by the RDUs. Collaborative regional efforts using an appropriately balanced “carrot and stick” approach can be the most effective option for federal policymakers and the Department of Homeland Security to improve chemical facility preparedness, and thus improve homeland security.

IMPROVISED INCENDIARY DEVICES: RISK ASSESSMENT, THREATS, VULNERABILITIES, AND CONSEQUENCES

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The current trend in terrorist tactics is the use of simple, inexpensive, and conventional weapons. One such weapon is improvised incendiary devices (IIDs). The homeland security community has underestimated the magnitude of the threat. Policy makers must recognize the potential for terrorist cells to use IIDs to create terror and fear in the public. IIDs have the potential to create devastating fires, resulting in mass casualties.

In addition to evaluating the risk of an IID attack and determining the state of preparedness of first responders, this thesis includes a proposal for the creation of two new national planning scenarios, urban and wildland conflagrations or firestorms. Recommendations include incendiary protocols in the weapon of mass destruction matrix as represented by “I” in CBIRNE (i.e., chemical, biological, incendiary, radiological, nuclear, explosive). This organizational change can be applied to the homeland security strategies, lexicons, and documents of federal, state, and local governments and the private sector to address the IID threat.

This thesis is intended to serve as a catalyst for the Department of Homeland Security to set policy that will decrease vulnerabilities to and consequences of this lesser-known threat.

KEYWORDS: Improvised Incendiary Devices, IID, Pyro-Terrorism, Arson, CBRNE, CBIRNE, Conflagrations, Firestorms, Incendiary Terrorism, Wildland Fires, Wildland-Urban Interface, WUI, Weaponized Fire

MILITARY INTEGRATION AS A FACTOR FOR POST-CONFLICT STABILITY AND RECONCILIATION: RWANDA, 1994-2005

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The international community adopted Disarmament, Demobilization, and Reintegration (DDRI) programs at the end of the Cold War in 1989 as a means to end violent conflicts in various parts of the world. The traditional DDR programs were designed either to disband the defeated enemy forces or to integrate ex-combatants where the fighting was not conclusive. Exclusion of ex-combatants has resulted in renewed conflict. This thesis argues that conventional DDR has neglected two important aspects that are crucial for sustainable stability and societal reconciliation: military integration and a sensitization program. In contrast, an approach that integrates former enemy forces and equally reinserts ex-combatants and government forces into civilian society not only ends violent conflict, but also bridges the social gap among ethnic groups and, consequently, enhances societal reconciliation. The Rwandan DDRI program considers integration/reintegration of ex-combatants that precedes the sensitization phase, which takes three to four months; this led to stability and reconciliation after the 1994 genocide. Ingando is a reconciliation tool that transforms negative perceptions that cause ethnic hatred; mitigates conflict influence factors; and manages defeat, shame, and remorse on the part of the loser. Therefore, DDRI programs that integrate a sensitization program and exit strategy lead to sustainable stability and reconciliation.

KEYWORDS: Military Integration, Disarmament, Demobilization, and Reintegration, DDR, Reinsertion, Ingando-Solidarity Camps, Stability and Societal Reconciliation
This thesis focuses on the medical part of the public health response to Hurricane Katrina, specific to the issues of utilization of the private, non-governmental health professional. A brief survey is completed by thirty-nine state-level bioterrorism hospital coordinators. Information obtained highlights the issues of the inability to deploy these private health professionals. Traditional governmental mutual aid mechanisms do not cover private non-governmental health professionals for workers compensation and death benefits.

A review of the potential deployment mechanisms provides insight to the challenges and complexity specific to private health professionals. The motivation for volunteerism highlights the importance of targeting volunteer activities to the motivation of the individual volunteer. Investigating the impact thwarting the private, non-governmental health professionals may have on future planning and response activities reinforces the need to modify the structures currently in place.

The National Response Plan stresses the importance of including private industry into emergency preparedness and response strategies. This thesis outlines a strategy to pilot a project working with an established state volunteer registry by providing mechanisms to federalize those pre-identified pre-credentialed volunteer health professionals. Once completed, this pilot could be expanded to other states, ensuring a solid mechanism to quickly and safely mobilize this critical response discipline.

