The work reported herein was supported by various Department of Defense activities, Federal Government agencies, and non-government agencies.

Reproduction of all or part of this document is authorized.

Reviewed by:  
Released by:
**Title and Subtitle**

Summary of Research 2010

**Performing Organization Name(s) and Address(es)**

Naval Postgraduate School  
Monterey, CA 93943-5000

**Sponsoring/monitoring Agency Name(s) and Address(es)**

Naval Postgraduate School  
Monterey, CA 93943-5000

**Distribution/Availability Statement**

Approved for public release; distribution is unlimited.

**ABSTRACT**

This report contains project summaries of the research undertaken at the Naval Postgraduate School. A list of recent publications is also included, which consists of conference presentations, books, contributions to books, published journal papers, and technical reports. The research was conducted in the areas of National Security Affairs, Computer Science, Defense Analysis, Information Science, Operations Research, Aeronautics and Astronautics, Electrical and Computer Engineering, Mathematics, Mechanical Engineering, Meteorology, Oceanography, Physics and Business and Public Policy. This also includes research by the Space Systems Academic Group, the Cebrowski Institute (formerly the Institute for Information Innovation and Superiority, I2SI), the Wayne E. Meyer Institute of Systems Engineering (formerly the Institute for Defense Systems Engineering and Analysis, IDSEA), the MOVES Institute (Modeling, Virtual Environments, and Simulation), and the Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS).

**Subject Terms**

<table>
<thead>
<tr>
<th>Security Classification of:</th>
<th>Limitation of Abstract</th>
<th>Number of Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclassified</td>
<td>Unlimited</td>
<td>Unlimited</td>
</tr>
</tbody>
</table>

**Security Classification**

Unclassified

**Telephone Number**

831-656-2099

**Name of Responsible Person**

Danielle Kuska
THE NAVAL POSTGRADUATE SCHOOL MISSION

Enhance the combat effectiveness of the Navy and Marine Corps by conducting and directing advanced education of commissioned officers, and providing such other technical and professional instruction as may be prescribed to meet the needs of the Naval service. In support of the foregoing, and to sustain academic excellence, foster and encourage a program of relevant and meritorious research.
PREFACE

Research at the Naval Postgraduate School is carried out by faculty in the four Graduate Schools, Research and Education Institutes, Research Centers, and the School of Aviation Safety. This volume contains research summaries for the projects undertaken by faculty during 2010. The summaries are grouped by School and Institute and include an overview, faculty listing, and a compilation of publications/presentations.

Questions about particular projects may be directed to the faculty Principal Investigator listed, the Department/Group Chair, or the Associate Chair for Research. Questions may also be directed to the Office of the Associate Provost and Dean of Research. General questions about the Naval Postgraduate School Research Program should be directed to the Office of the Associate Provost and Dean of Research at (831) 656-2099 (voice) or research@nps.edu (e-mail). Additional information is also available at the RESEARCH AT NPS website, http://www.nps.edu/Research/index.html.

Additional published information on the Naval Postgraduate School Research Program can be found in:

- **Compilation of Theses Abstracts**: A quarterly publication containing the abstracts of all unclassified theses by Naval Postgraduate School students:
  http://www.nps.edu/Research/MoreThesisAbst.html

- **Naval Postgraduate School Research Newsletter**: A monthly newsletter highlighting Naval Postgraduate School faculty and student research:
  http://www.nps.edu/Research/Newsletters.html

This publication and those mentioned above can be found online at:
http://www.nps.edu/Research/Publications/SummaryRes.html
INTRODUCTION

The research program at the Naval Postgraduate School exists to support the graduate education of our students. It does so by providing military-relevant thesis topics that address issues from the current needs of the Fleet and Joint Forces to the science and technology that is required to sustain the long-term superiority of the Navy/Department of Defense (DoD). It keeps our faculty current on Navy/DoD issues, and maintains the content of the upper division courses at the cutting edge of their disciplines. At the same time, the students and faculty together provide a very unique capability within the DoD for addressing warfighting problems. Our officers must be able to think innovatively and have the knowledge and skills that will let them apply technologies that are being rapidly developed in both the commercial and military sectors. Their unique knowledge of the operational Navy, when combined with a challenging thesis project that requires them to apply their focused graduate education, is one of the most effective methods for both solving Fleet problems and instilling the life-long capability for applying basic principles to the creative solution of complex problems.

The research program at the Naval Postgraduate School consists of both sponsored and institutionally funded research. The research varies from very fundamental to very applied, from unclassified to all levels of classification.

- **Sponsored Research Program:** This program includes those projects externally funded on the basis of proposals submitted to outside sponsors by the School’s faculty. These funds allow the faculty to interact closely with RDT&E program managers and high-level policy makers throughout the Navy, the DoD, other government agencies, and the private sector in defense-related technologies. The sponsored program utilizes Cooperative Research and Development Agreements (CRADAs) with private industry, participates in consortia with government laboratories and universities.

- **Naval Postgraduate School Institutionally Funded Research (NIFR) Program:** The institutionally funded research program has several purposes: 1) to provide the initial support required for new faculty to establish a Navy/DoD-relevant research area, 2) to enhance productive or proposed research through a research equipment recapitalization program, and 3) to cost-share the support of a strong postdoctoral program.
INTRODUCTION

The reimbursable program has grown steadily to provide the faculty and staff support that is required to sustain a strong and viable graduate school in times of reduced budgets. A profile of the sponsorship of the Naval Postgraduate School Research Program in FY2010 is provided in Figure 1.

The Office of Naval Research is the largest Navy external sponsor. The Naval Postgraduate School also supports the Systems Commands, Warfare Centers, Navy Labs and other Navy agencies. A profile of external Navy sponsorship for FY2010 is provided in Figure 2.

These are both challenging and exciting times at the Naval Postgraduate School and the research program exists to help ensure that we remain unique in our ability to provide education for the warfighter.

Karl A. van Bibber
Vice President and Dean of Research

September 2011
# TABLE OF CONTENTS

**INTRODUCTION**...............................................................................................................................................................ix

**SCHOOL OF INTERNATIONAL GRADUATE STUDIES**

**DEFENSE RESOURCES MANAGEMENT INSTITUTE**

Department Overview ........................................................................................................................................................................5
Faculty Listing ..................................................................................................................................................................................7
Project Summaries
- Traumatic Brain Injury (TBI) Evaluation Instruments and Processes for Clinical Follow-Up......................... 9
- Economic Causes of Conflict ......................................................................................................................................................... 9
- Scale Invariance in the Iraq Conflict and the Microlevel Foundations of Violence................................................. 9
- Corruption Effects Within Irregular Warfare.............................................................................................................................. 9
- Military Cost-Benefit Analysis..................................................................................................................................................... 10
- An Economic Approach to Bid Protests ................................................................................................................................. 10
- Advanced Analytical Decision Making (AADM) Research and Workshops ........................................................................ 10

Faculty Publications and Presentations ................................................................................................................................. 11

**DEPARTMENT OF NATIONAL SECURITY AFFAIRS**

Department Overview ................................................................................................................................................................... 19
Faculty Listing ..................................................................................................................................................................................21
Project Summaries
- The Paradoxes of Peacebuilding: International Interventions in Post-Conflict States .............................................. 23
- The Micro Political Economy of Natural Resource Governance ....................................................................................... 23
- 4th Annual Foreign Area Officer Conference ............................................................................................................................ 24
- Enabling CCC-AACO Partnership ............................................................................................................................................. 24
- Enabling the Center on Contemporary Conflict-Advanced Systems and Concepts Office Partnership ............................................................ 25
- Ungoverned Spaces ....................................................................................................................................................................... 25
- Ungoverned Spaces ....................................................................................................................................................................... 26
- The Definition of National Security Interests and Institutional Change .............................................................................................. 27
- Comparing Failed, Foiled, Completed and Successful Terrorist Attacks ......................................................................................... 27
- Towards Effective Emerging Infectious Diseases Surveillance: The Cases of Cambodia and Indonesia and the Experience of NAMRU-2 .................................................................................................................. 28
- Towards Effective Emerging Infectious Diseases Surveillance II: Cases of Swine Flu in Mexico 2009 and USA 1976 ........................................................................................................................................................................... 28
- Innovation in Terrorism: Causes, Processes, and Predictive Indicators ............................................................................................ 29
- Debating Jihad: Ideological Divides in the Radical Islamist Movement ................................................................................................. 29
- Support of Naval Intelligence Research and Education ................................................................................................................. 30
- Canada-China Space Engagement: Opportunities and Prospects .............................................................................................. 30
- Proliferation Paradigms: The Future of the NPT Regime in the Second Nuclear Era ..................................................... 30
- Space Deterrence and Cyber Deterrence: Comparative Challenges and Applications ............................................................ 31
- Post-Transition Military Politics: Army Missions in Democratic Peru and Ecuador ........................................................................ 31
- Resource Conflicts: Emerging Struggles over Strategic Commodities in Latin America ................................................ 32
- Near Term Afghanistan Data Development - Tier 1 ....................................................................................................................... 33
- Afghanistan Data Development for Cultural Geography Modeling .............................................................................................. 33
- Attack the Network Innovation Effort ....................................................................................................................................... 33
- NPS Afghan COIN Web Portal ..................................................................................................................................................... 33
- Capturing the Narrative 1991 Uprising in Iraq .............................................................................................................................. 34
- U.S.-India Strategic Partnership ..................................................................................................................................................... 34
- Indo-U.S. Strategic Dialogue 2010 ............................................................................................................................................... 34
- Eating Grass: Pakistan and the Bomb ......................................................................................................................................... 34

xi
TABLE OF CONTENTS

Trilateral Relations: China, India and Pakistan ................................................................. 35
US-Pakistan Strategic Dialogue .......................................................................................... 35
Assurance Strategies and National Security ................................................................. 35
MCIA Student Thesis Support Program ........................................................................ 36
NPS Student Thesis Support Program ........................................................................... 36
Meeting the Challenges of Nuclear Expansion in Southeast Asia: Frameworks for Effective Cooperation and Enhanced Security .............................................................. 37
Proliferation Dynamics in Southeast Asia: The Implications of Great Power Rivalry ................................................................. 37
Allied Security and an Integrated Satellite Network .................................................. 38
Global Trends and the Future of Warfare 2025 ............................................................... 38
Understanding and Responding to Conflict in Africa: Implications of focusing on root causes versus complex end-states .............................................................................. 38
Reducing Insecurity in Africa: Roles and Responsibilities of the U.S. Military, U.S. Government and Non-Governmental Communities ......................................................... 39
WME Innovation and Terrorism: Causes, Processes, and Predictive Indicators .................. 39
2010 Proliferation Seminar ............................................................................................. 39
Nonproliferation in the Middle East Strategic Dialogue ..................................................... 39
Nuclear Proliferation in the Middle East ........................................................................... 40
Public Policy and Nuclear Threats Training Program/Proliferation Pathways in Asia Conference ........................................................................................................ 40
South Asian Strategic Partnerships: Track 2 Dialogues with India and Pakistan .................. 40
Strategic Studies: Open-Source Research and Nuclear Weapons Design .................. 40
U.S.-Pakistan Strategic Partnership: A Track II Dialogue For Long-Term Security Cooperation ..................................................................................................................... 41
Guesswork: The Troubled Past of Prediction ..................................................................... 41
The Peace Soldier from the South: From Praetorianism to Peacekeeping? ....................... 41
NPS Asia Conference ....................................................................................................... 42
NPS Counterspace Doctrine ............................................................................................ 42
US-China Strategic Dialogue ........................................................................................ 42
US-China Strategic Dialogue, Phase V ........................................................................... 42
Competition Dynamics and Party System Evolution in Japan and Host-Nation Politics of
U.S. Bases in Asia ............................................................................................................ 43
Indian, Pakistani, and Chinese Relationship Dynamics: Impact on U.S. Strategic Interests ........................................................................................................ 44
Monterey Strategy Seminar ............................................................................................ 44
US-UK Strategic Dialogue ............................................................................................. 44
Extended Deterrence in the 21st Century ......................................................................... 44
Faculty Publications and Presentations .............................................................................. 47

GRADUATE SCHOOL OF OPERATIONAL AND INFORMATION SCIENCES

DEPARTMENT OF COMPUTER SCIENCE

Department Overview ..................................................................................................... 65
Faculty Listing .................................................................................................................. 67
Project Summaries
Analysis and Assessment of EFV Software Quality and Maintainability ....................... 69
Architecture Based on Behavior Models .......................................................................... 69
Affordable Quality Assurance for Reusable Components in Open Architectures ............. 69
Reusable Components in Open Architectures ..................................................................... 69
# TABLE OF CONTENTS

Development of Formal Method Strategy for the Next Generation Security Network

Server (SNS) ................................................................. 71
Hardware Security Evaluation ............................................. 71
Hardware Security Evaluation OB-1 ..................................... 71
OB-1 Evaluation Support ................................................. 71
Software Crypto Modeling (Continuation) ............................ 71
Formal UML Requirement Specification-Based Automatic Software Testing ........................................ 72
UML-Based Validation and Verification (IV&V) ................. 72
Identity and Database Challenges for Force Protection .......... 72
Research on Software Vulnerability Discovery Tools ....... 72
Team Monterey: Analysis of Identity Management Security for Groups .................................................. 73
Automated Media Exploitation .......................................... 73
DOD Cyber Policy Review .............................................. 74
Identity and Database Challenges for Force Protection .......... 74
Team Monterey: Analysis Identity Management Security for Groups .................................................. 75
Creating Realistic Forensic Corpora for Undergraduate Education and Research ........................... 75
TC: Large: Collaborative Research: 3DSEC: Trustworthy System Security Through 3-D Integrated Hardware ................................................................. 75
Biometric Challenges for Future Deployments ................... 76
Cryptologic Computer Scientist - 2010: Topics in Network Security and Vulnerability

Assessment ........................................................................ 76
Identity and Database Challenges for Force Protection .......... 77
Information Assurance Scholarship Program Support - 2010 ........................................................ 77
High Assurance Platform: HAPR2-C Security Requirements Definition ........................................ 77
Multilevel Secure Collaborative Web Technologies ......... 77
Multilevel Secure Cloud Services ...................................... 78
MYSEA - Phase VI .......................................................... 78
MYSEA - Phase VII, High Assurance Multi-Level Testbed .......................................................... 78
Team Monterey: Analysis Of Identity Management Security for Groups ........................................... 79
Documentation Driven Software Development ..................... 79
Establish/Maintain Software Engineering Test Lab (SETL) ................................................................ 80
Risk Assessment in Software Project ................................ 80
Monterey Workshop 2010 - Autonomic System Adaptation to Dynamic Environments: 

Robustness and Self-Healing ............................................. 81
Building Good Models from the Wrong Data ....................... 82
Identity and Database Challenges for Force Protection .......... 83
Language Evidence for Social Goals: A Linguistic Approach to Persuasion Moves in Discourse ................. 83
Tools for Topic Analysis .................................................. 84
Development of a Reference Model in Support of Verification and Validation of Systems ................... 84
Investigation of Dependable, Trustworthy, and Evolvable Distributed Computing ............................. 84
Investigation of Cloud Computing for Tactical Systems .......... 86
Identity and Database Challenges for Force Protection .......... 86
Adaptive Automated Detection of Emplacement of Explosive Devices ............................................. 87
Extending BASE-IT to Indoor Operations .......................... 88
Protecting Mobile Defense Networks ................................. 88
Self Protecting Electronic Medical Records ........................... 88
Inquisitive Semantics for Technology Transfer .................... 89
A Center for Science and Technology Transition .................. 89
Real Caller ID ............................................................... 89
A Revolutionary 4D Approach to Network-Wide Control and Management ..................................... 90
An Abstraction Driven Approach to Characterizing and Designing Networks with Analyzable Properties .......................................................... 90
Behavior Analysis of Network Traffic ............................................................................................................................................... 91
Integrating Cell Phone Technology with Marine Corps Tactical Networks .................................................................................. 91

Faculty Publications and Presentations ........................................................................................................................................ 93

DEPARTMENT OF INFORMATION SCIENCES

Department Overview .................................................................................................................................................. 129
Faculty Listing .......................................................................................................................................................... 131
Project Summaries

Information Sharing for Medical Triage Tasking During Mass Casualty and Humanitarian Operations .................................................. 133
Improved Terrain Generation from UAV Sensors .............................................................................................................. 133
Interoperability Standards Cost Effectiveness Analysis Tool (Phase II) .................................................................................... 133
Image Exploitation and UAV Mission Control System ........................................................................................................... 134
Cal Fire Mesh Networking & Fire Boundary Tracking ............................................................................................................ 134
TABLE OF CONTENTS

CENETIX-TNT  Experimentation Support and Network Management for USMC RPV ......................................................... 134
Field Exp Program – USSOCOM (FEPSO) ......................................................................................................................... 134
Field Experimentation Program - IT ................................................................................................................................. 135
Low Visibility Detector Networking ................................................................................................................................. 135
TNT – CENETIX Student Research for USSOCOM .......................................................................................................... 135
TNT – MIO Experimentation ............................................................................................................................................ 135
USMC M252X System Analysis ........................................................................................................................................ 136
Coasts International Field Experimentation Program .................................................................................................... 136
Field Information Support Tool (FIST) Philippines ........................................................................................................... 136
Flexible Architecture & Sensor Topology License Plate Recognition II (FAST LPR2) .................................................. 136
Pacific Endeavor 2010 .................................................................................................................................................... 137
Improving Health care Delivery for PTSD: An Integrated Approach Leveraging Systems Engineering and Organizational Design ............................................................................................................................ 137
C3F Sea Trial Experimentation Support .......................................................................................................................... 137
Joint Expeditionary Forces Experiment 2010-3 (JEFX10-3) .......................................................................................... 138
Joint Intelligence Operations Center (JIOC) Business Process Model ........................................................................ 138
Joint Intelligence Operations Center (JIOC) Operational Users Steering Group Support (OUSG) ................................ 138
Joint Multi-Mission Electro-Optic Systems (JMMES) Operational Test Agent (OTA) ...................................................... 138
NAVNETWARCOM Innovation and Experimentation Program
FORCEnet Laboratory Experiments (FY 09-10) .............................................................................................................. 139
Joint Multi-Mission Electro-Optic Systems (JMMES) Operational Manager Support to C3F ........................................... 139
JSBA (Joint Systems Baseline Assessment) 09 .................................................................................................................. 139
NAVNETWARCOM Innovation and Experimentation Program,
Trident Warrior and Limited Objective Experiments (FY 09) ....................................................................................... 139
Network-Centric Warfare Acceleration .............................................................................................................................. 140
SAO Field Experimentation .............................................................................................................................................. 140
Transnational Information Sharing Cooperation (TISC)
Joint Capability Technology Demonstrations (JCTD) .......................................................................................................... 140
Trident Warrior 2010 Experimentation (Fleet Support) ................................................................................................... 141
Trident Warrior FY11 (experimentation, fleet support, Sea Trials).................................................................................. 141
Rapid Prototyping VIRT: A product-line architecture for Persistent ISR Systems (done for MARCORSYS.COM) ........ 141
MIE M Transition and MIEM Editor Support .................................................................................................................... 141
Evaluation and Implementation of the RAPIDS Pointing Module (RPM) for Improved Throughput/Video Quality and Range of a Small Unmanned Aerial Vehicle (SUAV) .................................................... 142
Data Collection/Coding/Cleansing Process .................................................................................................................... 142
Implementing a CCOPs Performance Accounting Data Collection Tool to Support OPNAV
Budgeting Allocation for Signal Intelligence Collection Systems .................................................................................... 143
Integrating System Dynamics Modeling and Knowledge Value Added for Improved Analysis of Alternatives: A Proof of Concept Study ........................................................................................................... 143
KVA+RO+SD to Create Flexibility: Success and Failure Cases in use of 3DVis and Collaborative PLM Tools to Support SHIPMAIN ........................................................................................................................................... 143
Reducing the Cost of Complex Systems Testing Using Risk-Based Information-Driven Strategies Under Fixed-Cost Constraints ........................................................................................................................................... 144
Adaptability in Information Flow for Command and Control ......................................................................................... 144
Adaptive Architectures for Command and Control .......................................................................................................... 144
Collaboration and Knowledge Integration .......................................................................................................................... 145
Joint Improvised Explosive Device Defeat Organization ................................................................................................ 146
NPS Testbed for Team Collaboration Model Validation .................................................................................................. 146
TABLE OF CONTENTS

Human Terrain Analysis Collection System ................................................................. 146
OPNAV Service Oriented Architecture (SOA) ............................................................ 147
Trident Warrior 2010 Laboratory-Based Experimentation (Fleet Support) ............. 147
Center for Edge Power ............................................................................................ 148
USMC IM-KM Integration ..................................................................................... 148
Next Generation Command and Control (NGC2) .................................................... 149
Collaborative Systems Research ........................................................................... 149
Adaptive Architectures for Command and Control ................................................ 149
Collaborative Architecture Simulation Environments for Modeling and Simulation,
    Software Engineering and Information Assurance Management ......................... 150
Lightning Warning Overlap and Optimum Lightning Areas ..................................... 150
Unmanned Aircraft Systems Support to OSD UAS TASK FORCE ......................... 151
Information Warfare Curriculum 595 Support ....................................................... 151
Joint Battlespace Awareness Intelligence, Surveillance, and Reconnaissance Integration
    Capability (JBAIIC) Knowledge Management & Experimentation (KME) Project .... 151
Faculty Publications and Presentations ................................................................. 153

DEPARTMENT OF OPERATIONS RESEARCH

Department Overview .............................................................................................. 163
Faculty Listing ........................................................................................................ 165
Project Summaries
    Reinforced Infantry Battalion Mobile Ad-hoc Network (MANET) Study Technical Support .... 167
    Next-Generation Network Science ...................................................................... 167
    Performance Analysis of Ground Soldier Mobile Ad-Hoc Networks ..................... 168
    Vulnerability Analysis of Electric Power Infrastructure Supporting Vandenberg AFB .... 169
    The Human Social Cultural Behavior (HSCB) Modeling Initiative at the Naval Postgraduate School ................................................................. 169
    Irregular Warfare (IW) Data Validation Project .................................................... 169
    Irregular Warfare (IW) Methods and Tools (MMT) Tactical Validation, Verification and Accreditation (VV&A) Project ......................................................... 170
    Validation of Data Supporting Irregular Warfare (IW) Methods Models And Tools (MMT) .... 170
    Optimization of Sensor Allocation for Search and Surveillance ......................... 170
    Large-Scale Optimization .................................................................................. 171
    Large-Scale Optimization .................................................................................. 172
    MSC Schedule Planner Model ............................................................................ 174
    Chair of Applied Systems Analysis ................................................................... 174
    Sealift Capability: Size, Composition, and Employment ....................................... 174
    Military Applications of Optimization ................................................................ 175
    Collaborative Initiative for Layered Sensing Project ........................................... 175
    MCESG Assignment Tool .................................................................................. 177
    2009 Chile-USA Naval Operations Research Workshop ...................................... 178
    USMC F-35 Lightning Transition Planner ........................................................... 178
    FDA Optimization Support ............................................................................... 178
    IATF Social Network Functional Analysis .......................................................... 179
    Social Network Functional Analysis ................................................................. 179
    Support to DTRA Innovation Office .................................................................. 180
    Optimizing Threshold-Based Surveillance Systems ............................................ 181
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design of Experiments for Follow-on Operational Test of the Aegis Modernization Program</td>
<td>182</td>
</tr>
<tr>
<td>Training and Research Support for Director, Operational Test and Evaluation</td>
<td>182</td>
</tr>
<tr>
<td>Using Efficient Design of Experiments to Explore the Army’S Equipping Enterprise System</td>
<td>182</td>
</tr>
<tr>
<td>Modeling the Impact of Events on the Simulated Afghanistan Population and Modeling the Impact of Events on the Simulated Helmand Province</td>
<td>183</td>
</tr>
<tr>
<td>Development of Operational Planning Tools for the Maritime Operations Center</td>
<td>184</td>
</tr>
<tr>
<td>Integration of Operational-Level Optimization Decision Aids in the Next Generation</td>
<td>185</td>
</tr>
<tr>
<td>Maritime Information Sharing Taskforce</td>
<td>185</td>
</tr>
<tr>
<td>NWDC Chair of Warfare Innovation</td>
<td>186</td>
</tr>
<tr>
<td>Naval Operations Analysis to Support Northrop Grumman Ship System Analysis</td>
<td>186</td>
</tr>
<tr>
<td>Tailored Effects, Metrics, and Risk Management is Strategic Planning Workshop for OPNAV N00X</td>
<td>187</td>
</tr>
<tr>
<td>Prediction of Remaining Useful Life in Mechanical Components</td>
<td>187</td>
</tr>
<tr>
<td>Statistical Support to the Apache Block III Test Program</td>
<td>187</td>
</tr>
<tr>
<td>Statistical Support to OAD Using the Combined Information Data Network Exchange (CIDNE) Afghanistan Database</td>
<td>188</td>
</tr>
<tr>
<td>Statistical Training and Support to the Yuma Test Center</td>
<td>188</td>
</tr>
<tr>
<td>Optimizing Deployment of Cargo UAS</td>
<td>189</td>
</tr>
<tr>
<td>Optimization of Sensor Operation for Search, Surveillance, and Rapid Accurate Decision Making in Maritime, Littoral, and Urban Environments</td>
<td>189</td>
</tr>
<tr>
<td>A Dynamic Model for Political Stakeholders</td>
<td>190</td>
</tr>
<tr>
<td>Dynamics of Popular Attitudes in Counterinsurgency Situations</td>
<td>190</td>
</tr>
<tr>
<td>Irregular Warfare Automated Games</td>
<td>191</td>
</tr>
<tr>
<td>Modeling Counterinsurgency (COIN) Operations</td>
<td>191</td>
</tr>
<tr>
<td>Small Business Technology Transfer (STTR) for Counter Narcotics, Counter Terrorism and Counter Proliferation</td>
<td>192</td>
</tr>
<tr>
<td>Support of Us Marine Corps Total Life Cycle Maintenance Working Group (TLCM-WG)</td>
<td>193</td>
</tr>
<tr>
<td>Optimal Surveillance Patrol</td>
<td>194</td>
</tr>
<tr>
<td>Developing and Assessing the Marine Air Ground Task Force Tactical Warfare Simulation (MTWS)</td>
<td>194</td>
</tr>
<tr>
<td>Establishment of Efficient Designs of Experiments in Support of the US Army Warfighting Analysis Division’s (WAD) Analysis of the Equipping Enterprise System</td>
<td>197</td>
</tr>
<tr>
<td>Enabling Efficient High-Dimensional Design of Experiments for the System-of Systems Survivability Simulation (S4)</td>
<td>197</td>
</tr>
<tr>
<td>Improving the Integrated Training Center Model for Usability to Enable Accurate Time-To-Train Modeling</td>
<td>197</td>
</tr>
<tr>
<td>Human Performance at Sea 2010</td>
<td>198</td>
</tr>
<tr>
<td>ONR Workshops on Human Performance and Environmental Stressors</td>
<td>198</td>
</tr>
<tr>
<td>Performance Shaping Functions of Environmental Stressors: Motion</td>
<td>199</td>
</tr>
<tr>
<td>NPS Cost Analysis Support for CAPE</td>
<td>199</td>
</tr>
<tr>
<td>A Simulation-Optimization Model of Organizational Capacity for the Army Corps of Engineers, Sacramento District Office</td>
<td>200</td>
</tr>
<tr>
<td>Business Case Analysis AC/JCTD Project Support</td>
<td>200</td>
</tr>
<tr>
<td>Business Case Analysis (BCA) Support for Medium-Altitude Global ISR and Communications MAGIC) Joint Capability Technology Demonstrations (JCTD)</td>
<td>201</td>
</tr>
<tr>
<td>Daily Watch Joint Capability Technology Demonstration (JCTD)</td>
<td>201</td>
</tr>
<tr>
<td>Development of Distance Learning Masters in Cost Estimating and Analysis</td>
<td>201</td>
</tr>
<tr>
<td>Graduate Research Studies Program (Phase II)</td>
<td>202</td>
</tr>
<tr>
<td>Support to the Analysis of Costs and Benefits of the Vulture Program</td>
<td>202</td>
</tr>
<tr>
<td>US Marine Corps Performance Pricing Model</td>
<td>203</td>
</tr>
<tr>
<td>Developing a Reliable Leading Indicator of Mishaps</td>
<td>203</td>
</tr>
<tr>
<td>Navy Warfare Development Command’s Operations Research Chair of Warfare Innovation</td>
<td>204</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS

Transformable-Craft (T-Craft) Program Total Life Cycle Cost Modeling ................................................................. 204
Front-end Operations Research Analytical Models for CBP Tunnel Problem ............................................................. 205
Factors in Joint Typhoon Warning Center Watchfloor .............................................................................................. 205
Principles of Ensemble Modeling and Decision Support ............................................................................................. 205
Battlespace On Demand (BonD) Command Decision Making: Enhanced Decision Making
  Through More Effective Use of METOC .......................................................................................................................... 206
Adaptive Precision Adjustment for Efficient Optimization of Complex Systems ......................................................... 206
Asymptotic Analysis of Sample Allocation in Stochastic Optimization ........................................................................ 208
Optimization of Brigade Combat Team Assignments .................................................................................................. 208
Optimally Locating BETSS-C Surveillance Assets ........................................................................................................ 208
Modeling & Simulation (M&S) and Design Of Experiments (DOE) Applications for Test Planning ........................................ 214
SEED Center Support to Cultural Geography (CG) and Operation Enduring Freedom
  (OEF) Scenario Analysis .................................................................................................................................................. 210
Chair for Strategic Maritime Analysis .............................................................................................................................. 210
Effects of Sleep on Training Effectiveness in Soldiers at Ft Leonard Wood, MO ......................................................... 210
Fatigue Modeling Using Total Crew Model in Support of the Mission Module Manning for the Littoral Combat Ship ................................................................................................................... 211
Psychomotor Task Performance of Humans Exposed to Motion and Fatigue ............................................................... 212
Quantitative Evaluation of Squad and Team Leader Performance With and Without GSS ................................................ 212
The Science of Test: Advanced Test and Evaluation in Support of the DOD Test and Evaluation Enterprise ................................................................. 212
Quantitative Evaluation of Squad and Team Leader Performance with and without GSS (Quest=GSS) ........................................ 213
Irregular Warfare Automated Wargame .......................................................................................................................... 213
Stochastic Optimization Support ..................................................................................................................................... 213
Statistical Analysis for the Deployed Analyst .................................................................................................................... 214
Defending Independent Infrastructure Systems .............................................................................................................. 214
Optimal Interdiction Planner .......................................................................................................................................... 214
Faculty Publications and Presentations .......................................................................................................................... 217

GRADUATE SCHOOL OF ENGINEERING AND APPLIED SCIENCES

DEPARTMENT OF APPLIED MATHEMATICS

Department Overview ......................................................................................................................................................... 233
Faculty Listing ................................................................................................................................................................... 235
Project Summaries
  History of Mathematics at the Naval Postgraduate School ............................................................................................ 237
  Discretization vs. Rounding Error in Numerical ODE Solvers ......................................................................................... 237
  Extrapolation Methods for Numerical ODEs ........................................................................................................................ 237
  Deflation Methods for Divide-and-Conquer Eigenvalue Solvers ....................................................................................... 237
  Algebraic Attacks on AES ................................................................................................................................................ 238
  Compact Implementation of AES ..................................................................................................................................... 239
  Astrodynamics Research .................................................................................................................................................. 239
  Triangular Line Graphs ................................................................................................................................................... 239
  3-Circuit Center and Periphery in Graphs .......................................................................................................................... 240
  Functigraphs ........................................................................................................................................................................ 241
  Computational Mathematics for Storm Surge Modeling .................................................................................................. 242
  Efficient Time-Integrators for Local High-Order Methods .................................................................................................. 242
  The Mathematics of Storm Surge Modeling ........................................................................................................................ 243
  Multi-Scale Nonhydrostatic Atmospheric Models ............................................................................................................... 243
TABLE OF CONTENTS

Next-Generation Global and Mesoscale Atmospheric Models ....................................................... 244
Observability in Data Assimilation and Optimal Sensor Configuration ........................................ 245
Optimal Motion Planning in Obstacle-Rich Environment ................................................................. 245
Pseudospectral Optimal Control of Nonlinear Systems ................................................................. 246
Numerical Solution of the First Order Partial Differential Equations of Nonlinear Control ....... 246
Principal Tangent System Reduction ......................................................................................... 247
Workshop on Computational Issues in Nonlinear Control ......................................................... 247
A Study of Non-Reflecting Boundary Conditions ....................................................................... 247
High Order Nonlinear Solvers for Simple and Multiple Roots ................................................... 248
Large Time Behavior of Solutions and Finite Difference Scheme to a Nonlinear Integro-
Differential System .................................................................................................................. 248
Mathematical Models of Search ................................................................................................. 249
Game-Theoretic Approaches to Terrorist Insurgent Networks .................................................... 249
Theory of Games and Applications ......................................................................................... 249
Set Colorings in Graphs .............................................................................................................. 250
Colorings of Three Factors of a Complete Graph ....................................................................... 250
Investigation of Acoustic Cloaking .............................................................................................. 251
Modeling of Semiconductor Minority-Carrier Diffusion ............................................................. 251
Ninth International Symposium on Technology & the Mine Problem ....................................... 252
Tenth International Symposium on Technology & the Mine Problem ........................................ 252
Cryptographic Boolean Functions – Mathematical Issues ........................................................... 253
Cryptographic Boolean Functions – Computational Issues .......................................................... 253
Investigations on Number Theoretical Functions ....................................................................... 254
Fundamental Problems in Developing Laser-protection Materials .............................................. 254
Mathematical Modeling, Analysis and Scientific Computations of Complex Fluids ................. 255

Faculty Publications and Presentations ..................................................................................... 257

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Department Overview .................................................................................................................. 265
Faculty Listing .......................................................................................................................... 267

Project Summaries

Advanced Power System Models and Design Methods for Electrical Distribution Studies .......... 269
Electromagnetic Aircraft Launch Systems Power Electronics Performance Evaluation
  Principle Investigator ........................................................................................................... 269
Numeric Function Generators .................................................................................................. 269
Bent Functions for Cryptography ............................................................................................... 270
Robust Adaptive Control with External Disturbances and Unmodeled Dynamics .................... 271
ECE Distance Learning Program ............................................................................................. 271
Investigations Into Wavelet OFDM Receiver Performances ..................................................... 272
Future Airborne Capabilities Environment (FACE) ................................................................... 272
Integrated Circuit Design and Library Cell Development ......................................................... 272
GED Special Project Research .................................................................................................. 272
C4I Chair .................................................................................................................................. 273
NPS Support for CY2010-2012 Rapid Pro VIRT (RPV) ............................................................. 274
Wirelessly Networked Opportunistic Arrays .............................................................................. 275
Digital Tracking Array ............................................................................................................. 275
Electric Ship Thesis Topic Development ................................................................................... 276
Non Linear Model of a Twelve Phase Transformer Feeding A 24 Pulse Diode Rectifier ............ 276
Pulsed Power Supply (PPS) Design and Analysis for the Railgun .......................................... 276
Analysis and Modeling of Receivers for 4G-Like Signals .......................................................... 276
NSA/IDG Communications Research Lab and Thesis Research Support ................................... 277
TABLE OF CONTENTS

Performance Analysis of Receivers in Communications Systems Which Employ Multiple Input Multiple Output (MIMO), Space Time Coding (STC), and Orthogonal Frequency Division Multiplexing (OFDM) Techniques ................................................................. 277
A Comprehensive Review on Integration of Cellular Technology With U.S. Military
Communication Networks ................................................................................................................ 278
Configurable Fault-Tolerant Processors (CFTP) for Reliable Space-Based Computing ........ 278
Evaluate Fault Tolerance of the OPERA Multiprocessor .............................................................. 280
Low Power Fault-Tolerance for Reliable Space-Based Computing ......................................... 280
Maritime Domain Awareness System Demonstration ............................................................... 280
Project Gusty Oriole (U) .............................................................................................................. 281
BOB Evaluation and Analysis ..................................................................................................... 282
4G (LTE/WIMAX) Signal Identification and Classification Using Cyclostationary Characteristics ................................................................................................................................. 283
Geolocation Of WiMAX/4G Mobile Devices .................................................................................. 283
Long Term Evolution (LTE) Mobile Device Signal Analysis and Geolocation ........................ 284
Novel 3-D Geolocation of 4G Mobile Devices ............................................................................ 285
Wireless Networking and Communications Research ............................................................... 285
Joint Threat Warning System (JTWS) Threat Signals Projection and Research ...................... 286
JTWS FY09 Threat Signals Projection and Research ................................................................. 288
JTWS FY10 Threat Signals Projection and Research ................................................................. 288
Extending the Endurance and Capabilities of the Raven UAV Using Advanced Flexible Solar Cells ........................................................................................................................................ 289
Modeling, Design and Optimization of Multi-Junction Solar Cells Using Silvaco Virtual Wafer Fabrication Software .................................................................................................................. 289
Radiation Tolerant ASIC & VLSI Devices for Space Based Systems ........................................ 290
Inverse AC Propagation Model .................................................................................................... 290
Source Identification and Shielding ............................................................................................. 291
Pulsed Power Supply (PPS) Design And Analysis For The Railgun ........................................ 291
NCRADA-NPS-08-0114, Task One: Shipboard Electric System Modeling ................................. 292
Cueing Receiver For Faster EA Response .................................................................................. 292
Increasing the Dynamic Range of HTS RF SQUID ADC Using the Robust Symmetrical Number System (RSNS) .................................................................................................................. 293
N433 Threat Missile Simulator Validation Working Group ......................................................... 293
Navy Surface Anti-Ship Capable Missile Threat Simulator Validation Working Group .......... 293
Submarine Future EW Roadmap Working Group ......................................................................... 294
Ultrawideband Antenna Analysis .............................................................................................. 294
Enabling FORCEnet with Wireless Ad Hoc Networks .............................................................. 294
Analyze and Prioritize Left-Hand-Side-Of-Kill-Chain EW/IO Capabilities ................................ 294
Cyber Research to Support GED Mission Areas .......................................................................... 295
Investigation of Emerging Communications Technologies ...................................................... 296
PM and Travel Support for Shipboard IW Efforts ....................................................................... 296
Research and Travel in Support of PMW-160 Shipboard IW Efforts ........................................ 297
Surface EW Developments, Research/Lab Support ................................................................. 297
Moving Cognitive Radar Platform and Applications ................................................................. 297
Engineering of Small Satellites for Space-Based Experiments ............................................... 298
MEMS Acoustic Sensor ............................................................................................................... 298
Surface Warfare Developments Research and Lab Support ....................................................... 298
Electronic Component Failure Prediction .................................................................................. 298
IGBT Reliability Investigations ................................................................................................. 299
GTO Thyristor Reliability Investigations .................................................................................. 299
Support for the NPS Linear Accelerator (LINAC) ................................................................. 299
Support for the NPS Flash X-Ray ............................................................................................. 299


TABLE OF CONTENTS

Low Cost, Portable, Multi-User, Immersive Virtual Environment Systems For Education and Training in Worlds of Unlimited Size .......................................................... 300
Shipboard Calibration Enhancements ........................................................................ 300
Faculty Publications and Presentations .................................................................... 301

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

Department Overview .................................................................................................. 309
Faculty Listing .............................................................................................................. 312
Project Summaries

Aircraft Combat Survivability for JASPO ................................................................. 314
Spacecraft Survivability ............................................................................................ 314
Application of Advanced Wavefront Sensing and Control Techniques to a High Energy Laser Beam Control Testbed ................................................................. 314
Adaptive Pointing Control for Spacecraft ................................................................. 314
Directed Energy Summer Internship Program ......................................................... 315
Inertial Reference Unit ............................................................................................... 315
Integrated Tactical Platform Simulator for Maritime High Energy Laser Beam Control Test Bed ................................................................. 315
Key Technologies for Large Segmented Mirror Space Telescope ......................... 316
Maritime Beam Control ............................................................................................ 316
Maritime Beam Control ............................................................................................ 316
Maritime Beam Control/Redundant Spacing Calibration (RSC) ......................... 317
On-Orbit System Identification and Slew Maneuver for Flexible Spacecraft .......... 317
Robust Adaptive Control with External Disturbances and Unmodeled Dynamics .... 318
Spacecraft Design ...................................................................................................... 318
Spacecraft Design ...................................................................................................... 318
Spacecraft Systems .................................................................................................... 318
Spacecraft Systems .................................................................................................... 319
Tactical HEL Weapon Alignment System Architecture Efficiencies ................. 319
Direct Manufacturing Using 3-D Digital Printer: Mechanical Behavior of Polycarbonate Structures ............................................................................................ 319
Advanced Concepts Studies ..................................................................................... 320
Aluminum Oxide Characterization in High Aspect Ratio Grains ............................ 320
Constant Volume Combustion Technology Risk Reduction ................................. 321
Detonation Transition Lengths for Pulse Detonation Engines ............................... 321
New Technologies for Advanced Strategic Missile Systems ............................... 322
Steady and Unsteady Flow Experiments on Rotor Issues ..................................... 322
Unsteady Aerodynamics Research of Maneuvering UCAV ................................. 323
LCS Class Ship Shock Modeling & Simulation Using DYSMAS Code ............... 323
Accuracy Model Improvement .................................................................................. 324
Collateral Damage Methodology ............................................................................ 324
Support GWTS CB .................................................................................................... 324
Support CTEG task #5 - 3.01 .................................................................................. 324
Miscellaneous Air to Surface Tasks ....................................................................... 324
Coordinated Roadsearch for Multiple UAVs ........................................................... 325
Interfacial creep In Thin Film Interconnect Structures in Micro-Systems .......... 326
Analysis of the Complex Exponential Method for Modal Parameter Estimation from FSST
Data – Preliminary Investigation ................................................................................ 327
Development of Physics-Based Modeling and Simulation System for Fleet/Force Sustainment ...................................................................................................... 327
Cross Flow Fan – Improving Efficiency ................................................................. 327
TABLE OF CONTENTS

Rampressor – Rotating Rig Development ................................................................. 328
Transonic Fan Stage – Steam Ingestion Study ......................................................... 328
Autonomous USV Navigation in Riverine Environments ........................................... 329
Greater Autonomy for USVS in Riverine Environments ........................................... 329
Obstacle Avoidance Using Forward Look Sonar ....................................................... 329
Study on Autonomy ............................................................................................... 330
VSW Mine Neutralization ...................................................................................... 330
VSWMCM Program Manager and Support ............................................................ 330
Distributed SLAM for AUVs .................................................................................. 330
Herding and Active Force Protection Using Autonomous Agents ......................... 331
Competency Education Package for Aircraft Structures ........................................ 331
Study of Composite Structure With FSI Under Impact Loading ......................... 331
Study of Effect of Varying Strain Rates ................................................................. 332
Damage Detection in Composite Interface through Carbon Nanotube Reinforcement 333
Direct Manufacturing Using 3-D Digital Printer ..................................................... 333
Panel Line Module Structural Optimization .......................................................... 334
Underwater Shock Simulation of LCS .................................................................... 334
Evaluation of NiAl Propeller Bronze Following Friction Stir Processing (FSP) ....... 335
Microstructure - Processing - Property Relationships in Friction Stir Processing (FSP) of NiAl Bronze .......................................................... 335
Underwater Crack Repairs in High-Strength Structural Steels By Friction Stir Welding (FSW) .......................................................................................... 335
Advanced Marine Gas Turbine Technology Programs ........................................... 335
Certification, Combustion Studies, and Fuels Characterization of Bio-Derived for Tactical Navy Gas Turbines and Diesels ......................................................... 336
Space Situational Awareness: CubeSat Bus, Attitude Control, and Utilization .... 336
SHIPS: Development of a Ship-Human Integrated Performance System ......... 337
Agile Attitude Control Subsystem for Nanosats Based on Control Moment Gyroscopes: Flight Prototype ................................................................. 337
Autonomous Guidance and Control of Spacecraft Approaching a Tumbling Object and Agile Nanosatellite Attitude Control ................................................................. 337
Analysis, Simulation and Lab Experimentation of Guidance and Control of a Spacecraft with Robotic Manipulators for physical interaction with a Resident Space Object ........................................................................................... 338
Prototype Flight Unit of an Agile Nanosatellite Attitude Control System: Development, Testing, and Integration With an Experimental Nanosatellite ................................................................. 338
Space Situational Awareness CubeSat Bus ............................................................. 338
Tinyscope, Preliminary Investigation on Very Small Three-Axis Stabilized Spacecraft for Earth Imaging Applications From LEO ................................................. 339
A New Approach for Fast Wavefront Reconstruction ........................................... 339
CMG Experiments ............................................................................................... 339
Fuel Efficient and Emergency Return Trajectories for Moon-Earth Transfers via Practical Singular Burns and Accessory Engines ......................................................... 339
Minimum Fuel Relative Motion Trajectories Near an Uncooperative Target ...... 339
Pseudospectral Feedback Control for Space Applications ...................................... 340
Robotic Arm Laboratory ...................................................................................... 340
Spacecraft Agility ............................................................................................... 340
Spacecraft Experiments ...................................................................................... 340
Talon Dark Mirror ............................................................................................. 340
Naval Space Systems Engineering and Acquisition Chair .................................... 341
Case Study of a National Security Space Program ................................................ 341
Payload Derived Position Acquisition System for Parachute Recovery Systems .... 342
Situational Awareness in Urban Areas ................................................................. 342

xxii
# Table of Contents

**Faculty Publications and Presentations**

DEPARTMENT OF METEOROLOGY

- Department Overview.................................................................................................................. 355
- Faculty Listing .................................................................................................................................. 358
- Project Summaries
  - Multi-scale Observational Analyses within the Marsupial Pouch of Pre-depression Tropical Disturbances .................................................................................. 359
  - Convection and Shear Flow in TC Development and Intensification ................................................. 359
  - Regional Numerical Weather Prediction for Aerosol Modeling ...................................................... 359
  - Satellite Analysis Graduate Studies Support ...................................................................................... 360
  - State-Space Analysis of Model Error: A Probabilistic Parameter Estimation Framework with Spatial Analysis of Variance ................................................................. 360
  - Meteorological Measurements in Support of a Passive Imaging System for Measuring Atmospheric Scattering in a Marine Environment ................................................................. 361
  - Meteorological Support for a Passive Imaging System ......................................................................... 361
  - Next Generation EM/EO Performance Prediction Systems .................................................................. 361
  - Extending the NSLOT Model Wavelength Range ............................................................................. 361
  - Atmospheric Performance Surfaces for Submarine Periscope Detection ............................................ 362
  - State-Space Analysis of Model Error: A Probabilistic Parameter Estimation Framework With Spatial Analysis of Variance ................................................................. 362
  - Examinations of the Spread in Ensemble Forecasts of Tropical Cyclone Track and Intensity and their Relationships to Forecast Accuracy ........................................................................... 363
  - Extratropical transition of tropical cyclones over the western north pacific: Physical Characteristics, Downstream Impacts and Predictability ............................................................... 363
  - ITOP 2010 Field Experiment ......................................................................................................... 363
  - Western North Pacific Tropical Cyclone Formation and Structure Change in TCS08 ......................... 364
  - Western North Pacific Tropical Cyclone Formation and Structure Change in TCS08 and TCS08 Experiment Support ......................................................................................................... 364
  - A Multiscale Study of Tropical Cyclone Formation, Structure Change, and Predictability in the Western North Pacific Region and TCS08 Experiment Support ................................................. 364
  - Further Analysis of Tropical Cyclone Formation in the Western North Pacific Region as Part of the TCS08 DRI ....................................................................................................................... 364
  - Research and Development of New Theories on Hurricane Intensity and Structure Change .................. 365
  - On The Marsupial Theory F/Tropical Cyclogenesis Within Tropical Wave & Monsoon Trough Environments ......................................................................................................................... 365
  - PRE-Depression Investigation of Cloud-systems in the Tropics (PREDICT) .................................... 365
  - Use of NASA observations and numerical model simulations to understand the hurricane ‘fuel’ and ‘anti-fuel’ problems ........................................................................................................... 366
  - Wave Dynamics In Tropical Cyclones .................................................................................................. 366
  - A Moist Pathway to Extratropical Cyclogenesis and Its Implications for High Impact Weather and Atmospheric Predictability .......................................................................................... 366
  - Automation of Ocean Product Metrics .................................................................................................. 366
  - Climate Diagnostics and Prediction Workshop ......................................................................................... 366
  - Lightning Launch Commit Criteria Climatology (LLCCC) ................................................................... 367
  - Long Range Forecasting Support .......................................................................................................... 367
  - METOC Metrics For Naval Special Warfare .......................................................................................... 367
  - METOC Metrics Scorecard ..................................................................................................................... 368
  - Smart Climatology: Operational Implementation ...................................................................................... 368
  - Ft Ord Weather Forecasts for Prescribed Burns ..................................................................................... 368
TABLE OF CONTENTS

New Tools for Estimating and Managing Air Quality In Prescribed Burns ................................................. 368
Quantifying Sensible weather Forecast Variability ......................................................................................... 368
Weather Forecasting for Ft Ord Prescribed Burns .......................................................................................... 369
Aircraft Measurements for Understanding Air-Sea Coupling and Improving Coupled Model Predictions .................................................................................................................. 369
Evaluation and Improvement of High-Resolution Mesoscale Models on Boundary Layer Simulations Using Ground-Based Observations .............................................................................. 369
Collaborative Research: Physics Of Stratocumulus Top (POST) .................................................................. 369
Shipboard Measurements of Surface Flux and Near Surface Profiles and Analysis of Surface Flux Parameterizations ..................................................................................................................... 370
Understanding Air-Sea Coupling Processes and Coupled Model Predictions Using GOTEX Measurements and COAMPSINCOM .............................................................................................................. 370
Faculty Publications and Presentations ........................................................................................................... 371

DEPARTMENT OF OCEANOGRAPHY

Department Overview ........................................................................................................................................ 379
Faculty Listing .................................................................................................................................................. 381
Project Summaries

Analysis of South China Sea Shelf and Basin Acoustic Transmission Data ...................................................... 383
Collaborative Research: A Systematic Approach to Large Amplitude Internal Wave Dynamics: An Integrated Mathematical, Observational, and Remote Sensing Model ............................................................ 384
Determination of the Detection and Classification Probabilities and Range Limits of Inexpensive Acoustic Sensors and Data Processing Techniques for Monitoring Odontoceti Whales ................................................................................................................................. 384
DURIP: Portable, High-Efficiency, Wide-Band (500-1,200 Hz) Moored Sound Sources for Shallow-Water Low-Frequency Acoustic Propagation Studies ................................................................................. 386
Bi-Dimensional Empirical Model Decomposition for Mine Detection and Change Detection .................... 387
Littoral Oceanography For Mine Warfare ........................................................................................................ 387
Wave Effect on Underwater Bomg Trajectory and Tail Separation ................................................................ 390
Effects of Eddies and Waves on Westward Transport Off Central California ............................................... 391
Non-Assimilation Fusion of Data and Models .................................................................................................. 392
Oceanographic Conditions Off Central California .......................................................................................... 392
Analysis and Modeling of Ocean Acoustic Fluctuations and Moored Observations of Philippine Sea Sound-Speed Structure ......................................................................................................................................... 394
Special Research Awards in Ocean Acoustics: Postdoctoral Fellowship for Tarun Chandrayadula ............... 394
Atmosphere Impacts on Radar Detection and Signature Identification, and on AIS Transmission for Maritime Defense and Security (MDS) .............................................................................................................. 395
Evolution of Ocean Surface Waves Across a Muddy Continental Shelf .......................................................... 395
In-Situ Wave Observations in the ONR High Resolution Air-Sea Interaction DRI ........................................ 396
Modeling Wind Wave Evolution From Deep To Shallow Water .................................................................... 396
Wave-Current Interactions in Coastal Inlets and River Mouths ...................................................................... 396
High Fidelity Active Sonar Simulation (HiFAST): Fish School Models for High Fidelity Simulations of Biologic Clutter ........................................................................................................................................ 397
Autonomous Wide Aperture Cluster For Surveillance (AWACS) ..................................................................... 397
Development of a Real Time Signal-To-Noise Ration Estimation System (For PLUS INP) ......................... 398
Development of a Parallelized System of Noise Prediction for Maritime Security ........................................ 399
Collaborative Research: Does Coupling Between the Inner Shelf and Surf Zone Regulate Larval Supply to Intertidal Populations .................................................................................................................. 399
Collaborative Research: Observations and Predictions of Sand Grain Size Variability and

xxiv
TABLE OF CONTENTS

Morphodynamics on Beaches ......................................................................................................................399
Collaborative Research: Rip Current Dynamics in a Complex Beach Environment .............................................400
DURIP: Shallow-Water Autonomous Vehicles .................................................................................................400
Near Real-Time Monitoring of Indian River Inlet Scour Hole Edge Evolution Seaward of the Bridge Piers .........................................................................................................................401
A Comprehensive Modeling Approach Towards Understanding and Prediction of the THz FEL Analysis, Oscillator/Amplifier Physics Free Electron Laser Program ......................................................................................................................435
Super-Pressure Detonation Behavior ............................................................................................................435
Super-Energetic Explosive Behavior: Proof-of-Principle Experiment Documentation ........................................435
Dynamically Induced Super-Energetic Explosive Behavior on Shaped Charge Jetting .....................................434
AAW IM Technology Integrated Demonstration & Transition ........................................................................434
Advanced Methods in Radar Imaging .........................................................................................................433
Underwater Acoustic Detection and Tracking of Self-Propelled Semi-Submersibles (SPSS) ................................433
CenCOOS: Environmental Monitoring In Support Of Marine Protected Area Management ..........................407
Bearing Sea Studies and Data Collection ......................................................................................................407
Collaborative Research: Fingering Convection At Low Prandtl Number .......................................................408
Collaborative Research: Studies of the Influence of the Antarctic Circumpolar Current on the Atlantic Meridional Circulation ........................................................................................................408
Career: Fluxes and Structures in Double-Diffusive Convection ....................................................................409
Numerical Studies of Double-Diffusive Convection in the Interior of Giant Planets ..........................................409
Ocean-Ice Interaction in the Amundsen Sea: The Keystone of West Antarctic Stability ...............................410
Validation, Verification, and Exploitation of Ocean Model Numerical Guidance for ASW Decision Support ......................................................................................................................................410
A Feasibility Study for Understanding Climate Uncertainty with an Ocean Focus ........................................410