**KEYWORDS:** Medical, Private, Non-Governmental, Health Professionals, Thwarting Volunteerism, Liability, Workers Compensation, Death Compensation, Deployment, Survey, Public Health, Hurricane Katrina, Mutual Aid, EMAC

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Adaptive terrorist organizational structure and the lack of intelligence sharing were to blame for terrorist attacks on September 11, 2001. Because terrorist groups are moving toward a less predictable, but more diverse, dynamic, and fluid structure, effectively combating of terrorism requires fighting terrorists with a network. This network must be capable of collecting and sharing credible, reliable, and corroborative information on an unprecedented scale, transcending geographic, agency, and political boundaries.

This thesis demonstrates utilization of a network-theory approach for sharing information, which it is argued, can provide insight into the system dynamics of the U.S. intelligence community because it allows a systematic, comparative analysis of the system representation and fundamental problems associated with information sharing. The problems associated with past intelligence failures can be overcome with such a system because the use of a dedicated, nationally networked system will allow completion of three primary tasks: 1) examination of the strength of criminal/terrorist connections, 2) identification of suspects and mapping of networks, and 3) prediction of future behavior and better likelihood of prevention, response, and prosecution. A dedicated, national, networked intelligence-sharing system called Dedicated National Intelligence Network (DNIN), including geographic areas, regional centers, personnel, computer information technology (IT) networks, and policy options, is discussed.
KEYWORDS: Network Theory, Intelligence, Knowledge Management, Intelligence Sharing, Radicalization, Data Warehousing, Transactive Memory Systems, Terrorist Networks, Economy of Scale, Organizational Structure, Comparative Analysis, Network Centric

WHAT SHOULD BE THE RELATIONSHIP BETWEEN THE NATIONAL GUARD AND UNITED STATES NORTHERN COMMAND IN CIVIL-SUPPORT OPERATIONS FOLLOWING CATASTROPHIC EVENTS?

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Military civil-support operations following Hurricane Katrina revealed a compelling need for improving the command-and-control arrangements between the National Guard, operating in Title 32 status subordinate to the governors, and U.S. Northern Command (USNORTHCOM), which controlled all of the assigned Title 10 active duty forces subordinate to the President. This paper details the three mutually exclusive duty statuses of the National Guard, reviews the statutory, strategy, and policy environment, and examines the joint military doctrine that covers civil support. The three potential command-and-control models and their strengths and weaknesses are described. A detailed analysis of the USNORTHCOM’s Defense Support of Civil Authority concept plan with recommended enhancements is presented. The thesis concludes that the command-and-control arrangement is situationally dependent and provides considerations for the commander. There is no directive authority that compels the National Guard to work with U.S. Northern Command. However, there are mutual benefits to working in partnership to create the coordination and communication model organization and procedures for future civil support. The USNORTHCOM commander needs to build trust with the governors, and then get a full time National Guard brigadier general on his staff to complete the coordination with the states.

KEYWORDS: Defense Support of Civil Authorities, Civil Support, National Guard, Command and Control, U.S. Northern Command, National Response Plan

SACRAMENTO REGIONAL RESPONSE GUIDE TO RADIATION EMERGENCIES

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Accidental or intentional release of radiation may result in catastrophic consequences to urban and suburban populations. Any emergency response is compromised by insufficiently detailed protocols, and qualitative or quantitative wants in equipment and training. These challenges are no less acute for Sacramento County, which is an archetype of at-risk suburban and urban settings. Recognized standards in critical patient care illustrate the need for specific considerations for radiological contaminated patients in a response protocol. Current practices in Sacramento require patient decontamination prior to treatment or transport. This may adversely affect survival profiles, despite national and international standards that specifically provide for consideration of alternative procedures.

Radiation responses require a systems approach, whereby all work collaboratively towards a common goal. Incident commanders must appreciate their role in a radiation response, and know how to incorporate the response into a unified, multi-jurisdictional command. Additionally, an essential component of any radiation response protocol is to decrease the associated “fear” of radiation in both the general public and emergency responders.
Best practices research and recommendations at local, state, national, and international levels are compiled into a usable radiation response protocol that can be utilized in formulating protocols in radiation emergency response.

**KEYWORDS:** Sacramento Regional Radiation Protocol, Emergency Response Agencies, Local Agency, Fire District
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