Faculty Publications and Presentations ........................................................................................................413

DEPARTMENT OF PHYSICS

Department Overview ........................................................................................................................................429
Faculty Listing ..............................................................................................................................................431
Project Summaries

Vibration Measurements On Phalanx Block 1B Ciws During Live-Fire Testing, FY2010 ....................................433
Underwater Acoustic Detection and Tracking of Self-Propelled Semi-Submersibles (SPSS) .......................433
Advanced Methods in Radar Imaging .........................................................................................................433
AAW IM Technology Integrated Demonstration & Transition ........................................................................434
Dynamically Induced Super-Energetic Explosive Behavior on Shaped Charge Jetting .....................................434
Effects of Hydro-Reactive Jetting ..................................................................................................................434
Follow-on Investigations of the Effect of Hydro-Reaction During Hypervelocity Impact and Penetration .................................435
Investigation of the Effect of Hydro-Reaction During Hypervelocity Impact and Penetration ..................................435
Super-Energetic Explosive Behavior: Proof-of-Principle Experiment Documentation ..................................435
Super-Pressure Detonation Behavior ...........................................................................................................435
Free Electron Laser Program .......................................................................................................................435
FEL Optical Wavefront Analysis, THz FEL Analysis, Oscillator/Amplifier Physics ..........................................436
Particle Accelerator Ruggedization and Test Bed for Naval Integration and Weapons of Mass Destruction Detection .........................................................................................................................436
THz FEL Ship Integration .............................................................................................................................437
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONR FEL Development At NPS – INP</td>
<td>454</td>
</tr>
<tr>
<td>NPS and UMD THz Source Development</td>
<td>454</td>
</tr>
<tr>
<td>Use Of Bubbles For Pressure Mine Sweeping</td>
<td>454</td>
</tr>
<tr>
<td>Quasiperiodic Motion</td>
<td>454</td>
</tr>
<tr>
<td>Investigation of Asymmetric Flow Fields Induced by Localized Thermal Gradients</td>
<td>454</td>
</tr>
<tr>
<td>Shock Waves in Counter Directed Energy Applications</td>
<td>454</td>
</tr>
<tr>
<td>High Z Materials for Nuclear Radiation Detection: Synergy of Growth, Characterization and Defect Physics for Room Temperature Devices</td>
<td>454</td>
</tr>
<tr>
<td>Near Field Transport Imaging of Nanowires</td>
<td>454</td>
</tr>
<tr>
<td>Next Generation Remotely Triggered PLED Emitter for IFF for Special Operations Forces</td>
<td>454</td>
</tr>
<tr>
<td>NPS Next Generation Vehicle Mounted Identification Friend or Foe (VMIFF) and Cobra Gold 2010 Demonstration/Evaluation</td>
<td>454</td>
</tr>
<tr>
<td>Remotely Triggered Vehicle Mounted IFF (VMIFF)</td>
<td>454</td>
</tr>
<tr>
<td>Remotely Triggered Vehicle Mounted IFF (VMIFF)</td>
<td>454</td>
</tr>
<tr>
<td>Spiral 2 PLED Emitter for IFF for Special Operations Forces</td>
<td>454</td>
</tr>
<tr>
<td>Transport Imaging, Nuclear Radiation Detectors, Complex Oxides Transport Imaging of Semiconductor Nanowires</td>
<td>454</td>
</tr>
<tr>
<td>Autonomous Amphibious Robots For Surf Zone Operations</td>
<td>454</td>
</tr>
<tr>
<td>Generation and Dynamics of Intense Charged Particle Beams</td>
<td>454</td>
</tr>
<tr>
<td>Measurements and Modeling of the Static and Dynamic Behavior of the Porous Materials of Planetary Sciences</td>
<td>454</td>
</tr>
<tr>
<td>New Armor Concepts based on Fundamental Physics</td>
<td>454</td>
</tr>
<tr>
<td>MEMS Directional Ultrasonic Sensor</td>
<td>454</td>
</tr>
<tr>
<td>Real Time THz Detection using Microbolometer Focal Plane Array</td>
<td>454</td>
</tr>
<tr>
<td>High Sensitive THz Camera for Applications in Space Situation Awareness</td>
<td>454</td>
</tr>
<tr>
<td>MEMS Bi-material Focal Plane Array for Real Time THz Imaging</td>
<td>454</td>
</tr>
<tr>
<td>MEMS-based Miniature Microphone for Directional Sound Sensing</td>
<td>454</td>
</tr>
<tr>
<td>A THz Micromagnetron</td>
<td>454</td>
</tr>
<tr>
<td>Naval Sea Systems Command, Theses and Curriculum Support</td>
<td>454</td>
</tr>
<tr>
<td>Advanced Superconducting RF Cavity Study, Beam Halo Analysis, Photothermal Cathode Study (INP)</td>
<td>454</td>
</tr>
<tr>
<td>MW-Class Free Electron Laser Injector Technology Validation</td>
<td>454</td>
</tr>
<tr>
<td>SRF Injectors</td>
<td>454</td>
</tr>
<tr>
<td>Railgun Technology</td>
<td>454</td>
</tr>
<tr>
<td>Ground Systems Support (IPA)</td>
<td>454</td>
</tr>
<tr>
<td>Integrated Signatures Program</td>
<td>454</td>
</tr>
<tr>
<td>Mapping Structures and Trails Using Spectrometry and LIDAR</td>
<td>454</td>
</tr>
<tr>
<td>MASINT Outreach/Liaison Project</td>
<td>454</td>
</tr>
<tr>
<td>Remote Sensing Research</td>
<td>454</td>
</tr>
<tr>
<td>Remote Sensing Research in Support of OSD Special Capabilities Office</td>
<td>454</td>
</tr>
<tr>
<td>RS Technology Research (IPA)</td>
<td>454</td>
</tr>
<tr>
<td>Snow Cover Research with Multispectral Sensors</td>
<td>454</td>
</tr>
<tr>
<td>Space Surveillance Issues</td>
<td>454</td>
</tr>
<tr>
<td>Special Capability Satellite Development of the NanoSatellite Program</td>
<td>454</td>
</tr>
<tr>
<td>Special Capabilities Support to the OSD</td>
<td>454</td>
</tr>
<tr>
<td>Special Capabilities Support to the USD</td>
<td>454</td>
</tr>
<tr>
<td>Special Program Support</td>
<td>454</td>
</tr>
<tr>
<td>Spectral Analysis - Indian Head</td>
<td>454</td>
</tr>
<tr>
<td>Spectral Analysis for National Signatures Program</td>
<td>454</td>
</tr>
<tr>
<td>Spectral and Polarimetric Analysis for National Signatures Program</td>
<td>454</td>
</tr>
<tr>
<td>Spectral Test Planning and Ground Truth Support</td>
<td>454</td>
</tr>
<tr>
<td>Support for DOD Access to Data and Information</td>
<td>454</td>
</tr>
</tbody>
</table>
DEPARTMENT OF SYSTEMS ENGINEERING

Department Overview .................................................................................................................475
Faculty Listing ...........................................................................................................................477

Project Summaries

Maritime Surveillance Systems Program Support ................................................................................479
N8F Chair of Systems Engineering Analysis .......................................................................................479
Determination of Advanced Leading Indicators of Program Technical Issues ..................................................479
N8F Chair of Systems Engineering Analysis ..........................................................................................480
Modeling and Assessment of the C4ISR & Network Modernization Event 10 Architecture .........................480
Formal Modeling Of User Demand-Based Network Systems .....................................................................481
Software Product Line Approach to Open Architecture and Navy Weapons System Acquisition ....................481
Share Transition Support and Repository Tool Design ..............................................................................482
Naval Chair of Systems Engineering and Systems Engineering Research Program .................................483
Overcoming Architecture and Operational Problems With UAVs ...............................................................484
Tunnel Detection Research ...................................................................................................................485
Software Cost Estimation Metrics .........................................................................................................485
Advanced Sensor Systems and System Dynamic Identification for Naval Aviation Systems T&E and Health Management (CBM+) ........................................................................................................487
Naval Aviation Systems Engineering Challenges ....................................................................................487
Propulsion-Safety and Affordable Readiness Sensor Systems ......................................................................488
Propulsion Turbo-Machinery Monitoring ................................................................................................489
Advanced Operational Concept Development CRADA ............................................................................490
Systems Engineering Applied Leading Indicators and Control of Total Ownership Costs of DoD Acquisition Development Programs Through Integrated Systems Engineering Processes and Metrics .............................................................................................................................................491
Body of Knowledge and Curriculum to Advance Systems Engineering ......................................................491

Support to NSG for AGI/ONIR ...........................................................................................................455
Technical Analysis Support to ISSO .......................................................................................................455
Technical Support to the SCO ................................................................................................................455
Technology Joint Center of Excellence (JCOE) ........................................................................................455
Tracking and Detection with Non-Imaging Systems ..................................................................................455
URSUS-2 Sensor Selection .....................................................................................................................455
Deep Seaweb Surveillance ........................................................................................................................456
Operational Adaptation Using Seaweb Maritime Surveillance ....................................................................457
Seaweb Anti-Submarine Warfare Network ................................................................................................458
Seaweb Sensor Network ..........................................................................................................................459
Time/Frequency Relationships of an FFT-Based Acoustic Modem .............................................................459
NPS MW-Class On-Axis RF Coupler Work ...............................................................................................460
Collaborative Research on Blast Resistant Structures for Military Vehicles ..................................................460
Physics of Underwater Missile Launch ....................................................................................................460
Acoustic Vector Sensor Calibration ..........................................................................................................461
Numerical Modeling Efforts in Support Of 3-D Environmental Variability and Acoustic Vector Field Studies .................................................................................................................................461
Support for Studies on Current Transduction Systems and Measurement Infrastructure .................................462
Technical Challenge Support for Vector Sensor Array Development ..........................................................462
Concept for a Deep-Water Undersea Acoustic Network ............................................................................462
MEMS Acoustic Sensor ............................................................................................................................463

Faculty Publications and Presentations .................................................................................................465
TABLE OF CONTENTS

Support of Red Team Efforts for Base Protection ................................................................. 492
Generating a Systems Architecture Addressing the Capabilities, Requirements, and TPPs
for the Transformable Craft (T-Craft) .................................................................................... 492
Master of Science in Space Systems Operations Distance Learning Program ...................... 492
Autonomous Amphibious Robots for Surf Zone Operations ................................................. 493
Advanced Power System Model-Based Architecture and Design Methods ......................... 493
Design of Advanced Power Systems for War-Fighting Effectiveness .................................. 493
Model-Based Systems Engineering for the Unmanned Vehicle Sentry Architecture
Development ............................................................................................................................. 494
UV Sentry SoS Architecture Support and Development ....................................................... 494

Faculty Publications and Presentations .............................................................................. 497

SPACE SYSTEMS ACADEMIC GROUP

Department Overview ......................................................................................................... 507
Faculty Listing ....................................................................................................................... 509
Project Summaries

  Computer Algorithms and Architectures for Space Applications (Project Gusty Oriole) .......... 511
  Optimization and Design of High Efficiency Space-Based Multi-Junction Solar Cells using
    SILVACO Virtual Wafer Fabrication Software ............................................................... 512
  Mobile CubeSat Command and Control (MC3) Support .................................................... 512
  NPSCuL-Lite Flight Unit for Adamaat / Adamsat: NPSCuL-Lite Structures, Flight
    Documentation, and Integration Activities ........................................................................ 512
  Phase III: Final Integration and Testing of a Flight Nano Satellite Solar Cell Array Test ....... 513
  Student Rideshare Payload Model ...................................................................................... 514
  Space Situational Awareness: Cubesat Bus, Attitude Control, and Utilization .................... 515
  Naval Space Systems Academic Chair ............................................................................... 515
  NPS NPSSAT1 Satellite Support .......................................................................................... 516
  Space Systems Engineering Experience Tour and Space Systems Engineering Support .......... 516
  Space Systems Operations Thesis Research/Experience Tour .............................................. 516
  Naval Space Systems Engineering and Acquisition Chair .................................................. 517

Faculty Publications and Presentations .............................................................................. 519

GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY

Department Overview ......................................................................................................... 527
Faculty Listing ....................................................................................................................... 529
Project Summaries

  A Study of Budget Formulation and Execution in Defense Manpower Data Center
    (DMDC) .............................................................................................................................. 533
  DON Chief Management Officer: A Workshop to Explore Foundations for the CMO/
    DCMO in the Department of the Navy ........................................................................... 533
  The Enterprise Concept for Business Transformation in the Navy: An Analytical History .... 533
  Implementation of NSPS and DHS Personnel Systems ....................................................... 533
  Barriers to Implementing LED Lighting Innovations in the Navy ....................................... 534
  Cost of Attrition .................................................................................................................. 534
  Support to Commander Naval Surface Forces .................................................................. 534
  Support to the Naval Supply Systems Command ............................................................... 535
  Applying UID/RFID to Track Maintenance Assets in the US Department of Defense ........ 535
  Innovation Research .......................................................................................................... 535
  Applying Social Control Theory to Modeling and Assessments ........................................ 535
  Irregular Warfare (IW) Methods, Models, and Tools (MMT) Infrastructure & Essential
    Services Ontology ............................................................................................................. 536
# TABLE OF CONTENTS

- Capacity Modeling Of Fleet Readiness Center Southwest, Phase 1 .......................................................... 536
- Analysis of Flight Hour Program Management, Budget Execution, Cost-Avoidance and Financial Management Initiatives in CNAF .................................................................................................................. 536
- Analysis of Flight Hour Program Management, Budget Execution, Cost-Avoidance and Financial Management Initiatives in CNAP ............................................................................................ 537
- Analysis of Budgetary, Financial Management and Related Initiative in NAVSOC ................................. 537
- RADM George F.A. Wagner Chair ........................................................................................................ 537
- Assessment Of Inter-Organizational Collaborative Capacity (ICC) - Study One ...................................... 538
- DCAA Strategic Communication Assessment .......................................................................................... 538
- DCAA Strategic Communication Plan-Phase 2 ..................................................................................... 539
- DCAA Strategic Communication Assessment: Phase 3 ........................................................................ 539
- Executive Communication Reception Study ........................................................................................... 539
- Key Factors of Organizational Resilience .............................................................................................. 539
- Effects of Funding Generosity on Emergency Department Access and the Consequences ................. 540
- Acquisition Research Through the Acquisition Chair and Research Program ....................................... 540
- Acquisition Research Through the Acquisition Chair and Research Program ..................................... 540
- AMF JTRS - Chair of Acquisition and Acquisition Research Program .................................................. 540
- Chair of Acquisition Management and AMF JTRS Acquisition Research Program .......................... 541
- Chair of Acquisition Management and Acquisition Research Program - Annual Acquisition Research Symposium Registration & Gift Accounts ................................................................. 541
- Chair of Acquisition Management and Acquisition Research Program ................................................ 541
- Chair Of Acquisition Management And Acquisition Research Program .............................................. 542
- DASN (A&LM) - Chair of Acquisition and Acquisition Research Program ......................................... 542
- DDACM (Army) - U.S. Army Acquisition Student Support .................................................................... 542
- Department Of Defense (DoD) Acquisition Research Program (ARP) .................................................. 543
- Grants-OSD Sponsored Acquisition Research Program at the Naval Postgraduate School ................ 543
- NAVSEA - Chair of Acquisition and Acquisition Research Program ...................................................... 543
- OPAM - Analysis of DOE’S Cost Proposal Requirement for Competitive Environmental Operating and Capital Projects ........................................................................................................... 543
- PEO IWS 7.0 - Chair of Acquisition Management and Acquisition Research Program ..................... 544
- SSP - Chair of Acquisition and Acquisition Research Program ............................................................. 544
- Support Graduate Student and Acquisition Research at NPS ............................................................... 544
- Building Strategic Communication Capabilities .................................................................................... 544

## Faculty Publications and Presentations.................................................................................................. 545

### INSTITUTES AND CENTERS

#### CEBROWSKI INSTITUTE

- Department Overview ............................................................................................................................ 557
- Faculty Listing .......................................................................................................................................... 559
- Project Summaries
  - Challenges in Technology Transition ................................................................................................. 561
  - Collaborative Research II: A Field Guide for the Science of Computation ........................................ 561
  - CPATH CDEF: Resparking Innovation In Computing Education ........................................................ 561
  - Military Wireless Communications .................................................................................................... 561
  - Automated Media Exploitation Research P&R .................................................................................... 561
  - Establish an Experimentation Capability for Military Wireless Communications ............................ 562
  - Netcentric Certification Office .............................................................................................................. 563
  - CANES SOA Based Security Architecture ........................................................................................ 563
TABLE OF CONTENTS

Recognizing Patterns of Anomie that Set the Conditions for Insurgency ................................................................. 563
Recognizing Patterns of Anomie that Set the Conditions for Insurgency ................................................................. 563
Rapid Prototyping Valuable Information at the Right Time
(Rapid Pro VIRT) .................................................................................................................................................... 564
Strategic Communications ......................................................................................................................................... 564
Web 2.0 Information Sharing ..................................................................................................................................... 565
Disruptive Technology Exploration .......................................................................................................................... 565
Transformational C2 Services for Understanding the Impact of Globalization on Stability
and Security ............................................................................................................................................................... 565
On Integration of Cellular Technology with U.S. Military Communication Networks ...................................................... 565
On-Phone Topic and Author Analysis of SMS/Email Traffic ....................................................................................... 566
Identity and Database Challenges for Force Protection ................................................................................................ 566
ASN RDA Chseng NR-KP Implementation .................................................................................................................. 566
Assessment Federation Support .................................................................................................................................. 566
Hastily Formed Networks in Support of Humanitarian Assistance/Disaster Relief (HA/DR)
and Stability, Security, Transition and Reconstruction (SSTR) Operations ................................................................. 567
Integrating Cell Phone Technology with Marine Corps Tactical Networks ...................................................................... 567
Command and Control Rapid Prototype Capability (C2RPC) Service Oriented Architecture
(SOA) - Based Concept of Operations (CONOPS) .................................................................................................... 567
Decision Superiority in Cyberspace .......................................................................................................................... 568

Faculty Publications and Presentations ...................................................................................................................... 569

WAYNE E. MEYER INSTITUTE OF SYSTEMS ENGINEERING

Department Overview .................................................................................................................................................. 575
Faculty Listing ............................................................................................................................................................. 577
Project Summaries

Bi-Dimensional Empirical Model Decomposition for Mine Detection and Change Detection ............................................. 579
Underwater Bomb Trajectory Prediction for JABS from VSW to SW/DW ....................................................................... 579
NPS Chair of Undersea Warfare Program .................................................................................................................. 580
Undersea Warfare Research Support .......................................................................................................................... 580
Carbon Nanotube - Enhanced Fluid Technology Characterization .................................................................................. 580
Demonstration of Aerosol Duct Sealing Technology at Department of the Navy Facilities ........................................ 580
Reducing the Barriers-To-Research Into the Fleischmann-Pons Effect (FPE): Phase 2,
Produce, Test, and Characterize the System for a Peer Reviewed, Publishable Instrumentation Paper .......................................................... 582
Shipboard Electric System Modeling ........................................................................................................................ 583
 Expeditionary and Minewarfare Chair ....................................................................................................................... 583
Building Education and Workforce Capacity in Systems Engineering Among the Defense
Degree Granting Institutions ........................................................................................................................................ 583
Defense METOC Enterprise Architecture (DMEA) Development .................................................................................. 584
DMEA Development .................................................................................................................................................... 584
Reduction in Total Ownership Cost (RTOC) ................................................................................................................ 584

Faculty Publications and Presentations ...................................................................................................................... 585

MOVES INSTITUTE

Department Overview .................................................................................................................................................. 591
Faculty Listing ............................................................................................................................................................. 593
TABLE OF CONTENTS

Project Summaries

The Human Social Cultural Behavior (HSCB) Modeling Initiative at the Naval Postgraduate School .......................................................... 595
COMBATXXI: MCCDC Behavior Development and Technical Support ........................................................................................................... 595
A-RATS: Autonomous Robotic Adversarial Target Systems that extend Marksmanship Training to Live Ranges ........................................................................................................... 595
Creation of an Open Source Virtual Environment for Naval Health Research - Phase 1 ............................................................... 596
Marine Corps Small Arms and Marksmanship Training ......................................................................................................................... 596
Marine Corps Warfighting Laboratory Moving Targets Engagement Trainer ....................................................................................................................... 596
Battlespace Terrain Reasoning and Awareness Battle Command (BTRA-BC) Battle Engine Validation ........................................................................................................... 596
COMBATXXI Collaboration Server .......................................................................................................................................................... 597
M&S Catalog Metadata ................................................................................................................................................................. 597
S1000D Study .................................................................................................................................................................................. 598
Social/Cultural Modeling For Naval Analyses ...................................................................................................................................................... 599
Anti-Submarine Warfare (ASW) Community Of Interest (COI) Data Modeling Working Group (DMWG) Support for C4I System Interoperability and Track Visualization .................................................................. 600
Finding the Sweet Spot: Bridging SIOO0D, X3D, and SCORM for Embedded Performance Assessment .............................................................................................................................. 600
Massive Multiplayer Online War Game Leveraging the Internet (MMOWGLI) Project Execution ................................................................................................................................. 601
Master’S Thesis Research, LCDR Tariq Rashid: Development of a Persistent Virtual Environment Infrastructure for USW Training and Experimentation .................................................................................. 601
Project Counterplay: Evaluation of Online Gaming Capabilities .................................................................................................................. 601
Technical Support for Mine Warfare (MIW) Data Modeling Working Group and Open Business Model ............................................................................................................................... 602
Undersea Warfare Extensible Markup Language (USW-XML) Working Group For Anti-Submarine Warfare (ASW) Community Of Interest (COI) ........................................................................................................... 602
ADL Research and Technical Support .................................................................................................................................................. 603
Advanced Human Systems Initiatives at the Naval Postgraduate School’S (NPS) Modeling Virtual Environments and Simulation (MOVES) Institute ........................................................................................................... 603
FY10 Program Support to ONR Code 34 .................................................................................................................................................. 603
FY10 Program Support to ONR Code 341 ............................................................................................................................................... 604
FY10 Program Support to ONR Code 342 ............................................................................................................................................... 604
Healing Heros: Support and Consultation ................................................................................................................................................ 605
Medical Simulation and Training Technology ........................................................................................................................................ 605
Senior Research Scientist for Joint Program Committee (JPC-I) Medical Modeling Simulation and Training Technology Portfolio .................................................................................................................. 605
Command and Control Training System Research and Development .................................................................................................................. 605
Creative & Novel Context Generation for Sense~making using Conceptual Blending Theory ........................................................................................................... 606
Run-Time Course of Action Modification for Simulated Entities .................................................................................................................. 606
Dynamic Virtual Environments for Technology Assessment and Adoption .................................................................................................. 606
Educational Dominance Program Support ........................................................................................................................................... 607
Synthetic Environments for Assessment: Prototype Infrastructure and Scenario Development .................................................................................................................. 607
Behavior Analysis and Synthesis for Intelligent Training - BASE-IT .................................................................................................................. 607
TRAC Information Technology ................................................................................................................................................................. 607
Social Network Representation and Analysis ............................................................................................................................................. 607
Wiki-Based Social Networking for Combating Terrorism Professionals .................................................................................................. 608
Landing Signal Officer Automated Pass and Recovery Tracking System Replacement .................................................................................................................. 608
S1000D Analysis .................................................................................................................................................................................. 608
An Interactive Simulation to Train SWO Decision Making ........................................................................................................................................ 608
Creating A Game Based Port Protection Trainer ........................................................................................................................................ 609
TABLE OF CONTENTS

Damage Control Visualization Prototype ................................................................. 609
Investigations Into Using Game Engines as the Basis of Defense Based Game-Based Training and Analysis ................................................................. 609
TRAC-Monterey computational Platform for Combat Modeling and Analysis .................. 609
3D Display and Capture of Humans for Live-Virtual Training ............................................ 610
Behavior Analysis and Synthesis for Intelligent Training - BASE-IT .......................... 610
TRAC Information Technology ................................................................................. 610
Developing Expert Performance on Complex Cognitive Tasks........................................ 610
The MOVES Institute - Fiscal Year 2010 .................................................................. 611
Examining Tools and Methods for Assessment of Network Security and Interoperability ................................................................. 611
Advanced Distributed Learning Initiatives at NPS - Phase 2 ................................................... 611
Analysis of System Training Impact for Major Defense Acquisition Programs ............... 612
Rigid and Articulated Object Detection In Aerial Imagery .................................................. 612
Faculty Publications and Presentations ........................................................................ 613

CENTER FOR INTERDISCIPLINARY REMOTELY PILOTTED AIRCRAFT STUDIES

Department Overview .................................................................................................. 619
Faculty Listing ............................................................................................................. 623
Project Summaries
AECV Puma UAV Operations at Roberts Project .......................................................... 625
DANTE Test on Pelican ............................................................................................... 625
Engineering Flight Testing .......................................................................................... 625
LGuns Testing at McMillan Airfield ............................................................................. 625
NPS SBIR Program Support ....................................................................................... 625
Scan Eagle Operations at Roberts Project .................................................................... 625
UAV Operations at Roberts Project ............................................................................ 626
WTI 10-1 ..................................................................................................................... 626
WTI 10 1-2 .................................................................................................................. 626
WTI 11-1 & 2 .............................................................................................................. 626
Deployment Equipment for a Mobile Weather Radar .................................................... 626
Enhancements of CIRPAS Twin Otter Measurement Capabilities ................................. 627
NPS/CIRPAS Support of the CalNex Experiment in 2010 ............................................. 627
NPS/CIRPAS Support of DOE experiment Calwater .................................................... 627
NPS/CIRPAS Support of Office of Naval Research Airborne Research Objectives ........ 627
RACORO Field Campaign .......................................................................................... 628

NPS-USSOCCOM FIELD EXPERIMENTATION PROGRAM

Department Overview .................................................................................................. 631
Faculty Listing ............................................................................................................. 633
Project Summaries
Field Experimentation Program for Special Operations (FEPSO) .................................. 635
Field Experimentation Program for Special Operations (S&T) ....................................... 635
Camp Roberts and Pelican for TNT/CBE via Zivko Contract ...................................... 635
Development of a Multi-Intuitional Semi-Structured Learning Environment (MISSLE) to Enhance the Education, Experimentation and Equipage (E3) of Special Operations Forces .................................................................................................................. 636
FEPSO Hybrid Education Pilot .................................................................................... 636
RELIEF STAR-TIDES Collaboration ......................................................................... 636
Field Experimentation Program for Special Operations (Futures) ................................ 636
TNT/CBE Collaboration ............................................................................................. 637
# TABLE OF CONTENTS

## NATIONAL SECURITY INSTITUTE

**Department Overview** ........................................................................................................................................... 641
**Faculty Listing** .......................................................................................................................................................... 643

**Project Summaries**
- NPS Program Support to the Staff of the Secretary of the Navy ................................................................. 645
- Radio Frequency Identification to Support JWAC ................................................................................................. 645
- Command and Control Technology Integration for a Common Tactical Picture by the Salinas, California Police Department ........................................................................................................... 645
- Trident Warrior 2010 Experimentation (Fleet Support) ....................................................................................... 645
- Achieving Interoperability in Homeland Security Communications and Operations: A “Model County” Field Test ....................................................................................................................................... 646
- CA Homeland Security Consortium ..................................................................................................................... 646
- Reimbursable Detail of Milt Nenneman .................................................................................................................. 646
- Sensor Systems for Propulsion Safety, Affordability and Readiness ................................................................... 647
- Naval Postgraduate School Support to Joint IED Defeat Test Board (JTB) ......................................................... 647
- NPS Academic Support to Joint IED Defeat Organization .................................................................................. 647
- NPS Support to OSD Counter-Narcotics/Counterterrorism Office ....................................................................... 648
- Maritime Information Sharing Taskforce (MIST) New York/New Jersey ............................................................ 648
- Countering the IED Threat: Capabilities to Support Assessment of Strategies, Systems, and Employment Options through Computational Experiments ........................................................................ 648
- Improving the Integrated Training Center Model for Usability to Enable Accurate Time to Train Modeling ........................................................................................................................................... 650
- Multi-Source Intelligence Data Integration and Assimilation ............................................................................. 651
- Remote Sensing Techniques for Improved Earthquake Warning, Monitoring, and Response ........................ 651
- Generating a Systems Architecture Addressing the Capabilities, Requirements, and TPPs for the Transformable Craft (T-Craft) ........................................................................................................... 652

**Faculty Publications and Presentations** ............................................................................................................... 653

## CENTER FOR ASYMMETRIC WARFARE

**Department Overview** ........................................................................................................................................... 659
**Faculty Listing** .......................................................................................................................................................... 661

**Project Summaries**
- AUVSI FY10 Wildland Fire Fighting Program ...................................................................................................... 663
- CNIC Training and Exercise Development and Assessment ..................................................................................... 663
- FY10 Collaborative Assistance and Rapid Team Optimization System (CARTOS) ................................................ 665
- FY10 Defense Coordinating Officer/Defense Coordinating Element ....................................................................... 665
- FY10 Hawaiya Technologies .................................................................................................................................. 666
- FY10 Operation Golden Phoenix Training and Exercise Development ................................................................. 666
- FY10 Oxnard Harbor District Coastal Trident Port Emergency Planning And Exercise Program .......................................... 667
- FY10 RDT&E Radio Frequency Identification in Support to Joint Warfare Analysis Center (JWAC) ....................... 667
- FY10 Study of Pakistan Army Operational Lessons Learned in Counter-IED & Counterinsurgency (COIN) ........................................................................................................................................... 668
- InfraGard FY10 Cyber Attack and Security Exercise (CASE) Training and Exercise Program .................................. 668
- Research, Development and Analysis of Mass Evacuation Plans ........................................................................... 669
- Technical Support for Airborne Electronic Attack, Jamming and Technical Optimization ........................................ 669

**Faculty Publications and Presentations** ............................................................................................................... 671
# TABLE OF CONTENTS

GLOBAL PUBLIC POLICY ACADEMIC GROUP

<table>
<thead>
<tr>
<th>Department Overview</th>
<th>677</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty Listing</td>
<td>679</td>
</tr>
</tbody>
</table>

Project Summaries

- Understanding Chinese Organizations: Interviews and Research on the Influence of Chinese Culture on Organizational Behavior, Decision Making and Strategy .......................................................... 681
- Recognizing Patterns of Anomie that Set the Conditions for Insurgency .......................................................... 681
- Research Support to Hybrid Knowledge Management System for Complex Operations ........................................ 681
- Social Scientism and the Art of Model Development: A Review ........................................................................ 682
- USPTC FY10 Multi-Lateral Outreach Support Under the U.S.-Sweden Memorandum of Understanding (MOU) .................................................. 682
- USPTC and GPPAG FY10 Preparatory Work in Support for the Global Challenges Forum ........................................ 683
- Modeling Corruption Effects Within Irregular Warfare ......................................................................................... 683
- Cyber Security - Distributed Learning Curriculum Development ............................................................................. 683

Faculty Publications and Presentations ..................................................................................................................... 685

INDEX BY PRINCIPAL INVESTIGATOR ............................................................................................................................ 689
Established in 1965 and located at the Naval Postgraduate School (NPS), the Defense Resources Management Institute (DRMI) is a joint program that conducts professional education in resources management for senior military officers and civilian officials in all the services, and also for partner and allied nations. The goal of DRMI’s programs is to improve decision making and management skills related to the allocation and use of resources (financial, personnel, equipment, materiel, logistics, infrastructure, etc.) in modern defense organizations. DRMI programs building capacity and improving defense institutions are taught by Naval Postgraduate School (NPS) faculty, sponsored by the Office of the Secretary of Defense, and conducted in residence at NPS and in other locations worldwide.

Since 1965, over 14,000 U.S. and 18,000 international officials from 162 countries have participated in DRMI programs.

The DRMI research program is sponsored by the Office of the Secretary of Defense and is designed to support the multidisciplinary nature of the curriculum. The NPS DRMI faculty conducted over $550K in research contracts for DoD organizations through 2010.

DRMI's multidisciplinary faculty is drawn from the fields of management, economics, operations research, systems engineering, and organizational psychology. The faculty is composed of civilians with PhDs, retired U.S. military officers with Masters’ degrees, and active-duty military officers representing each of the services.

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. The School of International Graduate Studies’ program exceeded $20.7M in FY2010.
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jomana Amara</td>
<td>Assistant Professor</td>
<td>831-656-3591</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:jhamara@nps.edu">jhamara@nps.edu</a></td>
</tr>
<tr>
<td>Jose Z.L. Andin</td>
<td>LTC, USAF Lecturer</td>
<td>831-656-2051</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:diangeli@nps.edu">diangeli@nps.edu</a></td>
</tr>
<tr>
<td>Diana Angelis</td>
<td>Associate Professor</td>
<td>831-656-2072</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:larmey@nps.edu">larmey@nps.edu</a></td>
</tr>
<tr>
<td>Donald E. Bonsper</td>
<td>Senior Lecturer</td>
<td>831-656-2224</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:dbonsper@nps.edu">dbonsper@nps.edu</a></td>
</tr>
<tr>
<td>Phillip A. Costain</td>
<td>Senior Lecturer</td>
<td>831-656-2909</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:pacostai@nps.edu">pacostai@nps.edu</a></td>
</tr>
<tr>
<td>Jason Hansen</td>
<td>Assistant Professor</td>
<td>831-656-2447</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:jkhansen@nps.edu">jkhansen@nps.edu</a></td>
</tr>
<tr>
<td>Mark Hladky</td>
<td>Lecturer</td>
<td>831-656-3142</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:mhhladky@nps.edu">mhhladky@nps.edu</a></td>
</tr>
<tr>
<td>Stephen Hurst</td>
<td>Senior Lecturer</td>
<td>831-656-3480</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:sfhurst@nps.edu">sfhurst@nps.edu</a></td>
</tr>
<tr>
<td>Jonathan Lipow</td>
<td>Associate Professor</td>
<td>831-656-2661</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:jlipow@nps.edu">jlipow@nps.edu</a></td>
</tr>
<tr>
<td>Robert M. McNab</td>
<td>Associate Professor</td>
<td>831-656-3132</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:rmmcnab@nps.edu">rmmcnab@nps.edu</a></td>
</tr>
<tr>
<td>Francois Melese</td>
<td>Professor</td>
<td>831-656-2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:fmelese@nps.edu">fmelese@nps.edu</a></td>
</tr>
<tr>
<td>Luis Morales</td>
<td>Lecturer</td>
<td>831-656-3669</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:lmorales@nps.edu">lmorales@nps.edu</a></td>
</tr>
<tr>
<td>James H. Morris</td>
<td>Professor</td>
<td>831-656-2992</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:jhmorris@nps.edu">jhmorris@nps.edu</a></td>
</tr>
<tr>
<td>Mike J. Nixon</td>
<td>LTC, USA Lecturer</td>
<td>831-656-2992</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:jhmorris@nps.edu">jhmorris@nps.edu</a></td>
</tr>
<tr>
<td>Allan C. Polley</td>
<td>Senior Lecturer</td>
<td>831-656-2017</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:acpolley@nps.edu">acpolley@nps.edu</a></td>
</tr>
<tr>
<td>Eva Regnier</td>
<td>Assistant Professor</td>
<td>831-656-2912</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:eregnier@nps.edu">eregnier@nps.edu</a></td>
</tr>
<tr>
<td>Anke Richter</td>
<td>Associate Professor</td>
<td>831-656-2468</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:arichter@nps.edu">arichter@nps.edu</a></td>
</tr>
<tr>
<td>Anthony J. Seifert</td>
<td>LCDR, USN Lecturer</td>
<td>831-656-2306</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:rssulliv@nps.edu">rssulliv@nps.edu</a></td>
</tr>
<tr>
<td>Jay Simon</td>
<td>Assistant Processor</td>
<td>831-656-2457</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:jsimon@nps.edu">jsimon@nps.edu</a></td>
</tr>
<tr>
<td>Ryan Sullivan</td>
<td>Associate Professor</td>
<td>831-656-2791</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:lvauhan@nps.edu">lvauhan@nps.edu</a></td>
</tr>
<tr>
<td>Larry E. Vaughan</td>
<td>Senior Lecturer</td>
<td>831-656-2457</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:lvauhan@nps.edu">lvauhan@nps.edu</a></td>
</tr>
<tr>
<td>Kent D. Wall</td>
<td>Professor</td>
<td>831-656-2158</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:kdwall@nps.edu">kdwall@nps.edu</a></td>
</tr>
<tr>
<td>Natalie J. Webb</td>
<td>Associate Professor</td>
<td>831-656-2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:njwebb@nps.edu">njwebb@nps.edu</a></td>
</tr>
</tbody>
</table>
DEFENSE RESOURCES MANAGEMENT INSTITUTE

TRAUMATIC BRAIN INJURY (TBI) EVALUATION INSTRUMENTS AND PROCESSES FOR CLINICAL FOLLOW-UP

Jomana Amara, Assistant Professor
Defense Resources Management Institute
Sponsor: U.S. Department Of Veterans Affairs

OBJECTIVE: The primary aim of VA Boston’s proposed 2-year study is a description and analysis of how the TBI evaluation process relates to VA care patterns, accounting for the impact of co-occurring psychiatric conditions and other relevant factors (item (e) in the RFP). Jomana Amara, Ph.D., DOD Principal Investigator, will work with the research team under a contract to the Naval Postgraduate School. As faculty at NPS, Dr. Amara has studied defense economics for the past three years and has published on defense expenditures and applied econometrics. Her interest in health care costs for OEF/OIF led to two papers with Dr. Hendricks. She will take the lead on obtaining DOD data. She will also lead the efforts to check for complete DOD information on the study population and will contact the appropriate services or the DMDC to obtain updates as needed. She will work with Dr. Gardner and Ms. Wolfsfeld on the necessary data management. Dr. Amara will collaborate with HCFE through a contract with the Naval Postgraduate School. She will devote 20% time to this project in each year.

ECONOMIC CAUSES OF CONFLICT
Robert M. McNab, Associate Professor
Defense Resources Management Institute
Sponsor: Human Socio-Cultural Behavior (HSCB)

SUMMARY: Dr. McNab provided subject matter expertise in the area of economics. This effort focused on the economic incentives underlying conflict and developed an economic model that helped the development of the TRAC CGE model.

SCALE INVARIANCE IN THE IRAQ CONFLICT AND THE MICROLEVEL FOUNDATIONS OF VIOLENCE
Robert M. McNab, Associate Professor
Defense Resources Management Institute
Sponsor: Joint Improvised Device Defeat Organization

SUMMARY: Dr. McNab led a research team to investigate the distribution of violence in Iraq and whether there was a correlation between economic conditions and violence. This project provided evidence that violence in Iraq violated the “Law of War” and that forecasting efforts based upon this assumption were suspect.

CORRUPTION EFFECTS WITHIN IRREGULAR WARFARE
Robert M. McNab, Associate Professor
Defense Resources Management Institute
Sponsor: U.S. Training and Doctrine Command – Monterey

SUMMARY: Dr. McNab lead a research team to provide an extensive literature review and modeling effort on the influence of corruption on irregular warfare. The objective of this effort was to improve knowledge and assist the ongoing TRAC modeling effort.
DEFENSE RESOURCES MANAGEMENT INSTITUTE

MILITARY COST-BENEFIT ANALYSIS
Francois Melese, Professor
Defense Resources Management Institute
Sponsor: GSBPP Acquisition Research Program

OBJECTIVE: Anticipating future spending cuts, the conventional approach typical of Military Cost-Benefit analyses is expanded to explicitly include affordability.

AN ECONOMIC APPROACH TO BID PROTESTS
Francois Melese, Professor
Defense Resources Management Institute
Sponsor: GSBPP Acquisition Research Program and USAF

OBJECTIVE: Develop Strategies to Minimize the Cost of Protests to DoD while preserving competition to achieve the best possible performance, cost, and schedule combination for U.S. defense programs.

ADVANCED ANALYTICAL DECISION MAKING (AADM) RESEARCH AND WORKSHOPS
Kent D. Wall, Professor
Defense Resources Management Institute
Sponsor: The Boeing Company

OBJECTIVE: The objective of this task is to enhance the joint understanding of common analytical techniques that can be employed in the public and private sector in the support of multi-criteria decision-making. Focus will be on the latest research in methods of multi-criteria decision making, to include topics in economics, cost analysis, and uncertainty. The focus will be on exploring single vs. multi-objective decision making; analyzing models of preferences; developing cost estimating techniques and risk assessment concepts.


Francois Melese and Jonathan Lipow, “Does NATO have a Role to Play in the Global Financial Crisis?” European Security, Jan 2010.


BOOKS


CONTRIBUTIONS TO BOOKS


DEFENSE RESOURCES MANAGEMENT INSTITUTE


CONFERENCE PUBLICATIONS & PROCEEDINGS


CONFERENCE PRESENTATIONS


Simon, J. (2010). Decision Making with Prostate Cancer: A Multiple-Objective Model with Uncertainty. Pierskalla Award Session, INFORMS Annual Meeting, Austin, TX.


DEFENSE RESOURCES MANAGEMENT INSTITUTE


RESEARCH REPORTS


WORKING PAPER


Simon, J., Saari, D., & Keller, L. R. Modeling Altruistic Preferences. (2nd round, *Journal of Mathematical Psychology*)

Simon, J., & Melese, F.  A New Approach to Governments’ Vendor Selection Decisions: A Three-Stage Multiattribute Procurement Auction.  (2nd round, Decision Analysis)

Lipow, J., & Simon, J.  Military Reserves and Social Welfare.  (Economics Letters)


McInerney JE, & Richter A. Strengthening hospital preparedness for explosive or chemical events- Leveraging within hospital resources.  Revise and resubmit at Disaster Medicine and Public Health Preparedness.

McInerney JE, & Richter A. Strengthening hospital preparedness for chemical, biological, radiological, nuclear and explosive (CBRNE) events - Clinician opinions regarding physician/physician assistant response and training. Revise and resubmit at American Journal of Disaster Medicine.


DEPARTMENT OF NATIONAL SECURITY AFFAIRS

HAROLD TRINKUNAS
CHAIRMAN
OVERVIEW:
The Naval Postgraduate School’s (NPS) Department of National Security Affairs (NSA) specializes in the study of international relations, security policy, and regional studies. NSA is unique because it brings together outstanding faculty, students from the Army, Air Force, Navy, Marines, National Guard, and various civilian agencies, and scores of international officers from dozens of countries for the sole purpose of preparing tomorrow’s military and civilian leaders for emerging security challenges.

The faculty is made up of approximately fifty professors and instructors. Every member of the faculty is a specialist in an aspect of security studies or in the politics and culture of a specific region. The faculty members are drawn from the top Ph.D.-granting institutions in history, political science, and economics. They are deeply involved in cutting-edge academic research and publication, enhancing their ability to provide superior, graduate-level education in support of U.S. national security interests. The analysis of security studies at NPS has been listed among the top ten universities in the most recent (2006-2007) Faculty Scholarly Productivity (FSP) Index in the International Affairs and Development category. The faculty pride themselves on being responsive to the evolving needs of research and curricula sponsors, which creates a dynamic and exciting environment for students. Unlike other graduate programs, faculty, not teaching assistants, teach all classes.

RESEARCH PROGRAM-FY2010:
The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of National Security Affairs is provided below:
NATIONAL SECURITY AFFAIRS

Harold A. Trinkunas
Chairman & Associate Professor
831-656-2863
hattrinku@nps.edu

Daniel Moran
Associate Chairman for Instruction & Professor
831-656-2059
djmoran@nps.edu

Donald Abenheim
Associate Professor
831-656-3171
dabenheim@nps.edu

Zachary S. Davis
Research Professor
831-656-1036
zs Davis@nps.edu

Wade Huntley
Senior Lecturer
whuntle@nps.edu

Naazneen Barma
Assistant Professor
831-656-6250
nhbarma@nps.edu

Guido de la Vega
Professor
831-656-2744
gdelaveg@nps.edu

Maiah Jaskoski
Assistant Professor
831-656-3167
majaskos@nps.edu

Anne Marie Baylouny
Associate Professor
831-656-2739
ambaylou@nps.edu

Kenneth R. Dombroski
Lecturer
831-656-3219
kdombroski@nps.edu

Scott Jasper
CAPT, USN (Ret.)
Center for Civil-Military Relations
831-656-2913
sejasper@nps.edu

Thomas C. Bruneau
Distinguished Professor
831-656-1037
tbruneau@nps.edu

Sophal Ear
Assistant Professor
510-996-6911
sear@nps.edu

Tom Johnson
Research Professor
831-656-3190
thjohnso@nps.edu

Mark Chakwin
COL, USA
Foreign Area Officer Chair/
Senior Army Representative
831-656-3654
mbchakwi@nps.edu

Ryan Gingeras
Assistant Professor
831-656-2863
rgingera@nps.edu

Abbas Kadhim
Assistant Professor
510-847-5983
akkadhim@nps.edu

Anshu Chatterjee
Lecturer
831-656-2521
anchatte@nps.edu

Jeanne Giraldo
Lecturer
831-656-2990
jkgirald@nps.edu

Paul Kapur
Associate Professor
831-656-3898
spkapur@nps.edu

Victoria Clement
Assistant Professor
831-656-3293
vsclemen@nps.edu

Michael Glosny
Instructor
maglosny@nps.edu

Feroz Khan
Lecturer
831-656-3043
flkhana@nps.edu

Anne L. Clunan
Associate Professor
831-656-2904
acleunan@nps.edu

Mohammed M. Hafez
Associate Professor
831-656-1038
mnhafez@nps.edu

Jeffrey W. Knopf
Associate Professor
831-656-7729
jw knopf@nps.edu

Erik Dahl
Assistant Professor
831-656-3168
ejdahl@nps.edu

Jennith Hoyt
CAPT, USN
831-656-2288
jehoyt@nps.edu

Letitia L. Lawson
Senior Lecturer
831-656-2744
lllawson@nps.edu
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Email</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandi Leavitt</td>
<td>Research Assistant Professor</td>
<td><a href="mailto:srleavit@nps.edu">srleavit@nps.edu</a></td>
<td>831-656-3680</td>
</tr>
<tr>
<td>Jessica Piombo</td>
<td>Associate Professor</td>
<td><a href="mailto:jrpombo@nps.edu">jrpombo@nps.edu</a></td>
<td>831-656-2831</td>
</tr>
<tr>
<td>Robert Springborg</td>
<td>Professor</td>
<td><a href="mailto:rdspring@nps.edu">rdspring@nps.edu</a></td>
<td>831-656-3631</td>
</tr>
<tr>
<td>Theodore G. Lewis</td>
<td>Professor</td>
<td><a href="mailto:tlewis@nps.edu">tlewis@nps.edu</a></td>
<td>831-656-2830</td>
</tr>
<tr>
<td>Maria Jose Rasmussen</td>
<td>Associate Professor</td>
<td><a href="mailto:mrasmussen@nps.edu">mrasmussen@nps.edu</a></td>
<td>831-656-3673</td>
</tr>
<tr>
<td>Mikhail Tsypkin</td>
<td>Associate Professor</td>
<td><a href="mailto:mtsypkin@nps.edu">mtsypkin@nps.edu</a></td>
<td>831-656-2218</td>
</tr>
<tr>
<td>Robert E. Looney</td>
<td>Professor</td>
<td><a href="mailto:relOoney@nps.edu">relOoney@nps.edu</a></td>
<td>831-656-3484</td>
</tr>
<tr>
<td>Dirk Rogalski</td>
<td>Visiting Lecturer</td>
<td><a href="mailto:dbrogals@nps.edu">dbrogals@nps.edu</a></td>
<td>831-656-1036</td>
</tr>
<tr>
<td>Christopher P. Twomey</td>
<td>Assistant Professor</td>
<td><a href="mailto:etwomey@nps.edu">etwomey@nps.edu</a></td>
<td>831-656-3543</td>
</tr>
<tr>
<td>Tristan Mabry</td>
<td>Research Assistant Professor</td>
<td><a href="mailto:tjmabry@nps.edu">tjmabry@nps.edu</a></td>
<td>831-656-7528</td>
</tr>
<tr>
<td>James Russell</td>
<td>Senior Lecturer</td>
<td><a href="mailto:jarussel@nps.edu">jarussel@nps.edu</a></td>
<td>831-656-2109</td>
</tr>
<tr>
<td>Robert J. Weiner</td>
<td>Assistant Professor</td>
<td><a href="mailto:rjweiner@nps.edu">rjweiner@nps.edu</a></td>
<td>831-656-3952</td>
</tr>
<tr>
<td>Michael Malley</td>
<td>Assistant Professor</td>
<td><a href="mailto:msmalley@nps.edu">msmalley@nps.edu</a></td>
<td>831-656-2409</td>
</tr>
<tr>
<td>Zachary Shore</td>
<td>Associate Professor</td>
<td><a href="mailto:zshore@nps.edu">zshore@nps.edu</a></td>
<td>831-656-3358</td>
</tr>
<tr>
<td>James J. Wirtz</td>
<td>Professor &amp; Dean of SIGS</td>
<td><a href="mailto:jwirtz@nps.edu">jwirtz@nps.edu</a></td>
<td>831-656-3483</td>
</tr>
<tr>
<td>Alice L. Miller</td>
<td>Senior Lecturer</td>
<td><a href="mailto:hlmille1@nps.edu">hlmille1@nps.edu</a></td>
<td>831-656-2143</td>
</tr>
<tr>
<td>Scott N. Siegel</td>
<td>Assistant Professor</td>
<td><a href="mailto:snsiegel@nps.edu">snsiegel@nps.edu</a></td>
<td>831-656-3294</td>
</tr>
<tr>
<td>Glen Woodbury</td>
<td>Professor of Practice &amp; Director, Center for Homeland Defense &amp; Security</td>
<td><a href="mailto:glwoodbu@nps.edu">glwoodbu@nps.edu</a></td>
<td>831-656-3038</td>
</tr>
<tr>
<td>James C. Moltz</td>
<td>Associate Professor</td>
<td><a href="mailto:jcmoltz@nps.edu">jcmoltz@nps.edu</a></td>
<td>831-656-1039</td>
</tr>
<tr>
<td>Arturo C. Sotomayor</td>
<td>Assistant Professor</td>
<td><a href="mailto:acsotoma@nps.edu">acsotoma@nps.edu</a></td>
<td>831-656-2798</td>
</tr>
<tr>
<td>David S. Yost</td>
<td>Professor</td>
<td><a href="mailto:dyost@nps.edu">dyost@nps.edu</a></td>
<td>831-656-2579</td>
</tr>
</tbody>
</table>
THE PARADOXES OF PEACEBUILDING: INTERNATIONAL INTERVENTIONS IN POST-CONFLICT STATES

Naazneen H. Barma, Assistant Professor
Department of National Security Affairs

Sponsor: This research had no sponsor during this time period

OBJECTIVE: This study, originated as my dissertation project, focuses on the comparative dynamics of internationally sponsored institution-building efforts in post-conflict Afghanistan, Cambodia, and East Timor. Applying theories of comparative political and institutional development, I explore the outcomes in state- and democracy-building resulting from the approach the United Nations takes in post-conflict interventions. The various strands of literature that deal with post-conflict institution-building tend to share explicit or implicit analytical assumptions that underplay deeper causal processes embedded in state-society relationships and under-specify the mechanisms through which international models of governance can be implemented in politicized domestic contexts. My study addresses these gaps in the literature by emphasizing the inherently political nature of peacebuilding through transitional governance. I argue that the key factors in explaining outcomes are domestic political dynamics rather than the technical dimensions of international assistance. I thus move some way toward taking a longer-term and causally oriented look at outcomes with a view to generating explanations about peacebuilding processes that also contribute to broader theoretical debates in political science.

SUMMARY: During this time period, fieldwork-based research on Cambodia, East Timor, and Afghanistan was updated through review of recent articles and implementation reports, along with several interviews of international organization officials in Washington DC who have been involved with these interventions. The theoretical component of the argument was refined through a literature review—developing an argument describing a clear tradeoff between the simultaneous goals of state- and democracy-building in post-conflict interventions. The three detailed case studies in the evolving book manuscript illustrate how these dynamics unfold, through a most different systems comparative methodology. Three paper proposals on different aspects of the study were submitted—including the core theoretical argument, as well as a nuanced presentation of the three case studies themselves—to the Global International Studies Conference (accepted), the London School of Economics Global Governance International Conference (accepted), and the 2011 American Political Science Association annual conference (acceptance pending).

THE MICRO POLITICAL ECONOMY OF NATURAL RESOURCE GOVERNANCE

Naazneen H. Barma, Assistant Professor
National Security Affairs Department

Sponsor: This research had no sponsor during this time period

OBJECTIVE: This study analyzes the complexities of political economy and governance in resource-rich states in East Asia and the Pacific. Too often, nations with greater wealth from natural resources suffer from the ‘resource curse,’ growing more slowly than those that are resource-poor and suffering from weak accountability and institutions, poor social capital, and increased likelihood of conflict. In order to better understand the causal mechanisms affecting a resource-rich country’s fate, I previously (prior to my NPS faculty appointment commencing) co-directed a multi-country study (supported by the World Bank) examining political economy and governance challenges in developing countries facing this natural resource paradox. My contribution to the distinguished and wide-ranging literature on the resource curse is that I focus on understanding the micro-level political economy of natural resource governance and how it affects political economic development in post-conflict states. I examine iterated interactions among state, society, and industry stakeholders to understand how decisions around natural resource extraction and the taxation and spending of resource revenues can help to build—or, alternatively, to undermine—the state-society compact central to a country’s political economy.

SUMMARY: During this time period, an article was researched and drafted, examining the micro politics of oil and minerals management in four East Asian countries through a framework rooted in the natural resource value chain, in order to develop a sense of the mechanisms underpinning the resource curse in fragile nations. As the analytical foundation of this project a typology of the political economy of resource-dependent developing countries was
advanced—hinging on the ability of governments to make inter-temporal commitments and the political inclusiveness of the state-society compact. The article applied this framework to Cambodia and East Timor (two resource-dependent post-conflict countries) and to Laos and Mongolia (two resource-dependent countries that have not undergone violent conflict) in order to compare and contrast the diversity of outcomes in natural resource management. A proposal on this paper was submitted to the Midwest Political Science Association annual national conference (accepted). A panel proposal on topic of natural resource governance was also organized and submitted, in collaboration with other scholars in the field, for the 2011 American Political Science Association annual conference (acceptance pending).

PUBLICATIONS: During this time period, I brought to completion two publications from this project—a book and a peer-reviewed book chapter, as listed below, both to be published in early 2011.


4TH ANNUAL FOREIGN AREA OFFICER CONFERENCE
COL Mark Chakwin, USA, Foreign Area Officer Chair
Department of National Security Affairs
Sponsor: Secretary of the Air Force

OBJECTIVE: This conference prepares future Foreign Area Officers from all services for roles and duties they can expect in their future positions. By discussing key foreign area officer characteristics, roles, and responsibilities in an open forum, participants can engage panel members to seek a better understanding of challenges that lie ahead. This conference fills a gap in the FAO education and training program by allowing students to formulate questions and invite subject matter experts who can best answer those questions, benefiting both the FAOs and their spouses.

ENABLING CCC-AACO PARTNERSHIP
Anne L. Clunan, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA)

OBJECTIVE: Facilitate and improve collaboration between the Defense Threat Reduction Agency Advanced Systems and Concepts Office (DTRA/ASCO) and the Naval Postgraduate School (NPS) Center on Contemporary Conflict (CCC) and conduct a scoping project on a Weapons of Mass Destruction (WMD) journal.

SUMMARY: In 2010, Prof. Clunan secured support for the operations of the Center on Contemporary Conflict to operate and manage Defense Threat Reduction Agency-Advanced Systems and Concepts Office (DTRA-ASCO) programs. In order to better coordinate ongoing projects, create efficiencies in staffing, and enable smooth communication between NPS and CCC Principal Investigators (PIs) and DTRA/ASCO, Prof. Clunan led the Enabling CCC-ASCO Partnership project. The project provides liaison and administrative support for NPS and CCC staff and faculty. This partnership greatly enhanced the quality and efficiency of the DTRA-ASCO sponsored NPS and CCC research and activities. The project also provided support for a collaborative and systematic exploration of options related to producing a journal on Weapons of Mass Destruction located within the CCC. The exploratory project scoped publication possibilities, potential audiences, nature of the publication, roles and responsibilities, and other relevant aspects necessary to produce a journal beginning in FY11 that contributes to the missions of DTRA and NPS.
ENABLING THE CENTER ON CONTEMPORARY CONFLICT-ADVANCED SYSTEMS AND CONCEPTS OFFICE PARTNERSHIP

Anne L. Clunan, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA)

OBJECTIVE: Facilitate and improve collaboration between the Defense Threat Reduction Agency Advanced Systems and Concepts Office (DTRA/ASCO) and the Naval Postgraduate School (NPS) Center on Contemporary Conflict (CCC) and conduct a scoping project on a Weapons of Mass Destruction (WMD) journal.

SUMMARY: In 2010, Prof. Clunan secured support for the operations of the Center on Contemporary Conflict to operate and manage Defense Threat Reduction Agency-Advanced Systems and Concepts Office (DTRA-ASCO) programs. In order to better to coordinate ongoing projects, create efficiencies in staffing, and enable smooth communication between NPS and CCC Principal Investigators (PIs) and DTRA/ASCO, Prof. Clunan led the Enabling CCC-ASCO Partnership project. The project provides liaison and administrative support for NPS and CCC staff and faculty. This partnership greatly enhanced the quality and efficiency of the DTRA-ASCO sponsored NPS and CCC research and activities. The project also provided support for a collaborative and systematic exploration of options related to producing a journal on Weapons of Mass Destruction located within the CCC. The exploratory project scoped publication possibilities, potential audiences, nature of the publication, roles and responsibilities, and other relevant aspects necessary to produce a journal beginning in FY11 that contributes to the missions of DTRA and NPS.

UNGOVERNED SPACES
Anne L. Clunan, Associate Professor
Harold A. Trinkunas, Associate Professor
Department of National Security Affairs
Sponsor: Center for Civil Military Relations, Naval Postgraduate School (NPS)

OBJECTIVE: “Ungoverned spaces” are increasingly cited as a key threat to the U.S. government and its interests throughout the world. This project proposes to analyze the concept of ungoverned spaces and determine whether they really are ungoverned and constitute threats to states. Governance exists in areas frequently claimed as ungoverned spaces, such as feral cities, failed states, offshore financial markets and tribal areas such as the Afghan-Pakistan border. The notion of ungoverned spaces is potentially even more broadly applicable, to areas within otherwise functioning states, including the United States, where authority and jurisdiction are exercised by non-state actors. This ongoing project brings together international scholars with a broad interest in the problem of “ungoverned spaces”, including work focused on megacities, organized crime, transnational gangs, “home-grown” terrorist cells, money laundering, WMD proliferation networks, the privatization of security services, and the rise of internet social movements. The principal participants continue to contribute to an edited volume on the subject of ungoverned spaces.

SUMMARY: Clunan and Trinkunas organized a major ongoing research project in 2007 regarding the threats posed by ungoverned spaces, including conference held at the Naval Postgraduate School August 2-3, 2007. The conference was co-sponsored by the Center for Civil Military Relations at NPS and the Defense Threat Reduction Agency/Advanced Systems and Concepts Office (see below for DTRA sponsorship). In 2010 Profs. Clunan and Trinkunas oversaw the final steps for publication by Stanford University Press.

PUBLICATIONS:

Clunan, Anne L., and Harold A. Trinkunas, eds., Ungoverned Spaces: Alternatives to State Authority in an Era of Softened Sovereignty, (Stanford University Press, 2010).


Clunan, Anne L. and Harold A. Trinkunas, eds., “Conceptualizing Ungoverned Spaces: Territorial Statehood, Contested
UNGOVERNED SPACES

Anne L. Clunan, Associate Professor

Department of National Security Affairs

Sponsor: Defense Threat Reduction Agency (DTRA)

OBJECTIVE: This project will assess the command and control challenges that civilian and military planners face when dealing with “ungoverned spaces” and the WMD proliferation and terrorism threats that arise from them. Ungoverned spaces are increasingly cited as a key threat to the U.S. government and its interests throughout the world. Often these spaces are seen as synonymous with failed states, or states that are unable to effectively exercise sovereignty. A key goal of U.S. defense strategy is now to improve “effective sovereignty” in such areas, in order to deny sanctuary to WMD proliferators, terrorists, arms- and narco-traffickers, and gangsters. The project will expand our understanding of ungoverned spaces beyond the commonplace notion of “failed,” “failing” or “fragile” states to address spaces within otherwise functioning states that may harbor WMD proliferation networks or facilitate WMD terrorism. It will investigate which ungoverned spaces are priority threats to the United States and its allies. It will conclude with analysis of early warning indicators and policy makers’ and military planners’ attempts to manage the WMD proliferation and terrorism threats arising from ungoverned spaces in Africa, Asia, Eurasia, and the Americas.

SUMMARY: In this ongoing project, Clunan commissioned a series of research papers from subject-matter experts, including Prof. Piombo, to assess cases of ungoverned spaces around the world, an examination of early warning indicators of ungovernability, WMD proliferation and WMD terrorism networks, as well as an analysis of how military and civilian governmental agencies have responded in the past to WMD threats arising from ungoverned spaces for delivery at a Conference on Ungoverned Spaces she co-organized with Prof. Trinkunas and held August 2-3, 2007 at NPS. Clunan presented findings for policy makers and military planners in 2008.

PUBLICATIONS:

Clunan, Anne L., and Harold A. Trinkunas, eds., Ungoverned Spaces: Alternatives to State Authority in an Era of Softened Sovereignty, (Stanford University Press, 2010).


PRESENTATIONS:


THE DEFINITION OF NATIONAL SECURITY INTERESTS AND INSTITUTIONAL CHANGE

Anne L. Clunan, Associate Professor
Department of National Security Affairs
Sponsor: Naval Postgraduate School (NPS)

OBJECTIVE: Project investigates how and why post-Soviet Russia defines its national security interests regarding strategic arms control and European security in times of dramatic change.

SUMMARY: In 2010, Professor Clunan revised portions of her 2009 book The Social Construction of Russia’s Resurgence: Aspirations, Identity, and Security Interests (Baltimore: Johns Hopkins University Press) that resulted from this project, and prepared papers and presentations for delivery at conferences and workshops in 2010.

PRESENTATIONS:


COMPARING FAILED, FOILED, COMPLETED AND SUCCESSFUL TERRORIST ATTACKS

Erik J. Dahl, Assistant Professor
Department of National Security Affairs
Sponsor: U.S. Department of Homeland Security (DHS), Center for the Study of Terrorism and Behavior (CSTAB)

OBJECTIVE: Understanding the terrorist threat facing the United States requires analysis of not just successfully executed terrorist attacks, but also of failed and foiled efforts that intended to harm the United States or its allies. This collaborative research project seeks to address this gap in the open-source academic and government research community and, in so doing, expand our knowledge of the intentions and capabilities of al Qaeda.

SUMMARY: This is a joint project with the University of Maryland National Consortium for the Study of Terrorism and Responses to Terrorism (START); Stanford University; and the University of Liverpool, United Kingdom. This proposal has been accepted as part of a broader START Recompete proposal, which the University of Maryland has submitted to the DHS in response to the DHS-11-ST-061-001A research opportunity. As of February 2011, this proposal was still being considered by DHS.
NATIONAL SECURITY AFFAIRS

TOWARDS EFFECTIVE EMERGING INFECTIOUS DISEASES SURVEILLANCE:
THE CASES OF CAMBODIA AND INDONESIA AND THE EXPERIENCE OF
NAMRU-2

Sophal Ear, Assistant Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA)

SUMMARY: To draft a report describing the barriers to zoonotic virus surveillance in animals using the case study method comparing Cambodia and Indonesia and the respective experience of the US-Naval Medical Research Unit Two (NAMRU-2) in each country.

TOWARDS EFFECTIVE EMERGING INFECTIOUS DISEASES SURVEILLANCE II:
CASES OF SWINE FLU IN MEXICO 2009 AND USA 1976

Sophal Ear, Assistant Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA)

SUMMARY: Current Work and Preliminary Findings

Mexico 2009:

Political. Well-known flaws of the Mexican political system were clearly reflected during the A/H1N1 outbreak. Informality and lack of teamwork between government and international agencies, and inside of agencies, hampered the response to outbreak. Corruption interfered with the productivity of actors. Political agendas and party politics took precedence over the needs of the country.

Economic. Economic constraints were a major deciding issue on the successes and failures of dealing with the A/H1N1 outbreak in Mexico in 2009. At the time of the outbreak there were insufficient numbers of labs for analysis, and those that were present were financially constrained limiting the quality and diversity of information they could gather. Planning was also a weak area. Public health and government officials were ill equipped to make rapid decisions in response to the growing viral outbreak. In addition to a lack of planning and procedure, the impoverished and sparsely populated areas that experienced the disease were hard to identify and treat in a timely manner. These economic factors greatly played into the development of A/H1N1 response in Mexico and are valuable areas for analysis towards learning from the outbreak.

Cultural. Mexico has an array of cultural characteristics that had a direct effect on the outcome of the 2009 A/H1N1 outbreak. From the initial outbreak and recognition of the virus, there were issues with tracking and treating those infected due to a culture of self-medication. This tendency of Mexican citizens to treat themselves without pursuing professional medical assistance is pretty common in Mexico and helps explain the mortality rates.


One of the most difficult areas to control, when reflecting on Neustadt and Fineberg’s five major points, would be media. Communication on the situation creates awareness and understanding. It was pointed out that rural areas were difficult to reach, and knowledge of their condition was tenuous. But with proper awareness and information campaigns, the public is provided with knowledge and awareness that increases likelihood of speaking-out and bringing situations to the attention of government. Additionally, this overlaps with the point on maintaining credibility. Sharing such information allows the public to be responsive and not let the situation be an event contained within an administrative
bubble. Although it is important that the public not control the tempo, it allows for a more balanced and pragmatic perspective when the mood of the public is heard.

In general, it is always easy to criticize government management for problems, but questions on the general public mood and perception is also an issue to be discussed. This may also overlap with the difficulty experienced by Mexico in having the rural areas on board with program practices. There is a real limit to how we can influence and showcase the importance of the event, but perhaps more thorough media coverage is a blessing that can help to create the appropriate mood of concern by every citizen.

Ultimately, it comes down to ability and history. The U.S. has a strong record of experience and reliability for situations ranging from health, to politics, to economics. And, as observed in Mexico, that country’s credibility and perceived capacity for expertise on the event was simply not present. This underscores the long-term work necessary to build capacity not with “testing kits” but with real microbiology diagnostic capacity.

INNOVATION IN TERRORISM: CAUSES, PROCESSES, AND PREDICTIVE INDICATORS
Mohammed M. Hafez, Ph.D., Associate Professor
Department of National Security Affairs
Joint Research Project and Conference Report with Dr. Maria Rasmussen
Sponsor: Defense Threat Reduction Agency (DTRA)

OBJECTIVE: We investigate the contexts, causes, and processes of terrorist innovation. Our aim is to generate predictive indicators that could help counterterrorism specialists in law enforcement and intelligence respond to emergent advances in the use of weapons of mass effect (WME)—defined by the U.S. Department of Homeland Security as “weapons capable of inflicting grave destructive, psychological and/or economic damage.” Our approach involves analyzing past cases of innovative terrorism to generate insights into how terrorists come to adopt new patterns of tactical and strategic behavior to advance their objectives. Our two deliverables are organizing a two-day conference with 16 experts in August 2010, and a report summarizing the key judgments from the conference.

SUMMARY: We invited 16 experts to research and write on seven case studies of innovative terrorism as well as provide theoretical analysis of innovation in terrorism. We invited the experts to a workshop in Monterey, California, in August 2010. We completed the workshop report and submitted it to the sponsor in August 2010. We also briefed the sponsor on the report in August 2010. The sponsor was pleased with the project and has since agreed to fund Year 2 of this project.

PUBLICATIONS:

DEBATING JIHAD: IDEOLOGICAL DIVIDES IN THE RADICAL ISLAMIST MOVEMENT
Mohammed M. Hafez, Ph.D., Associate Professor
Department of National Security Affairs
Sponsor: NPS Institutionally Funded Research, Research Initiation Program

OBJECTIVE: This research project explores the ideological debates that divide global jihadists. It is a contribution to the broader US objective of engaging in a battle of ideas with radical Islamism. My aim is to gain insight into how radical Islamists associated with the Jihadi Salafist strand rationalize their extremist worldviews in relation to ideological and theological challenges posed by mainstream and other radical Islamists.
SUMMARY: Research commenced in October 2008. However, due to departmental responsibilities, RIP funding and research had to be suspended in 2010 and instead deferred to 2011.

PUBLICATIONS:


SUPPORT OF NAVAL INTELLIGENCE RESEARCH AND EDUCATION
CAPT Jennith Hoyt, USN, Senior Intelligence Officer
Department of National Security Affairs
Sponsor: Office of Naval Intelligence

OBJECTIVE: The objective of this project is to ensure naval intelligence officers have a sponsor providing funding for individual and group research and development, in addition to school provided funding. Efforts in FY10 will particularly focus on national-intelligence organizational changes to include counter-terrorism, maritime domain awareness, manpower, and operations support activity. In addition, normal operational intelligence research and education projects will be pursued.

CANADA-CHINA SPACE ENGAGEMENT: OPPORTUNITIES AND PROSPECTS
Wade L. Huntley, Senior Lecturer
Department of National Security Affairs
Sponsor: Canadian International Council Canada-China Project

OBJECTIVE: Assess implications for Canadian space policy of the US-China relationship on space issues and more broadly.

SUMMARY: U.S. and Chinese space activities are increasingly a focal point of these countries broader relationship. Canada has specific interests shaped by that relationship, among which space policy issues are also significant, and maintains historically unique relationships with both countries. This project considered Canadian engagement of the US-China relationship on space issues within the contexts of its broader relationships with these countries and its distinct global posture, considering opportunities and obstacles of both bilateral and trilateral approaches.

PUBLICATIONS:

“Canada-China Space Engagement: Opportunities and Prospects,” Canadian International Council (forthcoming 2011)

PROLIFERATION PARADIGMS: THE FUTURE OF THE NPT REGIME IN THE SECOND NUCLEAR ERA
Wade L. Huntley, Senior Lecturer
Department of National Security Affairs

OBJECTIVE: Assess the long-term future of the global nuclear nonproliferation regime by transcending contemporary political debates and linking disparate scholarly research on nuclear acquisition motivations and regime type.

SUMMARY: This ongoing research project grapples with a problem and a puzzle. The problem is how to reduce the dangers to global security posed by nuclear weapons in the second (i.e. post-Cold War) nuclear era. The puzzle is how to adapt global nonproliferation norms and institutions to the growing willingness in world politics to allow...
judgments about the “responsibility” of governmental behavior to supersede the prerogatives of state sovereignty across numerous issues of international relations (from human rights to climate change), given that existing norms and institutions premise the sanctity of state sovereignty and “equal” obligations.

PRESENTATIONS:


SPACE DETERRENCE AND CYBER DETERRENCE: COMPARATIVE CHALLENGES AND APPLICATIONS

Wade L. Huntley, Senior Lecturer
Department of National Security Affairs

OBJECTIVE: This new project seeks to comparatively evaluate the utility of deterrence to counter cyber and space threats.

SUMMARY: Preserving the security of U.S. space and cyber systems is a relatively new and rapidly growing element of U.S. national security. In addition to options for protecting U.S. space and cyber interests, analysis of prospects for deterring space and cyber attacks is increasing. Emerging assessments of prospects for space and cyber deterrence presently lack attention to several questions arising from comparisons of the deterrence demands between these two security domains and against the backdrop of nuclear-based deterrence concepts. Not least among these questions are the opportunities and constraints presented by the interaction of these domains in real-world security contexts. This project (initiated in Fall 2010) will develop a comparative framework to critically evaluate contrasting assessments of deterrence utility within each domain, incorporating existing knowledge on deterrence effectiveness more effectively than is possible considering the issue areas separately.

POST-TRANSITION MILITARY POLITICS: ARMY MISSIONS IN DEMOCRATIC PERU AND ECUADOR

Maiah Jaskoski, Assistant Professor
Department of National Security Affairs

Sponsor: This Research Had No Sponsor in 2010.

OBJECTIVE: This book manuscript addresses why militaries choose the security missions they do, and who benefits from those missions.

In terms of explaining missions, it challenges two expectations regarding military behavior: that, being bureaucracies, militaries act so as to maximize their budgets; and that, preferring external defense and, in Latin America, counterinsurgency, above other security missions, militaries will focus more intensely on these more “professional,” sovereignty missions than on policing assignments. Contrary to these expectations, this research finds that the Peruvian and Ecuadorian armies have neglected their sovereignty missions at different moments since democratization, even when doing so has meant foregoing resources. Rather than putting professional, lucrative missions first, the two armies have prioritized maintaining predictability for troops on the ground in the most immediate sense.

With respect to the question of who benefits from military missions, a dimension of mission performance that thus far has received virtually no attention, the manuscript examines the local political economy of the two armies. In both countries actors other than the national government have hired the army for security work, and these deals occur largely at the local level.
PUBLICATIONS:

Accepted Submissions to Peer-Reviewed Journals:


“The Ecuadorian Army: Neglecting a Porous Border while Policing the Interior.” Forthcoming, Latin American Politics & Society. Estimated publication date: Spring 2012. (Accepted for publication during CY2011.)

“Public Security Forces with Private Funding: Local Army Entrepreneurship in Peru and Ecuador.” Forthcoming, Latin American Research Review. Estimated publication date: Summer 2012. (Accepted for publication during CY2011.)

Revise and Resubmit Requests:

“Post-Transition Military Politics: Army Missions in Democratic Peru and Ecuador.” Book manuscript. Request to revise and resubmit received from Johns Hopkins University Press. Projected date for resubmission: Summer 2011.

Conference Papers:


Invited Talks:


Research Writing/Working Groups:

Participant. Transnational and Local Dynamics in the Andes Research Cluster. Chicano Latino Research Center, University of California, Santa Cruz.

Future Research Products:

“Private Financing of the Military in Latin America: A Local Political Economy Approach to the Peruvian and Ecuadorian Armies.” Paper submitted to journal for review (January 2011); to be delivered at the International Studies Association Annual Convention as part of “Markets for Force” workshop (and edited volume project), Montreal, March 16-19, 2011.

RESOURCE CONFLICTS: EMERGING STRUGGLES OVER STRATEGIC COMMODITIES IN LATIN AMERICA

Maiah Jaskoski, Assistant Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency

OBJECTIVE: This project seeks to explain how social conflict over extractive resources in Latin America influences national government policy regarding resource production, with an over-the-horizon eye on the implications for uranium extraction.

SCOPE: This study will focus on both the national and sub-national level in the central Andes. Understanding
dynamics at the sub-national level is critical, because it is at the level where resource extraction takes place and where pressures are exerted on companies and the national government for (1) changed company practices, such as reduced extraction or environmental harm, and/or (2) the distribution of royalties directly from companies to sub-national governments. Indeed, my research finds that in Peru and Ecuador companies in the hydrocarbons and mining sectors have directly hired army units at the local and regional levels to provide security for the companies to maintain production.

NEAR TERM AFGHANISTAN DATA DEVELOPMENT - TIER 1
Thomas Johnson, Research Professor
Department of National Security Affairs
Sponsor: TRADOC Analysis Center-Monterey

OBJECTIVE: The program of Culture and Conflict Studies (CCS) has been tasked with supporting the development of a cultural geography model for Kandahar Province, Afghanistan. CCS research will consist of synthesizing and analyzing data on population identity groups in seven key districts of Kandahar Province. CCS will also provide subject matter expertise and help identify specific narratives that resound with particular identity groups.

AFGHANISTAN DATA DEVELOPMENT FOR CULTURAL GEOGRAPHY MODELING
Thomas Johnson, Research Professor
Department of National Security Affairs
Sponsor: TRADOC Analysis Center-Monterey

OBJECTIVE: The program of Culture and Conflict Studies (CCS) has been tasked with supporting the development of a cultural geography model for Helmand Province, Afghanistan. CCS research will consist of synthesizing and analyzing data on population identity groups in seven key districts of Helmand Province. CCS will also provide subject matter expertise and help identify specific narratives that resound with particular identity groups.

ATTACK THE NETWORK INNOVATION EFFORT
Thomas Johnson, Research Professor
Department of National Security Affairs
Sponsor: Air Force Research Lab

OBJECTIVE: This project will provide subject matter expertise to Toffler Associates/4iNNO in support of the Air Force Research Laboratory (AFRL) and Joint IED Defeat Organization’s (JIEDDO) efforts to develop innovative solutions to the Attack the Network problem in Afghanistan. It will provide Toffler Associates/4iNNO with the full benefit of the Program for Culture & Conflict Studies’ knowledge and expertise related to the Afghan government, Afghan culture, and counter-IED activities.

NPS AFGHAN COIN WEB PORTAL
Thomas Johnson, Research Professor
Department of National Security Affairs
Sponsor: Office of the Secretary of Defense

OBJECTIVE: CCS research will consist of synthesizing and analyzing data on population identity groups in seven key districts of Kandahar Province. CCS will also provide subject matter expertise and help identify specific narratives that resound with particular identity groups.
CAPTURING THE NARRATIVE 1991 UPRISING IN IRAQ
Abbas Kadhim, Assistant Professor
Department of National Security Affairs
Sponsor: The American Academic Research Institute in Iraq (TAARII)

OBJECTIVE: The goal of this project is to document the uprising events that took place in the Iraqi cities. Until now, we do not have any accurate account of the uprising and scholars have not paid enough attention to this momentous event. This is partly because the fact that the uprising is still not sufficiently documented. To increase documentation on the uprising, this project will involve interviews with the participants in order to collect their personal roles and observations of the events in their respective towns. The interviewees are scattered in many parts of the world. Fortunately, many of them reside in the United States. Extensive contact-lists have been gathered by the PI from the detention camps in Saudi Arabia after the uprising. The people from these camps will have first-hand knowledge of the events, which will enhance the quality of the project. Visits to major cities where Iraqis have made large communities, such as Detroit, San Diego, Los Angeles, San Francisco, Houston and Washington, D.C., will also be made to spend some time conducting interviews. Other interviews will be conducted by phone and other means of communication with Iraqis in more remote locations inside and outside the United States. The project will conclude with a final report, including supporting documentation as a completion of the fellowship.

U.S.-INDIA STRATEGIC PARTNERSHIP
Paul Kapur, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA), Advanced Systems and Concepts Office

OBJECTIVE: This project will examine issues affecting long-term strategic cooperation between the United States and India by (1) examining potential areas for strategic cooperation, (2) assessing challenges, and (3) formulating ideas for new strategies to enhance U.S.-India strategic ties over the next decade.

INDO-U.S. STRATEGIC DIALOGUE 2010
Paul Kapur, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA), Advanced Systems and Concepts Office

OBJECTIVE: To hold a two-day meeting, in conjunction with Jawaharial Nehru University, that examines the current state and future trajectory of Indo-U.S. relations.

EATING GRASS: PAKISTAN AND THE BOMB
Feroz Hassan Khan, Lecturer
Department of National Security Affairs

SUMMARY: This book is a comprehensive history of Pakistan nuclear program; its people, politics and regional security. The book will cover several themes on motivations and consequences of nuclear proliferation, strategic stability, nonproliferation challenges and the future stability of the state.

Significance: The book is intended to fill a large void. There presently exists no credible comprehensive study of Pakistan’s nuclear program and polices. All books are based on from a singular lens of nuclear proliferation specifically AQ Khan. This book is based on five years of interviews from primary sources in Pakistan and research. Most U.S. governmental analyses of Pakistan’s problematic nuclear past do not adequately capture the deep-seated motivations, historical drivers, and rationales for the likely trajectories. Most Pakistani citizens are equally unaware of their own
nuclear history and challenges because it has been either shrouded in secrecy or covered in mythical stories and conspiracies.

TRILATERAL RELATIONS: CHINA INDIA AND PAKISTAN

Feroz Hassan Khan, Lecturer
Department of National Security Affairs

SUMMARY: This project is sponsored by DTRA and would involve me in writing the Pakistan chapter which is researched under the stewardship of Dean James Wirtz. An author’s conference was held in Washington D.C. in which initial presentations were made and guidance for further research was made.

Trilateral relations are an important component of world politics. This project explores interaction among India, Pakistan, and China with South Asia as focal point. The objective is to make a fundamental assessment of how trilateral relations affect foreign and defense policies in Asia and explore how trilateral dynamics affect prospects for war and peace in the region. The project develops a comparative framework that identifies trilateral interactions affecting national policies at three levels of analyses: international, regional and domestic. It addresses trilateral relations from the perspective of international relations theory describing the interactions amongst the three actors which shapes the threat perceptions and economic opportunities. The project distinguishes how trilateral relations create a fundamentally different international setting than bilateral relationships and how it essentially complicate strategic relations.

US-PAKISTAN STRATEGIC DIALOGUE

Feroz Hassan Khan, Lecturer
Anne L. Clunan, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA)

OBJECTIVE: Continue the ongoing U.S.-Pakistan Strategic Dialogue with focus on internal security threats, strategic stability in the region and establishment of nuclear security regime.

ASSURANCE STRATEGIES AND NATIONAL SECURITY

Jeffrey W. Knopf, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA), Advanced Systems and Concepts Office

OBJECTIVE: Many defense strategies, such as deterrence, are based on threats; they seek to hold at risk what others value. Such strategies are not always appropriate. For example, when other states are motivated by insecurity and fear of the first state, the use of threats can backfire. An alternative approach involves seeking to assure the other state its security concerns will be met. Such assurance strategies have been used to promote nuclear nonproliferation, but assurance has not been studied nearly as thoroughly as strategies like deterrence. This project aims to identify conditions associated with the success or failure of assurance strategies both in general and specifically in relation to preventing nuclear proliferation.

SUMMARY: The P.I. organized a two-day workshop in Colorado Springs, CO, in August 2009. It brought together approximately 20 subject matter experts to discuss security assurances and nonproliferation. The P.I. wrote and presented an introductory paper that defined security assurances and derived several hypotheses from existing literature. These hypotheses were assessed in other papers written for the workshop. The P.I. used the remaining funding from the grant in 2010 to complete two sets of tasks. First, the P.I. used the time to edit and revise his own introductory paper, turning it into a separate introduction chapter and theory chapter for an eventual edited volume,
and developing some material deleted from the theory chapter into a separate article for journal submission. Second, the P.I. used 2010 to give feedback to the various paper authors, receive their revised papers, and edit and revise these papers into final form for an edited book volume. The completed volume has been submitted for publication.

PUBLICATIONS:

Stanford University Press has given an advance contract for the edited volume, meaning the editorial board pre-approves it for publication if it receives favorable outside reviews. The manuscript is now under external review. The P.I. has also submitted a journal article derived from the project that is currently under review.

PRESENTATIONS:


MCIA STUDENT THESIS SUPPORT PROGRAM
Sandra Leavitt, Research Assistant Professor
Department of National Security Affairs
Sponsor: Marine Corps Intelligence Activity (MCIA)

OBJECTIVE: Support NS students’ thesis and dissertation research related to security in areas where the U.S. Marine Corps is most likely to operate in the next five to 25 years.

SUMMARY: Interested NS students apply for funded domestic or international travel to conduct interviews or access archives in support of their thesis research. A small panel of CCC/NS professors, in conjunction with the sponsor, will select students based on applications submitted quarterly. Students are expected to brief their research findings at MCIA. We expect to make 10 awards.

NPS STUDENT THESIS SUPPORT PROGRAM
Sandra Leavitt, Research Assistant Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA)

OBJECTIVE: Provide enhanced research opportunities for NS students interested in producing a thesis broadly related to Campaign X, combating weapons of mass destructions, nuclear proliferation, nuclear policy issues, or similar topics of interest. This will, in turn, provide a fresh perspective on complex issues and emerging threats to DTRA and its Experimental Branch (NTMX).

SUMMARY: Interested NS thesis candidates applied for funded domestic or international travel to conduct interviews or access archives in support of their thesis research.
OBJECTIVE: This project will assess the proliferation challenges posed by the expansion of civilian nuclear capabilities in Southeast Asia and identify ways of meeting those challenges. In particular, it will examine the current state and future prospects in the region for (1) the development of civilian nuclear programs; (2) government compliance with international nuclear agreements; (3) Asian initiatives to address nuclear safety and security; and (4) national regulatory capacity to reduce the extent of ungoverned spaces in the region.

BACKGROUND: Southeast Asian countries traditionally posed little risk of nuclear proliferation. They have had very small nuclear research capabilities and have faced no incentive to acquire or develop nuclear weapons. The assumptions on which this conventional wisdom has rested are changing. First, Southeast Asian nuclear capabilities will expand sharply as they turn to nuclear power to meet rising electricity demand. Second, the region is faces growing rivalry among the great powers, especially as China and India seek to broaden their influence in the region while expanding their nuclear arsenals. Together these trends highlight the need for stronger nonproliferation mechanisms as well as the challenge of creating them.

SCOPE: This project will assess the region’s key security concerns and identify ways of addressing them. The main challenges are the (a) planned expansion of Southeast Asian nuclear capabilities, (b) changing Southeast Asian perceptions of great power rivalries, and (c) the impact on the nonproliferation regime of North Korean non-compliance and Burmese efforts to bypass the regime. To meet these concerns, the project will explore Southeast Asian support for (a) Asian institutions for managing nuclear security (e.g., SEANWFZ and ASTOP), and (b) arrangements to control the fuel cycle. Both of these are critical to preventing the proliferation of weapons of mass destruction in the region. In preparation for the next phase of this project, a visit will be made to Indonesia. Its government plays an especially important role in shaping the region’s approach to nuclear energy and its cooperation is essential to meeting the threat that weapons of mass destruction present.
RUSSIA, CHINA AND THE NEW GEOGRAPHY OF SPACE TECHNOLOGY
ASSISTANCE: INVESTIGATING “HARD POWER” IMPLICATIONS OF GROWING
RUSSO-CHINESE “SOFT POWER”
James Clay Moltz, Associate Professor
Department of National Security Affairs

OBJECTIVE: Prof. Moltz will conduct research and write a detailed study on Russian and Chinese space technology cooperation with third parties and its implications, particularly for long-term U.S. security. This research will be based on extensive study and on-site interviews in China and Russia. Deliverables will include a chart of Russian and Chinese space contacts with third parties, a narrative report, and Power Point briefings for ASCO and other DOD officials.

ALLIED SECURITY AND AN INTEGRATED SATELLITE NETWORK
James Clay Moltz, Associate Professor
Department of National Security Affairs

OBJECTIVE: Prof. Moltz will conduct research and write a briefing discussing emerging threats to U.S. space assets and possible options for redressing these vulnerabilities through the development of an integrated satellite architecture among U.S. military allies. Prof. Moltz will first brief the underlying concept behind this study to the DTRA/ASCO Track 2 meetings in Hawaii in February 2010 (if requested by DTRA) with Japanese and South Korean officials, experts, and military personnel. Based on initial feedback, he will then conduct additional research and hold discussions with relevant U.S. space officials and operators to determine possible parameters. A contractor will provide a technical analysis of related system requirements and compatibility issues. The final study will be completed in the late fall of 2010 and briefed in Washington, DC, for DTRA/ASCO, OSD Space Policy, the State Department, and other relevant parties.

GLOBAL TRENDS AND THE FUTURE OF WARFARE 2025
Daniel J. Moran, Professor
Department of National Security Affairs
Sponsor: National Intelligence Count - Long Range Analysis Unit

OBJECTIVE: The PIs and invited subject-matter experts will convene a conference at the Naval Postgraduate School in early 2011 to examine future warfare and other security challenges arising for hypothesized changes in the international environment out to the year 2025.

UNDERSTANDING AND RESPONDING TO CONFLICT IN AFRICA: IMPLICATIONS OF FOCUSING ON ROOT CAUSES VERSUS COMPLEX END-STATES
Jessica Piombo, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA-ASCO)

SUMMARY: Research project on strategies of conflict resolution, assessing the choice to focus on root causes of conflict or strategies to address the effects of conflict after it occurs.
REDUCING INSECURITY IN AFRICA: ROLES AND RESPONSIBILITIES OF THE U.S. MILITARY, U.S. GOVERNMENT AND NON-GOVERNMENTAL COMMUNITIES
Jessica Piombo, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA-ASCO)

SUMMARY: DTRA-ASCO sponsored project to convene a workshop analyzing projects that span the development-security divide in the African AOR. Participants included USG from multiple agencies (DoD, State, USAID), academics and members of nongovernmental organizations.


WME INNOVATION AND TERRORISM: CAUSES, PROCESSES, AND PREDICTIVE INDICATORS
Maria J. Rasmussen, Associate Professor
Mohammed M. Hafez, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA)

OBJECTIVE: Would it be possible to anticipate future terrorist innovation in order to take proactive and preemptive measures to avert its development? This project seeks to address the causes of innovation in terrorism in order to generate predictive indicators that could help counterterrorism specialists in law enforcement and intelligence respond to potentially emerging WME forms of terrorism.

The project seeks to expand our understanding of the factors and forces which drive a terrorist group to innovate. By focusing on historical cases of WME innovation in terrorism, the project hopes to move beyond the usual description of threats and risks and towards a greater understanding of early warning indicators of terrorist behavior.

2010 PROLIFERATION SEMINAR
James Russell, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA/ASCO)

OBJECTIVE: This project will convene the CCC-ASCO annual proliferation seminar in the summer of 2009 in Monterey that has become a flagship event in the CCC-ASCO partnership. This year’s event will review proliferation challenges for new administration.

NONPROLIFERATION IN THE MIDDLE EAST STRATEGIC DIALOGUE
James Russell, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency

OBJECTIVE: The 2010 event will focus on managing the fallout of the international community’s efforts to manage Iran’s nuclear ambitions. The forum will provide an opportunity to engage the regional security communities on their reactions to these efforts.
OBJECTIVE: Convene conference in Dubai or another regional venue that examines the role of extended deterrence and security guarantees by outside powers in affecting the proliferation calculations of regional states.

PUBLIC POLICY AND NUCLEAR THREATS TRAINING PROGRAM/PROLIFERATION PATHWAYS IN ASIA CONFERENCE

OBJECTIVE: The training program and conference will examine current WMD proliferation pathways in the Asia-Pacific region and the threats they pose to U.S. security and interests. Top experts from within and outside the USG will assess options for improving U.S. strategies and policies to counter the threats posed by WMD proliferation and terrorism.

SOUTH ASIAN STRATEGIC PARTNERSHIPS: TRACK 2 DIALOGUES WITH INDIA AND PAKISTAN

OBJECTIVE: This project will examine issues affecting long-term strategic cooperation between the United States and India and between the United States and Pakistan by (1) examining potential areas for strategic cooperation, (2) assessing challenges, and (3) formulating ideas for new strategies to enhance strategic ties over the next decade. These conferences will be the second in a series of track two dialogues between the United States and India and the United States and Pakistan.

STRATEGIC STUDIES: OPEN-SOURCE RESEARCH AND NUCLEAR WEAPONS DESIGN

OBJECTIVE: Lawrence Livermore National Labs is doing a study that seeks to determine the degree to which non-state actors can assemble an improvised nuclear devise. The goal of this project is to study the difference in problem solving and information gathering behaviors in scientists and engineers. In this study, we specifically investigate questions involving the acquisition and fabrication of special nuclear materials, and other necessary materials, for use in a nuclear weapon. Our hypothesis is that the fields of engineering and science involve fundamentally different technical skills, though processes and personal characteristics, and as a result, there are significant difference in 1) problem solving strategies, 2) ability to identify credible reference materials, 3) organizational behaviors, and 4) quality difference between undergraduate and graduate student behaviors, and the impact of a discipline-specific vs. Interdisciplinary team structures. The project will involve five three-person teams of NPS students.
U.S.-PAKISTAN STRATEGIC PARTNERSHIP: A TRACK II DIALOGUE FOR LONG-TERM SECURITY COOPERATION
James Russell, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency

OBJECTIVE: This project will: (a) examine the stability of Pakistan’s command and control system and the safety and security of its nuclear arsenal; (b) to discuss the U.S.-Pakistan partnership within the context of Pakistan’s internal security threats, increased tension with India and the deteriorating security situation along the Pakistan-Afghanistan border.

GUESSWORK: THE TROUBLED PAST OF PREDICTION
Zachary Shore, Associate Professor
Department of National Security Affairs
Sponsor: Defense Threat Reduction Agency (DTRA)

OBJECTIVE: This research project will deepen our understanding of the problems and prospects for humanistic approaches to prediction. Specifically, it will explore the ways in which states have forecast the actions of enemies and allies in foreign policy and military affairs. Secondarily, it will consider some of the potential limitations to quantitative methods, in order that past errors might not be repeated.

SUMMARY: Assessed historical case studies to explore the prospects and potential pitfalls of prediction models.

THE PEACE SOLDIER FROM THE SOUTH: FROM PRAETORIANISM TO PEACEKEEPING?
Arturo C. Sotomayor, Assistant Professor
Department of National Security Affairs
Sponsor: Research Initiation Program (RIP)

OBJECTIVE: This project examines how participation in United Nations (UN) peacekeeping operations (PKO) affects military institutions in democratizing states. It conducts a rigorous comparative analysis of four states – Argentina, Brazil, Nepal, and Uruguay- and traces their historical engagement in peace operations during the post-transition to democracy era. It then assesses the effects of peacekeeping participation on three sets of dependent variables: military professionalism, doctrine, and civil-military integration in foreign and defense policy.

SUMMARY: Project work in 2010 included field research; gathering additional data; and presenting work in progress in several professional conferences. Field research was conducted at the U.N. mission in Haiti (known as MINUSTAH) and in the U.N. Headquarters, in New York. Specifically, the project involved up-dating the data for peacekeeping participation, interviewing peacekeepers from Brazil, Argentina, Uruguay and Nepal in the field, and visiting the U.N. Department of Peacekeeping Operations to gather additional data. Portions of this research have been published in International Peacekeeping. Two draft chapters were completed, in preparation for expected submission to Cornell University Press in 2011, which has expressed interest in reviewing the manuscript and suggested the inclusion of Nepal as an additional case study.

PUBLICATIONS:

PRESENTATIONS:


NPS ASIA CONFERENCE

Christopher P. Twomey, Assistant Professor
Department of National Security Affairs
Sponsor: Office of the Secretary of Defense (Policy)

OBJECTIVE: This classified project brings together policy makers at the Assistant Secretary or Deputy Minister level from the United States and a foreign partner for official diplomatic exchanges. My substantive contribution, involving collaboration with NPS faculty as well as experts from NDU and RAND and a team of NPS students, is available upon request at the SECRET level. Related research is listed below.

PUBLICATIONS:


NPS COUNTERSPACE DOCTRINE

Christopher P. Twomey, Assistant Professor
Department of National Security Affairs
Sponsor: NASIC

OBJECTIVE: This research is classified.

US-CHINA STRATEGIC DIALOGUE

Christopher P. Twomey, Assistant Professor
Department of National Security Affairs


US-CHINA STRATEGIC DIALOGUE, PHASE V

Christopher P. Twomey, Assistant Professor
Department of National Security Affairs

OBJECTIVE: This project brings together Chinese and American national security experts for a dialogue on nuclear strategy, arms control, missile defense, and nuclear proliferation in order to improve mutual understanding and reduce the possibility of political or military conflict between China and the United States.

Summary: The U.S.-China Strategic Dialogue brings together Chinese and U.S. strategic experts in their personal capacities to discuss the role of nuclear weapons in Sino-American relations with the aim of minimizing mutual
misunderstanding and identifying practical steps for bilateral cooperation. This fourth annual meeting of track-two dialogues promises to be highly successful; the meeting was held in May, 2010.

PUBLICATIONS:


“Asia’s Complex Strategic Environment: Nuclear Multipolarity and Other Dangers to Asian International Security,” revising for publication, Asia Policy, January 2011 issue.

“Dogs that Aren’t Barking, Much: The Rise of China’s Strategic Forces and Regional Reactions and Implications,” part of a special issue submission to Security Studies in future.

COMPETITION DYNAMICS AND PARTY SYSTEM EVOLUTION IN JAPAN and HOST-NATION POLITICS OF U.S. BASES IN ASIA

Robert J. Weiner, Assistant Professor
Department of National Security Affairs
Sponsor: Naval Postgraduate School (Research Initiation Program)

OBJECTIVE: The project has two prongs. The first analyzes party and electoral competition and party system development in Japan: how parties pursue and avoid competition, how new opposition forces are evolving, and how these dynamics shape policy change in Japan, including change in foreign policy and U.S.-Japan alliance management. The second begins exploratory research for a new line of research on the host-nation domestic politics surrounding overseas U.S. military bases, particularly in Japan and elsewhere in Asia. This is a continuing project.

SUMMARY: With the exception of a short fieldwork trip to Hawaii and Japan supported by funds postponed (with RSPO approval) from 2009, work in 2010 consisted of follow-up on-campus research. Project work yielded significant progress on a book manuscript examining party competition in Japan (provisionally titled No Contest: Anti-competition in Japan and other ‘Competitive’ Party Systems). Final revisions (partly prompted by unexpected results of 2009 and 2010 elections) were nearly completed in preparation for expected submission to a university press in Winter 2011 (Stanford University Press has expressed interest). In 2010, one journal article on Japanese parties’ electoral strategies in comparative perspective and one edited-volume chapter on the evolution of the Democratic Party of Japan (DPJ) were accepted for publication, and a related short report on the DPJ was published. Project work also involved continued updating of an original database on the DPJ’s national-level candidates, as well as continuing review of secondary literature on military-base politics. Portions of the research were presented in 2010 at two conferences jointly sponsored by the NIC and State Dept. INR Bureau and one panel presentation held at UC-Berkeley, briefed to officials at PACOM JIOC, and conveyed through participation at the U.S.-Japan Strategic Dialogue sponsored by DTRA and CSIS-Pacific Forum.

STRATEGIC IMPACT OF SHIFTING NUCLEAR CONSCIOUSNESS IN JAPAN

Robert J. Weiner, Assistant Professor
Department of National Security Affairs

OBJECTIVE: Assess the scope and medium-term (5- to 10-year) durability of (1) recent shifts in Japanese public opinion away from Japan’s non-nuclear status quo, (2) recent sharp changes in Japan’s policy making infrastructure that amplify the weight of public opinion, and (3) these changes’ impact on Japan’s nuclear security policy, its confidence in the US alliance and nuclear umbrella, and likelihood of a populist shift away from its “strategically rational” non-nuclear stance, and (4) identify “red flag” indicators of Japanese pro-nuclear shifts and how the US might prevent or respond to such shifts.
NATIONAL SECURITY AFFAIRS

INDIAN, PAKISTANI, AND CHINESE RELATIONSHIP DYNAMICS: IMPACT ON U.S. STRATEGIC INTERESTS

James J. Wirtz, Professor & Dean School of International Graduate Studies
Department of National Security Affairs
Sponsor: Strategic Systems Programs

OBJECTIVE: This research project will support DTRA, DOD, and USG by helping develop an increased understanding of the geopolitical and contextual interactions between Pakistan, India, and China related to their regional and global nuclear and nuclear-related activities.

MONTEREY STRATEGY SEMINAR

James J. Wirtz, Professor & Dean School of International Graduate Studies
Department of National Security Affairs
Sponsor: Strategic Systems Programs

OBJECTIVE: The seminar will focus on the future issues of investigation for arms control compliance.

US-UK STRATEGIC DIALOGUE

James J. Wirtz, Professor & Dean School of International Graduate Studies
Department of National Security Affairs
Sponsor: Strategic Systems Programs

OBJECTIVE: This project will continue the CCC’s strategic dialogue between British and American national security experts on naval strategy, arms control, regional defense, and military cooperation in order to improve mutual understanding. With events like this conference, gradual progress will be made with regard towards openness and community building. Numerous topics have been broached at the unofficial level that would be beyond the pale in official dialogues. Moving forward, the CCC intends to continue efforts to solicit better-connected views from within the British system and discuss issues of interest in Washington and London through this meeting of the US-UK Strategic Dialogue to be held in FY2010.

EXTENDED DETERRENCE IN THE 21ST CENTURY

David S. Yost, Professor
Department of National Security Affairs

OBJECTIVE: The objective was to advance understanding of the evolving requirements for U.S. extended deterrence in the 21st century, notably with regard to U.S. nuclear weapons. This includes matters such as nuclear deterrence doctrine and corresponding policy issues.

SUMMARY: Changes in the international security environment since the collapse of the Soviet Union in 1989-1991 have created a new context for the analysis of U.S. alliance policy and theories of extended deterrence. The issues include the evolving purposes of the U.S. nuclear force posture and security commitments to allies, questions of doctrine and declaratory policy, and the future of relevant international arms control regimes. The continuing proliferation of weapons of mass destruction and developments in Russia, China, and elsewhere are also of concern to the United States and its allies.

PUBLICATIONS:

Yost, D., “NATO’s Evolving Purposes and the Next Strategic Concept,” International Affairs, vol. 86, no. 2 (March


PRESENTATIONS:


Khan, F.H. “Prospects for Indian and Pakistani Arms Control and Confidence Building Measures” in Naval War College Review, Summer, 2010, Vo. 63, No. 3


Miller, Alice L. “The 18th Central Committee Politburo: A Quixotic, Foolhardy, Rashly Speculative, but Nonetheless Ruthlessly Reasoned Projection,” China Leadership Monitor, No.33 (Summer 2010)

Miller, Alice L. “Who Does Xi Jinping Know and How Does He Know Them?” China Leadership Monitor, No.32 (Spring 2010).


Moran, D. “Climate Change and Climate Politics,” for *Strategic Insights* (December 2010).


Trinkunas, Harold A. “Civilian Praetorianism and Military Shirking during Constitutional Crises in Latin America” (with David Pion-Berlin), *Comparative Politics* 42.4 (July 2010): 395-411.

Weiner, R., “What is the DPJ Today?” *The Oriental Economist* 78:1 (January 2010), 9-10


**EDITORIALS**


Ear, S. “Analysis: Chomsky should listen to his own advice and admit errors” (with Geoffrey Cain), Opinion, The *Phnom Penh Post*, 18 October 2010.

Johnson, T. “Why this man is a symbol of Afghanistan’s fiery, fragile future,” *National Post*, October 9, 2010
NATIONAL SECURITY AFFAIRS

Johnson, T. “Supply route may decide outcome of Afghan war,” Ottawa Star, October 4, 2010

Johnson, T. “Fatalities escalate in Afghanistan war,” San Diego Tribune, July 30, 2010

Johnson, T. “Troops seek to replicate gains made in Afghan village,” Stars and Stripes, July 12, 2010


Johnson, T. “Naval Postgraduate School Team Designs Smart Phone App,” TMCNet, June 1, 2010


Johnson, T. “Opium, the CIA and the Karzai Administration,” History News Network, April 12, 2010

Johnson, T. “Opium and the CIA: Can the U.S. Triumph in the Drug-Addicted War in Afghanistan?”, GlobalResearch.ca, April 9, 2010

Johnson, T. “Behind Karzai’s War of Words,” Toronto Star, April 8, 2010

Johnson, T. “Afghanistan experts at USF symposium...,” St. Petersburg Times, March 25, 2010

Johnson, T. “Arrest of No. 2 May Signal Taliban Feud: McChrystal,” Reuters, March 5, 2010


Johnson, T. “Top Taliban’s Arrest an Ominous Signal,” Globe and Mail, February 23, 2010


Johnson, T. “What Will Deal with Taliban Mean for Afghan Women?”, Toronto Star, February 7, 2010

Johnson, T. ““Model” District No Safe Haven,” Toronto Star, January 1, 2010


INTERVIEWS


Johnson, T. “U.S. Strategy in South Asia: Is it really working?” NPR: To the Point, April 6, 2010.


BOOKS


CONTRIBUTIONS TO BOOKS


BOOK REVIEWS


Monographs


Teaching Modules

Ear, S. “PACOM Strategic Focus: Cambodia”, Joint Foreign Area Officer Skill Sustainment Pilot Program, Asia-in-Residence Course, Chapel on the quarterdeck of Herrmann Hall, Naval Postgraduate School, Monterey, California, 24 June 2010, 8am.


Conference Publications & Proceedings


Conference Presentations


Clunan, Anne L., “Global Market Forces and Provision of Governance in the Commons.” Presentation prepared for delivery at the Conference on Cooperation and Conflict in the Commons, Virginia Beach, VA, June 29-July 1, 2010.


Ear, S. “Towards effective emerging infectious diseases surveillance in Cambodia and Indonesia,” 2010 International Conference on Emerging Infectious Diseases (ICEID) in Atlanta, Georgia, USA, July 11 - 14, 2010.


Ear, S. “Is peace possible without social justice?” Video Talk for 141 Questions at the Universal Forum of Cultures Valparaiso 2010 organized by the Universal Forum of Cultures Foundation, Valparaiso, Chile, 22 October-4 December 2010.

Ear, S. “Cambodia, the US, and China: Continuity and Change in Foreign Relations” Fulbright Senior Specialist Talk delivered at the Institute of Security and International Studies, Faculty of Political Science, Chulalongkorn University, Bangkok, Thailand, 20 December 2010.


Weiner, R., brief on “DPJ Governance and Security Policy Implications” at HQ PACOM JIOC, Honolulu, HI, 9 June 2010.


**CONFERENCE PRESENTATIONS WITHOUT PAPER**


**CONFERENCES PARTICIPATED**

Johnson, T. International Conference on Afghanistan and “Pakistan and Afghanistan: The Challenges of Governance, University of South Florida’s Tampa Campus from March 24 to 26, 2010.
Johnson, T. Keynote speaker at the United States Army Special Forces Command (Airborne) USASFC (A) commanders and senior leadership conference, 18 November, 2010, Pinehurst Resort and Country Club, in Pinehurst, N.C.


MEETING ABSTRACT


DISCUSSANT


Clement, V. Chair of Break-out Session: “The Foreign Service Institutes Policy Leadership Division,” Soft Power and Long-Term U.S. Interests in Central Asia, hosted by the Bureau of South and Central Asia Affairs (SCA) and the Bureau of Intelligence and Research (INR), March 1, 2010.


TECHNICAL REPORTS

NATIONAL SECURITY AFFAIRS

WORKSHOP & RESEARCH REPORTS


WORKING PAPER

GRADUATE SCHOOL
OF OPERATIONAL AND
INFORMATION SCIENCES

PETER PURDUE
DEAN
DEPARTMENT OF
COMPUTER SCIENCE

PETER J. DENNING
CHAIRMAN
OVERVIEW:

The Department of Computer Science provides graduate training and education in major areas of computer science. Both basic and advanced graduate courses are offered. Course work and research lead to either the degree of Master of Science, Doctor of Philosophy, or Master of Computing Technology. The requirements to complete any program are rigorous and comparable to those of other major universities.

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Computer Science is provided below:

Size of Program: $6M
COMPUTER SCIENCE

Peter J. Denning
Chairman, Director of the Cebrowski Institute & Professor
831-656-3603
pjden@nps.edu

Chris Eagle
Associate Chairman & Senior Lecturer
831-656-2378
cseagle@nps.edu

Pranav Anand
Visiting Assistant Professor
831-656-2449
panand@nps.edu

Mikhail Auguston
Associate Professor
831-656-2607
maugusto@nps.edu

Eric Bachmann
Research Assistant Professor
831-656-4066
bachmann@nps.edu

Valdis A. Berzins
Professor
831-656-2610
berzins@nps.edu

Robert Beverly
Assistant Professor
831-656-2132
rbeverly@nps.edu

Karen Burke
Research Associate Professor
831-656-3988
kburke@nps.edu

Richard S. Coté
Senior Lecturer
831-656-2519
rscole@nps.edu

Christian J. Darken
Associate Professor
831-656-2095
cjdarker@nps.edu

Rudolph P. Darken
Professor
831-656-7588
darken@nps.edu

Duane Davis
CDR, USN
Program Officer
831-656-7980
dtdavi1@nps.edu

George Dinolt
Professor of Practice
831-656-3889
gwdinolt@nps.edu

Doron Drusinsky
Associate Professor
831-656-2168
ddrusins@nps.edu

John Falby
Senior Lecturer
831-656-3390
falby@nps.edu

John D. Fulp
Senior Lecturer
831-656-2280
jdfulp@nps.edu

Simson Garfinkel
Associate Professor
831-656-7602
slgarfin@nps.edu

John Hiles
Research Professor
831-656-2988
jehiles@nps.edu

Ted Huffmire
Assistant Professor
831-656-7601
tdhuffmir@nps.edu

Cynthia E. Irvine
Professor
831-656-2461
irvine@nps.edu

Mathias N. Kolsch
Assistant Professor
831-656-3402
kolsch@nps.edu

Timothy E. Levin
Research Associate Professor
831-656-2239
levin@nps.edu

Theodore G. Lewis
Professor
831-656-2830
tlewis@nps.edu

Gilbert Lundy
Associate Professor
831-656-2094
blundy@nps.edu

Luqi
Professor
831-656-2735
luqi@nps.edu

Craig H. Martell
Associate Professor
831-656-2110
cmartell@nps.edu

Robert B. McGhee
Professor Emeritus
831-656-2026
mcghee@nps.edu

James Bret Michael
Professor
831-656-2655
bmichael@nps.edu
COMPUTER SCIENCE

William Murray
Research Associate Professor
831-656-2830
whmurray@nps.edu

Andrew Schein
Research Assistant Professor
203-428-7355
aischein@nps.edu

Dennis M. Volpano
Associate Professor
831-656-3091
volpano@nps.edu

Thomas W. Otani
Associate Professor
831-656-3391
twotani@nps.edu

Alan B. Shaffer
CDR, USN
Assistant Professor
831-656-3319
abshaffe@nps.edu

Daniel F. Warren
Senior Lecturer
831-656-2353
dwarren@nps.edu

Loren Peitso
Assistant Professor
831-656-3009
lepeitso@nps.edu

Man-Tak Shing
Associate Professor
831-656-2634
shing@nps.edu

Duminda Wijesekera
Visiting Associate Professor

Zachary Peterson
Assistant Professor
831-656-3316
znpeters@nps.edu

Gurminder Singh
Professor
831-656-3041
gsingh@nps.edu

Geoffrey G. Xie
Professor
831-656-2693
xie@nps.edu

Richard Riehle
Visiting Professor
831-656-3316
rdriehle@nps.edu

Joseph A. Sullivan
CDR, USN
Military Faculty
831-656-7582
jasullivan@nps.edu

Joel D. Young
LT COL, USAF
Military Faculty
831-656-3518
jdyoung@nps.edu

Neil C. Rowe
Professor
831-656-2462
ncrowe@nps.edu

Daniel F. Warren
Senior Lecturer
831-656-2353
dwarren@nps.edu

Andrew Schein
Research Assistant Professor
203-428-7355
aischein@nps.edu

Dennis M. Volpano
Associate Professor
831-656-3091
volpano@nps.edu

Thomas W. Otani
Associate Professor
831-656-3391
twotani@nps.edu

Alan B. Shaffer
CDR, USN
Assistant Professor
831-656-3319
abshaffe@nps.edu

Daniel F. Warren
Senior Lecturer
831-656-2353
dwarren@nps.edu

Loren Peitso
Assistant Professor
831-656-3009
lepeitso@nps.edu

Man-Tak Shing
Associate Professor
831-656-2634
shing@nps.edu

Duminda Wijesekera
Visiting Associate Professor

Zachary Peterson
Assistant Professor
831-656-3316
znpeters@nps.edu

Gurminder Singh
Professor
831-656-3041
gsingh@nps.edu

Geoffrey G. Xie
Professor
831-656-2693
xie@nps.edu

Richard Riehle
Visiting Professor
831-656-3316
rdriehle@nps.edu

Joseph A. Sullivan
CDR, USN
Military Faculty
831-656-7582
jasullivan@nps.edu

Joel D. Young
LT COL, USAF
Military Faculty
831-656-3518
jdyoung@nps.edu

Neil C. Rowe
Professor
831-656-2462
ncrowe@nps.edu

Andrew Schein
Research Assistant Professor
203-428-7355
aischein@nps.edu

Dennis M. Volpano
Associate Professor
831-656-3091
volpano@nps.edu

Thomas W. Otani
Associate Professor
831-656-3391
twotani@nps.edu

Alan B. Shaffer
CDR, USN
Assistant Professor
831-656-3319
abshaffe@nps.edu

Daniel F. Warren
Senior Lecturer
831-656-2353
dwarren@nps.edu

Loren Peitso
Assistant Professor
831-656-3009
lepeitso@nps.edu

Man-Tak Shing
Associate Professor
831-656-2634
shing@nps.edu

Duminda Wijesekera
Visiting Associate Professor

Zachary Peterson
Assistant Professor
831-656-3316
znpeters@nps.edu

Gurminder Singh
Professor
831-656-3041
gsingh@nps.edu

Geoffrey G. Xie
Professor
831-656-2693
xie@nps.edu

Richard Riehle
Visiting Professor
831-656-3316
rdriehle@nps.edu

Joseph A. Sullivan
CDR, USN
Military Faculty
831-656-7582
jasullivan@nps.edu

Joel D. Young
LT COL, USAF
Military Faculty
831-656-3518
jdyoung@nps.edu

Neil C. Rowe
Professor
831-656-2462
ncrowe@nps.edu
COMPUTER SCIENCE

ANALYSIS AND ASSESSMENT OF EFV SOFTWARE QUALITY AND MAINTAINABILITY
Mikhail Auguston, Associate Professor
Department of Computer Science
Sponsor: USMC - MARCORSYSCOM

SUMMARY: Develop the methodology and tools for Analysis and Assessment of EFV Software Quality and Maintainability

My role in the project: development of new methods and tools for Analysis and Assessment of EFV Software Quality and Maintainability.

ARCHITECTURE BASED ON BEHAVIOR MODELS
Mikhail Auguston, Associate Professor
Department of Computer Science
Sponsor: NAVAIR

SUMMARY: Development of Monterey Phoenix architecture modeling framework for naval avionics systems.

My role in the project: development of new methods and tools for system architecture modeling.

AFFORDABLE QUALITY ASSURANCE FOR REUSABLE COMPONENTS IN OPEN ARCHITECTURES
Valdis A. Berzins, Professor
Department of Computer Science
Sponsor: Navy

OBJECTIVE: The Navy’s open architecture framework is intended to promote reuse and reduce costs. However, current approaches to software acquisition require reusable software components to be retested each time they are used in a new context, which is a major contributor to cost per instance of reuse. The proposed research focuses on exploiting open architecture principles to safely reduce testing costs for reusable software components. Software components that are reused without modification need to be retesting in some, but not necessarily in all cases. This project will investigate conditions under which testing of unmodified components can be safely avoided, methods to identifying situations in which retesting can be safely reduced, and policies on how to effectively focus and automate resting in cases where some retesting is needed.

REUSABLE COMPONENTS IN OPEN ARCHITECTURES
Valdis A. Berzins, Professor
Department of Computer Science
Sponsor: Navy

OBJECTIVE: The navy is currently implementing the open architecture framework for developing joint interoperable systems that adapt and exploit open system design principles and architectures. The main problem is how to practically achieve dependability in software intensive systems with many possible configurations when the actual configuration of the system is subject to frequent and possibly rapid change, and the environment of typical reusable subsystems is variable and unpredictable. Our preliminary investigations indicate that current methods for achieving dependability in open architectures are insufficient. Conventional methods for testing are suited for stovepipe systems, and depend strongly on the assumptions that the environment of a typical system is fixed and known in detail to the quality assurance team at test and evaluation time. This research seeks to develop new approaches to quality assurance and testing that are better suited for providing affordable reliability in open architectures, and explains some of the
additional technical features that an Open Architecture must have in order to become a Dependable Open Architecture.

SUMMARY: We have interviewed representatives from four of the organizations actually involved in developing Navy technology upgrades. These interviews indicated (with unanimous support) that those organizations’ highest current priorities are reducing testing for unmodified software components after a technology upgrade and adapting automated testing methods into production use. The research, therefore, is exploring practical methods for checking conditions under which it is safe to reduce or eliminate retesting for unchanged components, and sought solutions that leverage automated testing in the contexts in which it is easiest and most effective to do so. The main points are summarized below.

- Retesting of unchanged components is sometimes but not always needed. The need for retesting depends on whether or not component requirements changed, whether or not component behavior changed, whether or not component workload changed, and whether or not the resources available to the component have changed.
- A type of dependency analysis known as program slicing can be used to identify parts of the unchanged code that have the same behavior in the new release as in previous one. If the new release has the same slice as the old release for a given service, then that service will have exactly the same behavior in the new release as in the old one and, consequently, may not need regression testing. This fact is useful because program slices can be computed for software systems on practical (large) scales. The testing-reduction method that follows from this observation is to compute the slice of each service with respect to the new release and the old release, and retest only the services for which these slices differ.
- Program slicing can determine if the behavior of unmodified code remains the same, by checking whether or not that code can be affected by changes to other components that have been modified.
- Automated invariance testing can be used to check that the behavior of modified components or services whose specifications remain the same still have the same behavior even though their implementations have been modified. This kind of testing can strengthen slicing analyses by enabling it to certify that additional unchanged components do not have to be retested.

We have also explored the application of a different kind of technology (constraint programming) to software reuse. This technology that can be used to check whether the translations in software adapters are adequate to support the functionality of reusable components whose interfaces do not quite fit the standards associated with an open architecture. This is a common situation for legacy components and COTS components that were developed without knowledge of the open architecture. Details are reported in publication [1]. This work provides a step towards the long term goal of enabling rapid replacement of reusable components within an open architecture without compromising overall system dependability. We also investigated automated stress testing for reusable components [2], validation of statistical models of system environments and methods to automatically generate test cases based on such models [3,4].

PhD students under our supervision have initiated dissertation research on several aspects of the proposed work, and one of those students graduated this year.

PUBLICATIONS:


DEVELOPMENT OF FORMAL METHOD STRATEGY FOR THE NEXT GENERATION SECURITY NETWORK SERVER (SNS)

George W. Dinolt, Professor of Practice
Department of Computer Science
Sponsor: SPAWAR

OBJECTIVE: Boeing is a leader in providing highly secure network solutions and information assurance. The SNS-4000 series is Boeing’s next generation high assurance Multilevel Secure (MLS) guard based on Field-Programmable Gate Array (FPGA) components. NPS and Boeing will collaborate to develop a Formal Methods Strategy for the new SNS-4000 series, including generating the model for the entire system. Additionally, the components will be tested and evaluated for Common Criteria Evaluation Assurance Level 7.

HARDWARE SECURITY EVALUATION

George W. Dinolt, Professor of Practice
Department of Computer Science
Sponsor: SPAWAR

OBJECTIVE: Preliminary Investigation on developing concepts for the evaluation of the properties of hardware, both CPU’s and supporting peripheral chips to support secure operation.

HARDWARE SECURITY EVALUATION OB-1

George W. Dinolt, Professor of Practice
Department of Computer Science
Sponsor: SPAWAR

OBJECTIVE: Preliminary Investigation on developing concepts for the evaluation of the properties of hardware, both CPU’s and supporting peripheral chips to support secure operation.

OB-1 EVALUATION SUPPORT

George W. Dinolt, Professor of Practice
Department of Computer Science
Sponsor: SPAWAR

OBJECTIVE: Provide technical support to SPAWARSYSCEN Charleston in developing the process for evaluating high assurance Cyber system, and in applying that process to the evaluation of the OB-1 system.

SOFTWARE CRYPTO MODELING (CONTINUATION)

George W. Dinolt, Professor of Practice
Department of Computer Science
Sponsor: SPAWAR

OBJECTIVE: Continuation of multiyear effort to produce concept, mathematical modeling approaches to provide the same level of protection to the implementations of cryptographic algorithms and the data managed by those algorithms as is provided by hardware based implementations of those algorithms.
COMPUTER SCIENCE

FORMAL UML REQUIREMENT SPECIFICATION-BASED AUTOMATIC SOFTWARE TESTING
Doron Drusinsky, Associate Professor
Department of Computer Science
Sponsor: USMC-MARCORSYSCOM

OBJECTIVE: Assist and guide NASA IV&V center in UML-based specification, modeling, programming, code-generation, validation, testing and verification of safety critical systems and distributed systems.

UML-BASED VALIDATION AND VERIFICATION (IV&V)
Doron Drusinsky, Associate Professor
Department of Computer Science
Sponsor: National Aeronautics and Space Administration

OBJECTIVE: Assist and guide NASA IV&V Center in UML based specification modeling, programming, code-generation, validation, testing and verification of safety critical systems and distributed systems.

SUMMARY: In 2009-2010 worked performed under RCSHL consisted the application of a newly developed log-file based verification framework for formal specification statechart assertions. This framework was also adopted by the NASA IV&V center for use in their Independent Test Capability (ITC) facility they are currently constructing.

Due to the sudden change in leadership at the IV&V center (the director was removed with short notice), and subsequent funding difficulties facing that center, the FY2010 funding was not provided as promised. I therefore discontinued this research effort.

IDENTITY AND DATABASE CHALLENGES FOR FORCE PROTECTION
Chris Eagle, Senior Lecturer
Department of Computer Science
Sponsor: Defense Manpower Data Center

OBJECTIVE: The Defense Manpower Data Center (DMDC) maintains records on Department of Defense personnel in dozens of databases containing over 40 million records. Threats to DMDC data are external and internal, some intentional, and some inadvertent. This research, under the auspices of Team Monterey Phase II, at NPS will focus on three primary areas: the identification of threats to selected subgroups of individuals for whom records are maintained in the DMDC databases, analysis of the costs of data and transitively population exposure, and threat mitigation through a combination of technical and procedural countermeasures.

RESEARCH ON SOFTWARE VULNERABILITY DISCOVERY TOOLS
Chris Eagle, Senior Lecturer
Department of Computer Science
Sponsor: National Security Agency

OBJECTIVE: Research for this project is classified.
TEAM MONTEREY: ANALYSIS OF IDENTITY MANAGEMENT SECURITY FOR GROUPS
Chris Eagle, Senior Lecturer
Department of Computer Science
Sponsor: National Security Agency

OBJECTIVE: Unavailable.

AUTOMATED MEDIA EXPLOITATION
Simson L. Garfinkel, Associate Professor
Department of Computer Science
Sponsors: (1) USMC-MARCORSYSCOM
(2) Defense Intelligence Agency
(3) Office of the Secretary of Defense

OBJECTIVE: To develop new techniques and automated tools for analyzing captured data containing devices.

SUMMARY: This project, started in 2005, seeks to develop new algorithms, techniques and eventually tools for automatically processing information from hard drives, USB memory sticks, cell phones, and other data carrying devices.

The thrust of this research covers three main areas:
1. Developing open source tools for working with electronic evidence.
2. Developing an unclassified Real Data Corpus (RDC) consisting of “real data from real people” that can be used to develop new algorithms, quantify results, and test automated tools.
3. Developing new algorithms and approaches for working in a “data-rich environment” such as a large collection of hard drives that have been seized during the course of law enforcement or military operations.

Key work accomplished in 2010 includes:
• Significantly increasing the size of the Real Data Corpus.
• Development and fielding of bulk_extractor tool for rapid media exploitation.

PUBLICATIONS:

THESES DIRECTED:
Kristian P. Kearton, Visualization Framework for Temporal Analysis of Social Networks, March 2010
COMPUTER SCIENCE

DOD CYBER POLICY REVIEW
Simson L. Garfinkel, Associate Professor
Department of Computer Science
Sponsor: OSD

OBJECTIVE: This project seeks to assist OSD Policy by reviewing and contributing the draft DoD policy on Cyber Policy.

SUMMARY: Professor Garfinkel assisted in the drafting and review of DOD’s “CyberPolicy 3.0”. This policy review stressed professor Garfinkel’s research areas of aligning security and usability (HCI-SEC) and the practical application of off-the-shelf technology that might create measurable improvements in cybersecurity posture within the 1-3 year time horizon. Garfinkel also provided analysis and support in the identification of specific research efforts within the US academic environment that might be directly beneficial to DOD’s Cyberspace objectives.

PUBLICATIONS:
Simson Garfinkel and Lorrie Cranor. Institutional review boards and your research. Communications of the ACM, June 2010

IDENTITY AND DATABASE CHALLENGES FOR FORCE PROTECTION
Simson L. Garfinkel, Associate Professor
Department of Computer Science
Sponsors: DMDC

OBJECTIVE: This project seeks to analyze the privacy and security vulnerabilities caused to DoD employees by publicly available DoD information sources.

SUMMARY: The DoD411 LDAP server is a publicly available database that is accessible without authentication from anywhere on the Internet. It contains the names and email addresses of all DoD employees and many DoD contractors.

In 2010 Professor Garfinkel, Capt. Kenneth (Nate) Phillips, and LT Aaron Pickett worked as part of Team Monterey on a project to characterize the availability and quality of information available on DoD411. We developed a tool for automatically downloading information from DOD411 and for correlating this information with data available on Facebook, LinkedIn, and MySpace. No special access is required.

PUBLICATIONS:
Garfinkel, Simson L. Residual Data Found on Guardian Edge-Protected Removable Storage Media. NPS Technical Report NPS-CS-10-003. February 2010

Garfinkel, Simson L. Counter Intelligence Risks Posed By Information Stored in DOD411---The DISA Global Directory Service (DoD411), NPS Technical Report NPS-CS-10-004, July 2010

PRESENTATIONS:
DMDC Intelligence Consortium, 2010
Other presentations made as appropriate to Navy flag officers executive education, and to DONCIO Privacy Office.

THESES DIRECTED:
LT Aaron Pickett, Vulnerabilities for Malicious Data Fusion from Unprotected U.S. Navy Personnel Information, June 2010
COMPUTER SCIENCE

Cpt. Kenneth Phillips, Correlating Personal Information Between DoD411, LinkedIn, Facebook, and MySpace with Uncommon Names, June 2010

Maj. Stephen Lavelle, Fabricating Synthetic Data In Support Of Training For Domestic Terrorist Activity Data Mining Research, Master’s Thesis, September 2010.

TEAM MONTEREY: ANALYSIS IDENTITY MANAGEMENT SECURITY FOR GROUPS
Simson L. Garfinkel, Associate Professor
Department of Computer Science
Sponsor: DMDC

OBJECTIVE: This project seeks to analyze the privacy and security vulnerabilities caused to DoD employees by the correlation of information left on stored media and in social network services.

SUMMARY: NPS has been developing a number of techniques to automatically scan computer media and draw correlations between various devices.

CREATING REALISTIC FORENSIC CORPORA FOR UNDERGRADUATE EDUCATION AND RESEARCH
Simson L. Garfinkel, Associate Professor
Department of Computer Science
Sponsor: National Science Foundation

OBJECTIVE: This project seeks to improve computer security education by creating realistic data that can be used for education and research in computer forensics.

SUMMARY: In 2010 Garfinkel published more than 500GB of realistic computer forensic data on the Internet. This data contains no personally identifiable information and can be used without prior consent for education and research. Support agreements were executed with University of Washington Applied Physics Lab, University of North Carolina, and Erie Community College, Buffalo to support this project.

PRESENTATIONS:
July 27, 2010 - Building Realistic Forensics Corpora for education (ECC)
July 27, 2010 - The Open Source Forensics Stack (Erie Community College)

TC: LARGE: COLLABORATIVE RESEARCH: 3DSEC: TRUSTWORTHY SYSTEM SECURITY THROUGH 3-D INTEGRATED HARDWARE
Ted Huffmire, Assistant Professor
Department of Computer Science
Sponsor: National Science Foundation (NSF)

OBJECTIVE: The goal of this multi-year, multi-university, collaborative research project is to augment commodity integrated circuits after fabrication with a separate layer of security circuitry. 3-D Integration is a proven technique for combining two chips. The additional layer is an integrated circuit that implements application-specific policy enforcement functionality.

SUMMARY: In CY2010, we published the results of our work on a 3-D cache management application in the premier ACSAC conference. We also published the results of our work on self-protection and dependency layering
for 3-D applications in the WESS workshop. We also filed a provisional patent application describing our methods. PI Huffmire gave a presentation to the INFOSEC Research Council (IRC) in Arlington in January 2010. PI Huffmire visited UC San Diego in August 2010 and Microsoft Research in September 2010 to coordinate with his collaborators.

PUBLICATIONS:

Workshop Papers:


Conference Papers:


Patents:


PRESENTATIONS:

Invited Talks:


BIOMETRIC CHALLENGES FOR FUTURE DEPLOYMENTS
Cynthia E. Irvine, Professor
Department of Computer Science
Sponsor: US Army Study Program Management Office

OBJECTIVE: The proposed study will identify future potential deployment locations the Army may face over the next 5, 10, and 20 years and how that will impact the use of biometric technologies and shape emerging CONOPS. It will consider both technical and non-technical factors associated with the use of various biometric modalities.

CRYPTOLOGIC COMPUTER SCIENTIST - 2010: TOPICS IN NETWORK SECURITY AND VULNERABILITY ASSESSMENT
Cynthia E. Irvine, Professor
Department of Computer Science
Sponsor: National Security Agency

OBJECTIVE: The proposed effort is to continue an educational relationship between the Naval Postgraduate School and the National Security Agency. This activity involves the education of a cadre of Cryptologic Computer Scientists in specialized cyber security topics associated with network security and system vulnerability analysis. It will include two specialized courses: one on network security and the second on advanced vulnerability analysis.
IDENTITY AND DATABASE CHALLENGES FOR FORCE PROTECTION
Cynthia E. Irvine, Professor
Department of Computer Science
Sponsor: Defense Manpower Data Center

OBJECTIVE: The Defense Manpower Data Center (DMDC) maintains records on Department of Defense personnel in dozens of databases containing over 40 million records. Threats to DMDC data are external and internal, some intentional, and some inadvertent. This research, under the auspices of Team Monterey Phase II, at NPS will focus on three primary areas: the identification of threats to selected subgroups of individuals for whom records are maintained in the DMDC databases, analysis of the costs of data and transitivity population exposure, and threat mitigation through a combination of technical and procedural countermeasures.

INFORMATION ASSURANCE SCHOLARSHIP PROGRAM SUPPORT - 2010
Cynthia E. Irvine, Professor
Department of Computer Science
Sponsor: Defense Manpower Data Center

OBJECTIVE: The objective of the proposed work is to support student research and studies in information assurance. This work will be conducted as part of the Information Assurance Scholarship Program. Faculty and staff in the Center for Information Systems Security Studies and Research (CISR) at the Naval Postgraduate School will provide student participants with guidance and material support relating to prerequisite studies and research leading to Masters and PhD degrees in Computer Science, Information Sciences, Software Engineering, MOVES, Electrical Engineering, Computer Engineering, and Systems Engineering.

HIGH ASSURANCE PLATFORM: HAPR2-C SECURITY REQUIREMENTS DEFINITION
Cynthia E. Irvine, Professor
Department of Computer Science
Sponsor: National Security Agency

OBJECTIVE: The NSA High Assurance Platform (HAP) Program is an effort to define a framework for the development of high confidence computing components for use in a range of operational contexts. To help validate the applicability of emerging hardware and software technologies, and the effective use of the target Computing Platform in different operational use-scenarios, the HAP Program also develops interim HAP reference implementations. The HAP Release 2 (HAPR2) implementation is ongoing.

This proposal is to conduct research to develop a set of commercially achievable security requirement for the HAPR2 implementation that can be incorporated into the Computing Platform Architecture and Security Criteria (CPC) specification for the HAP Program. This investigation will also include a preliminary study of composition of assurable platform instances from HAP-conformant platform components.

MULTILEVEL SECURE COLLABORATIVE WEB TECHNOLOGIES
Cynthia E. Irvine, Professor
Department of Computer Science
Sponsor: National Reconnaissance Office

OBJECTIVE: The Multilevel Secure Collaborative Web Technologies (MLS.Cloud) project will explore the use of social networking, web-based media and content aggregation in an MLS context. The range of web-based technologies available to enhance productivity and sharing is broad. The MYSEA Multilevel Testbed will be used as the platform to conduct research on two types of Web-based productivity tools: social media technologies and content aggregation
mechanisms. Specifically, this proposal is for support to pursue extension of the user experience in an environment in four areas: streaming video and video sharing; blogging and micro-blogging; news aggregation; and web mash ups.

MULTILEVEL SECURE CLOUD SERVICES
Cynthia E. Irvine, Professor
Department of Computer Science
Sponsor: National Reconnaissance Office

OBJECTIVE: The objective of the Multilevel Secure Cloud Services project is to investigate and develop several MLS remote-access methods in which policy enforcement is transparent. Resource abstraction and resource provisioning are at the heart of the cloud services tasks: MLSDNS, MLS cloud storage and MLS cloud applications. The Domain Name System (DNS) is a critical enabling technology for web-based abstractions, allowing a single name to be mapped to one or more hosts. We propose to extend DNS to enforce an MLS policy over IP-level access requests and implement these changes using MYSEA as a test bed. This abstraction can be utilized, among other things, for load distribution and for provisioning multiple hosts to provide fault-tolerant services. The MLS cloud storage and MLS cloud applications tasks will lay the groundwork for future implementations of MLS policy with cloud resource abstractions.

MYSEA - PHASE VI
Cynthia E. Irvine, Professor
Department of Computer Science
Sponsor: National Reconnaissance Office

OBJECTIVE: In the DoD Intelligence Community, access to information at different sensitivity levels is a critical capability, yet highly secure multi-level systems. Current needs point toward solutions able to adapt to changing situations and threats, that must also be affordable, usable, and highly effective.

MYSEA Phase VI will develop field-ready capabilities for multilevel, adaptive information and security services, which will demonstrate the feasibility of the MYSEA distributed architecture. Affordability is based on the judicious, minimized use of high assurance (expensive) components; usability is supported via common commercial products and their interfaces; and the high assurance evaluation target reflects the comprehensive effectiveness of our solution.

MYSEA Phase VI comprises several research areas: distributed, multi-level security services; support for adaptive security; scalability analysis and testing; infrastructure support; and evaluation/accreditation support. It extends the existing MYSEA prototype, and will be developed, tested and measured in the controlled MLS testbed environment.

MYSEA - PHASE VII, HIGH ASSURANCE MULTI-LEVEL TESTBED
Cynthia E. Irvine, Professor
Department of Computer Science
Sponsor: National Reconnaissance Office

OBJECTIVE: In the DoD Intelligence Community, access to information at different sensitivity levels is a critical capability, yet highly secure multi-level solutions that are context-adaptable, affordable, usable, and highly effective are not available.

MYSEA Phase VII will continue an effort to develop field-ready capabilities for multilevel, adaptive information and security services, which will demonstrate the feasibility of the MYSEA distributed architecture. Affordability is based on the judicious, minimized use of high assurance components; usability is supported via common commercial products and their interfaces; and the high assurance evaluation target reflects the comprehensive effectiveness of our solution.
MYSEA Phase VII comprises several research areas: distributed, multi-level security services; adaptive security support; infrastructure support; and evaluation/accreditation support. It extending MYSEA, this effort will be conducted in the controlled MLS testbed environment.

TEAM MONTEREY: ANALYSIS OF IDENTITY MANAGEMENT SECURITY FOR GROUPS
Cynthia E. Irvine, Professor
Department of Computer Science
Sponsor: Defense Manpower Data Center

OBJECTIVE: The Department of Defense maintains approximately 15,000 networks incorporating on the order of 7 million computers that are attacked approximately 50,000 times per day. Among these assets are databases containing high value information, which must be protected from adversarial exploits. Standard best practices in system security management provide considerable protection, yet for high-value information, many risks are unknown. The objective of the proposed work is to conduct analyses of risks associated with large data sets. The analyses will include examination of techniques that would permit unauthorized access to data; methods to extract high value data; identification and parameterization of metadata in support of data extraction; identification of issues associated with multi-domain use of data, and estimation of exposure costs for selected sets of high value information.

DOCUMENTATION DRIVEN SOFTWARE DEVELOPMENT
Luqi, Professor
Department of Computer Science
Sponsor: ARO

OBJECTIVE: The objective of this research is to enhance integration of computer aided software development activities throughout an entire life cycle. Based on the new representation and tools for documentation, we will provide a mechanism to monitor and quickly respond to changes in requirements. Overall, it will increase the agility and accuracy of software development and modification.

SUMMARY: This project addresses the problem of how to improve the productivity of software development while still producing high-confidence, high-quality software that has traceability, flexibility and maintainability required by complex DoD software systems (such as Systems of Embedded Systems). Based on the proposed Documentation Driven Development (DDD) approach, this research presents a system of enhanced integration of computer-aided software methods and communications with stakeholders.

One of the main parts of the DDD approach is a Document Management System (DMS) that operates in two general dimensions: vertical when it automatically transfers information between requirements, design and implementation stages, and horizontal when it maintains the interface between stakeholders and computer tools. The project addresses the horizontal dimension by creating converters that reduce the ambiguity typical for the requirements expressed in Natural Languages. The project addresses the vertical dimension by implementing a mapping procedure between formal descriptions extracted from requirements and system design expressed in universal modeling language (UML). This mechanism also maintains the consistency of requirements/modifications and facilitates traceability of the transformation.

In order to represent requirements documents most of which are written in Natural Language (NL) we developed a converter - a system for translating requirements into formal descriptions that are understandable by computers and are unambiguous and precise as possible. Pursuing this goal took several stages that included designing metrics for measuring ambiguity and consistency of NL descriptions; using NL processing tools to transform texts into XML based language; and extracting an ontology of the software engineering (SE) domain and merging it with a general English ontology (Word Net). In addition, we are exploring new possibilities for computer-aided interfaces that help humans with routine tasks. In doing so we applied Cognitive Science and machine learning methods to design user interfaces that can learn and assist users.
We also studied Knowledge System Integration Ontology (KSIO) that aligns data and information systems with current situational context for the efficient knowledge collection, integration and transfer. The role of ontology is to organize and structure knowledge (e.g. by standardized terminology) so that semantic queries and associations become more effective and efficient.

In order to establish high reliability of a complex system and reduce the risk early in a life cycle we applied risk analysis methods on the level of software architecture. This enables identifying unreliable features of architecture early in the software lifecycle, thus reducing the cost of development. We also accomplished work on effective transition drivers that create executable code from design specifications. As a result, users of a prototyping environment are able to stay at a high level of abstraction and need not concern themselves with the details of the composed and generated code. Simultaneously, the prototyping environment generates appropriate information for installation and operation of all parts of the system. In order to verify conformance between intended design and implementation we applied automatic binding techniques to transform architectural constraint artifacts to dynamic monitoring properties that ensure the conformance during implementation and runtime. We completed surveys and reports on Natural Language Processing, Project Risk Assessment, Decision Support and Project Management. We also studied the use of constraint programming to check whether translations in software adapters are adequate to support new or reconfigured reusable components, which is part of achieving reliable adaptable systems.

Organized, hosted and chaired Monterey Workshop 2010 to address autonomic system adaptation to dynamic environments, which is relevant to the goals of DDD.

PUBLICATIONS:


ESTABLISH/MAINTAIN SOFTWARE ENGINEERING TEST LAB (SETL)

Luqi, Professor
Department of Computer Science
Sponsor: Joint Information Operations Center

OBJECTIVE: Establish a Lab for the purpose of stress testing real DoD systems with an emphasis on a holistic approach. The systems will be made available through a separate Internet Service Provider (ISP) then NPS to enable the testing of different access configuration and to allow for outside entities to red term the systems. This lab will be used to evaluate multiple different DoD systems over the years.

RISK ASSESSMENT IN SOFTWARE PROJECT

Luqi, Professor
Department of Computer Science
Sponsor: NAWCWD

OBJECTIVE: This research is to study and develop a revolutionary software risk management method that integrates quantitative metrics with domain risk knowledge to derive risk assessment and facilitate management decision making processes throughout software development life cycle. The decision aid from the method is intended to produce a high level software risk management plan that encompasses risk assessment and risk control. The method should also support simulation using strategic plan for risk control to predict and estimate risk outcomes as a predictor or trend analysis.

SUMMARY: A complex real-time system is generally composed of individual real-time systems that were developed by different organizations with different tools and run on different platforms. The development of complex real-time
COMPUTER SCIENCE

systems is more challenging than the development of individual real-time systems. In general, complex real-time systems are usually deployed for long periods of time, are used globally, and have mission critical requirements. Besides, complex systems must rapidly accommodate frequent changes in requirements, mission, environment, and technology. Risk assessment is essential to the successful development of a software system, especially for evolutionary development of complex systems.

The Documentation-driven development (DDD) method is a novel approach for supporting complex real-time software systems. The flexibility to adapt complex systems to requirements changes (agility) comes from an efficient documentation management system (DMS) and a process measurement system (PMS) that can bridge gaps between different disciplines and reduce the requirements for participants in system evolution to have specific knowledge. Risk assessment is the core part of PMS that monitors the frequent changes in system requirements and assesses the effort and success probability of the project with a measurement model based on a set of quantitative metrics. The metrics can be automatically collected in the requirements phase and stored and organized in DMS.

Based on the PMS framework, this project aims at doing research on an evolutionary software risk management methodology that integrates quantitative metrics with domain risk knowledge to derive risk assessments and support risk control. This would facilitate management decision making processes throughout a software development life cycle, and would help produce a high level software risk management plan that encompasses risk assessment and risk control.

Basic research has been carried out on the study of four major indicators for accurately measuring investment risk during the software cycle: volatility, organizational efficiency, product complexity, and technological maturity. By using causal analysis we identified four major risk contributors: resource risk, process risk, product risk and technology risk. Each of these factors introduces risks individually and due to their interactions. Technology risk mainly consists of two parts. One arises from the software technologies that are selected to implement the project. The other arises from the domain technologies involved in the project. Although the impact of technology maturity on risk is apparent and non-negligible, this factor has seldom been explicitly considered in the state-of-the-art risk assessment models. We developed a risk model that incorporated this factor and associated metrics.

PUBLICATIONS:


MONTEREY WORKSHOP 2010 - AUTONOMIC SYSTEM ADAPTATION TO DYNAMIC ENVIRONMENTS: ROBUSTNESS AND SELF-HEALING  
Luqi, Professor  
Department of Computer Science  
Sponsor: ARO

OBJECTIVE: The objective of this project is to hold a workshop titled “Modeling, Development and Verification of Adaptive Systems”. The workshop was the 16th in a series of workshops, initiated in 1993 and devoted to exploring the critical problems associated with cost-effective development of high-quality software systems. These workshops have a rich history of bringing together both American and European scientists that share a common interest in seeing that software development research serves as a catalyst for practical advances in next-generation software intensive systems. These workshops have been highly praised by participants for their high quality of presentations and discussions and given rise to many new collaborations that have significantly advanced the field. Historically, the workshop has been funded by both US and European organizations. US organizations have included ONR, NSF, AFOSR, ARO, DARPA, and many others.

SUMMARY: The 16th Monterey Workshop investigates an intriguing direction for potential innovation: mechanisms by which organisms cope with harsh, unfavorable, and variable conditions in the natural world. Distillation and formalization of common strategies of complex systems that persevere and function in severely stressful or unexpected
situations can aid in the design of systems that must be able to weather similarly chaotic environments.

While these observed strategies provide a potential source of inspiration, unlike nature, software engineers are not limited to trial and error. We can formulate mathematical models and design principles to provide systematic avenues for realizing, analyzing, and improving software reliability. Specialization to meet the particular needs of software development and clever design based on insights gained from natural strategies may eventually surpass the robustness of biological systems. Multiple approaches are explored here, ranging from decentralization-based redundancy and improved verification of flexible systems with many configurations to self-adaptive, self-management and self-correction capabilities.

We note several presentations dealing with the notion of adaptation in software systems. It is amazing how this notion could be specialized and refined in various application domains such as autonomous space systems, reconfiguration of modular robots, adaptation to application design, managements of unpredictable changes in specifications, and certification of reconfiguration. This subtopic was covered in many different ways during the workshop, without prior coordination of the invitees. This outcome is not surprising if we consider that ubiquitous systems are rising, with increasing rates of new requirements, new operating environments, subsystem failures, and hostile activity.

In some contexts adaptation is a necessity, for a variety of reasons. For example, autonomic robots in some space missions have to be self-adaptive because there is no way to get an answer from earth, due to a 40 minute delay. In the context of reconfigurable modular robots, runtime adaptation is needed because there is no way to pre-compute the potential moves, due to a combinatorial explosion of possible starting states. Variability in modeling languages requires adaptability because the application-specific extensions needed are discovered only when we know the application. Lightweight formal methods supporting reconfiguration in response to varying system loads are needed to derive a system change that will not violate any system constraints, to ensure success of the proposed adaptation before attempting any system modifications. In these and many other cases, details of the required adaptation depend on information that is not available at the time the system is designed.

The workshop was held at Microsoft Headquarters in Redmond, WA in April 2010. It was attended by many of the top researchers in the field of software engineering, and produced an assessment of the current state of the art in adaptive software system design and verification.

PUBLICATIONS:


BUILDING GOOD MODELS FROM THE WRONG DATA
Criga H. Martell, Associate Professor
Department of Computer Science
Sponsor: National Reconnaissance Office

OBJECTIVE: Over the past four decades or so, the analysis of documents and newswire has progressed from infancy to a robust field with massive amounts of linguistic data and algorithms capable of performing a number of tasks important to the analyst. However, these gains have come from decades of work, a great deal of which was spent in hand-labeling the data that is used in these algorithms with the “truth” of the matter. That is, for each of the many tasks, a gold-standard data set was created (mostly) by hand and used for building the respective algorithms.

On the other hand, those who wish to analyze newer forms of communication do not have analogous resources available to them; chat, blogs, SMS, etc. are sufficiently different forms of communication that the pre-existing data (built for document or newswire analysis) doesn’t work. As an example, Forsyth and Martell (2007) show that a system trained to do part-of-speech tagging on chat achieved only 57.4% accuracy. In that same work, however, it
was shown that adding just a relatively small amount of data from the chat domain—10,000 posts to over a million words of Wall Street Journal data—allowed for algorithms that produced 87.1% accuracy. This was extended over 90% accuracy in Forsyth’s 2007 NPS Masters Thesis. That is, although we do not have mass amounts of data, as does the document and newsfeed analysis communities, we believe we can leverage the data created in these other communities so that we can build systems that allow for robust analysis of these newer forms of communication. In short, we wish to build good models of these domains from data obtained from other domains (or the wrong data).

IDENTITY AND DATABASE CHALLENGES FOR FORCE PROTECTION

Criag H. Martell, Associate Professor
Department of Computer Science
Sponsor: Defense Manpower Data Center

OBJECTIVE: The Defense Manpower Data Center (DMDC) maintains records on Department of Defense personnel in dozens of databases containing over 40 millions records. Threats to DMDC data are external and internal, some intentional, and some inadvertent. This research, under the auspices of Team Monterey Phase II, at NPS will focus on three primary areas: the identification of threats to selected subgroups of individuals for whom records are maintained in the DMDC database, analysis of the costs of data and transitive population exposure, and threat mitigation through a combination of technical and procedural countermeasures.

LANGUAGE EVIDENCE FOR SOCIAL GOALS: A LINGUISTIC APPROACH TO PERSUASION MOVES IN DISCOURSE

Criag H. Martell, Associate Professor
Department of Computer Science
Sponsor: University of Maryland

OBJECTIVE: The overall goal of the Socio-Cultural Content in Language (SCIL) Program is to explore and develop novel designs, algorithms, methods, techniques and technologies to extend the discovery of the social goals of members of a group by correlating these goals with the language they use. Human language use reflects social goals of members of a group by correlating these goals with the language they use. Human language use reflects social and cultural norms, contexts and expectations. Social variables (such as religion, status, gender, education) and contextual features (such as formality, participant beliefs, social situations) can influence the form and feathers of language. Because language use responds to such social and cultural influences, then correlating social goals and language forms and content should provide a rich and expanded understanding of the attributes, roles and nature of the associations and intentions of the members of social groups.

The partners will collaborate to develop a method to use language to identify social goals pertaining to persuasion. The intent of this joint research project is to develop a well defined and computationally tractable characterization of dependent and independent variables that will be the focus of analysis. The collaborators will produce a class of appropriate models to capture the correlation between independent and dependent variables. NPS and UMD will build data sets that permit the development, successive refinement, and formative evaluation of the aforementioned models. Once the data sets have been established, the collaborators will perform human coding of relevant variables in the data sets for purposes of model training and evaluation. The partners will jointly produce evaluation metrics that will enable the comparison of alternative approaches, the assessment of progress, and the identification of error categories in order to make further improvements. Furthermore, NPS will build a set of Web Services to facilitate the delivery of the research results to the sponsor.
OBJECTIVE: We are in Year 1 of our 5-year plan. We will use this augmented funding to further our year-1 research in two areas: Dialogue-Act Analysis/Annotation and Good Models from Bad Data.

DEVELOPMENT OF A REFERENCE MODEL IN SUPPORT OF VERIFICATION AND VALIDATION OF SYSTEMS
James Bret Michael, Professor
Department of Computer Science
Sponsor: NASA

OBJECTIVE: Unavailable

INVESTIGATION OF DEPENDABLE, TRUSTWORTHY, AND EVOLVABLE DISTRIBUTED COMPUTING
James Bret Michael, Professor and Principal Investigator
Albert Barreto, Lecturer
George W. Dinolt, Professor of Practice
Doron Drusinski, Associate Professor
Alexander J. Nelson, Research Assistant
Thomas W. Otani, Associate Professor
Loren E. Peitso, Senior Lecturer
Man-Tak Shing, Associate Professor
Department of Computer Science
Sponsor: Office of the DoD Chief Information Officer

OBJECTIVE: To investigate how the DoD can acquire distributed systems that are dependable, trustworthy, and can evolve as the technology, policy, and requirements change without causing the government to unnecessarily experience undesirable deviations in cost, schedule, or performance. The research supports the Enterprise Services & Integration Directorate’s efforts to address technical and policy issues associated with the realization of the DoD CIO Storefront and leveraging of the capabilities provided by the Directorate’s partners such as the Defense Information Systems Agency Computing Services Directorate’s Rapid Access Computing Environment (RACE).

SUMMARY: In 2010, we introduced a three-stage plan toward achieving an ideal state of cloud computing called a “cloud Nirvana.” The stages are: migration (movement of data and applications to the cloud), integration (merging, or purging, of unnecessary duplication of both data and applications), and unification (removing the boundary between data and applications). While exploring these stages we identified four key enablers for reaching cloud Nirvana: providing for freedom of movement between clouds; adopting an information-centric view of data processing; treating data and their associated manipulators as objects; and ensuring cloud services are trustworthy and dependable.

We conducted detailed case studies to identify the potential impacts of cloud computing on existing workflows in the Army Test and Evaluation (T&E) enterprise domain as well as the use of cloud computing to support Synchronized Disaster Response Operations. We also supported the efforts of the National Institute of Standards and Technology’s development of a unified set of use cases for informing policy and technical decisions about the application of cloud computing within the federal government.

We explored how trust in cloud computing could be achieved, starting with an examination of implementation structures
and assurance provisions for security and investigation security architectures, while taking into consideration the:

- Amorphous nature and scale of cloud computing
- Mathematical models that will be needed to analyze cloud security properties
- Underpinnings on which application-, enterprise-, and user-level security policies and properties can be implemented
- Foundations on which the implementation assurances can be ascertained

In addition, we participated in the General Services Administration’s interagency initiative known as Federal Risk and Authorization Management Program (FedRAMP) to provide a government-wide certification and accreditation (C&A) process for cloud services.

We investigated how data and the operation on data should be organized and structured in order to leverage cloud computing to the fullest extent possible. We introduced an object-oriented (OO) approach to managing the content in the cloud, using a well-understood formalism for specifying and enforcing extended OO relationships, both between documents and between applications and documents.

PUBLICATIONS:


THESES DIRECTED:


INVESTIGATION OF CLOUD COMPUTING FOR TACTICAL SYSTEMS
James Bret Michael, Professor and Principal Investigator
Albert Barreto, Lecturer
George W. Dinolt, Professor of Practice
Doron Drusinski, Associate Professor
Alexander J. Nelson, Research Assistant
Thomas W. Otani, Associate Professor
Loren E. Peitso, Senior Lecturer
Man-Tak Shing, Associate Professor
Department of Computer Science
Sponsor: Office of the DoD Chief Information Officer

OBJECTIVE: To explore central issues faced by the DoD in adopting cloud computing for tactical systems.

SUMMARY: Large-scale weapons systems employ distributed computing, but these systems typically do not have a services orientation found in systems architected to leverage cloud computing. In 2010 we identified some of the technical enablers for applying cloud computing in tactical systems. We developed high-level generic use cases to understand how cloud computing can play a role in supporting changes in the workflows employed by warfighters to attain information superiority. From those use cases we identified the following topical areas as being of high priority for further investigation:

- Interoperability among hybrid clouds
- Timeliness of data, computation, and communication
- System safety
- System security
- Continuity of operations
- Dynamic reconfiguration
- Phased migration to the cloud

PUBLICATIONS:

IDENTITY AND DATABASE CHALLENGES FOR FORCE PROTECTION
Zachary Peterson, Assistant Professor
Department of Computer Science
Sponsor: Defense Manpower Data Center

OBJECTIVE: The Defense Manpower Data Center (DMDC) maintains records on Department of Defense personnel in dozens of databases containing over 40 million records. Threats to DMDC data are external and internal, some intentional, and some inadvertent. This research, under the auspices of Team Monterey Phase II, at NPS will focus on three primary areas: the identification of threats to selected subgroups of individuals for whom records are maintained in the DMDC databases, analysis of the costs of data and transiively population exposure, and threat mitigation through a combination of technical and procedural countermeasures.
OBJECTIVE: Study methods for detecting of emplacement of improvised explosive devices using a field of sensors.

SUMMARY: Work in 2010 represented the conclusion of this three-year project. This task is difficult and requires a wide spectrum of strategies. We explored both imaging and nonimaging sensors, but our focus was on nonimaging. We conducted experiments with people moving through public areas and tried to detect suspicious behavior by those people.

Based on precedents in criminology, the main clues to IED emplacement are suitability of the location, anomalousness of the behavior, occurrence of goal-changing behavior, and coordinated activity. Suitability of the location is based on emplacement difficulty, concealability, and ability to escape. Anomalies can be in time, location, speed, manner, and other properties of the behavior. Goal-changing behavior is a clue since most people in a public area are passing through, and tend to be consistent in their speed, direction, and manner of motion; significant changes suggest changing of goals reflecting concealment of intentions or opportunism. Finally, unusually coordinated activity can be suspicious.

We found that IED-emplacement behavior could be tracked with simple sensors, but that the choice of sensors and their deployment is critical. The most useful were infrared motion detectors, sonar, audio, and light. To establish a baseline for normal activity, we also found it essential to use video cameras to analyze the terrain patterns over a period of time. The best way to handle the sensor data was to use it to build probability distributions of location, and then calculate a set of metrics indicating particular kinds of suspicious behavior. Results showed we could identify most kinds of suspicious behavior, but had problems with background noise of various kinds when operating in public areas.

PUBLICATIONS:


THESES DIRECTED:

P. J. Young, “A Mobile Phone-Based Sensor Grid for Distributed Team Operations,” M.S. in Computer Science at NPS, 9/10

T. Le, “Efficiency and Effectiveness Analysis of Spectrum XXI Frequency Management Software in the U.S. Air Force,” M.S. in Computer Science at NPS, 9/10
EXTENDING BASE-IT TO INDOOR OPERATIONS

Neil C. Rowe, Professor
Department of Computer Science
Sponsor: Naval Modeling and Simulation Office (NMSO)

OBJECTIVE: Develop methods for automatic assessment of Marine training indoors with nonimaging sensors.

SUMMARY: We built a sensor network for assessing Marine performance in “clearing a building”, searching for people and contraband. We used a set of three rooms which we instrumented with ten computers running microphones, infrared motion detectors, photocell-type infrared detectors, light-intensity sensors, sonar, and pressure sensors under removable objects. We equipped simulated Marines with fake weapons with orientation and vibration sensors. We had the Marines execute a set of 14 scripts representing both correct and incorrect variations on a room-clearing plan. We collected the data and filtered it, then plotted exceptional readings on synchronized timelines. Plots clearly showed the stages in room clearing. Results showed clear differences between correct and incorrect execution of room clearing. This suggests that automated assessment of indoor training is possible with inexpensive nonimaging sensors.

PROTECTING MOBILE DEFENSE NETWORKS

Neil C. Rowe, Professor
Department of Computer Science
Sponsor: Defense Department Office of Strategic Development (OSD)

OBJECTIVE: Develop methods to protect mobile defense networks using deception.

SUMMARY: This was money to enable student Jonathan Alston to buy wireless equipment and support computers for his M.S. Thesis. Work is being coordinated with the Naval laboratory at Point Mugu.

SELF PROTECTING ELECTRONIC MEDICAL RECORDS

Aviel D. Rubin, Computer Science Student
Christoph Lehmann
Darren Lacey, Computer Science Student
Matthew Green, Computer Science Student
Zachary N. J. Peterson, Assistant Professor
Department of Computer Science
Sponsor: National Science Foundation

OBJECTIVE: This project proposes to utilize novel cryptographic techniques to protect Electronic Medical Records (EMRs) and to provide secure means for storing the EMRs in un-trusted locations, such as in the cloud or on an individual’s smartphone.

SUMMARY: The current focus of Peterson’s work has been to apply attribute-based encryption (ABE) to the problem of distributed role-based access control of electronic medical records in a deployed system. His work has addressed many of the practical constructs, such as key generation and management, needed to effectively and securely implement an ABE-EMR system. To date, his work has resulted in a prototype system that allows individuals to securely store their EMRs in an iPhone application, allowing offline and emergency access to a patient’s record. A paper describing this work is currently in submission to the International Conference on Applied Cryptography and Network Security.
OBJECTIVE: To develop a notion of compliant responses to support technology transfer dialogue.

SUMMARY: Ideally, customers would articulate their requirements as properties in such a way that vendors could offer proofs that their products guarantee these properties. What is frequently done in practice is far less rigorous. Vendors make assertions about their technology which must be reconciled with customer requirements. One area where this occurs often is computer security. Recent work in formal semantics, namely inquisitive semantics, is examined for the purpose of building a foundation for this process. Inquisitive semantics gives rise to a notion of coherent responses to questions called compliant responses.

Compliance is to dialogue what entailment is to classical logic.

The notion is unsuitable for resolving issues constructively which characterizes technology transfer. A variant is introduced for this purpose called constructive compliance.

A CENTER FOR SCIENCE AND TECHNOLOGY TRANSITION

OBJECTIVE: To develop the components of a center for science and technology transition and identify the challenges it presents.

SUMMARY: The DoD is burdened by an integrated defense acquisition, technology, and logistics life cycle management system that is designed to acquire large-scale systems such as ships. As such, the process can take years to complete. The DoD acquisition system is therefore at odds with transitioning rapidly-evolving technologies produced by industry. A new process is needed to support transitioning such technologies.

THESES DIRECTED:


REAL CALLER ID

OBJECTIVE: Develop a passive caller ID and forwarding system for cellphone users.

SUMMARY: A cellphone user should be able to move from one cellphone to another and yet be reachable through their fixed public phone number. The Real Caller ID project aims to provide this capability.

PRESENTATIONS:

Real Caller ID Project, Military Wireless Consortium, Naval Postgraduate School, July 2010.
A REVOLUTIONARY 4D APPROACH TO NETWORK-WIDE CONTROL AND MANAGEMENT

Geoffrey C. Xie, Professor
Department of Computer Science
Sponsor: National Science Foundation

OBJECTIVE: IP networking is a spectacular success, catalyzing the diffusion of data networking across academic institutions, governments, businesses, and home, world-wide. Yet, despite the fundamental importance of this infrastructure, today’s networks are surprisingly fragile and increasingly difficult to configure, control, and maintain. As our dependency on data networking grows, so do the risks of security breaches, large scale outages, and service disruptions.

The networking research community has responded vigorously to address these challenges, resulting in better understanding of the limitations of existing IP network control and management capabilities, ranging from inherent ambiguities that arise in interdomain routing, to poor convergence properties, to inadequate traffic, topology, performance and fault monitoring, to porous security, and to weak traffic engineering. Where partial solutions have been found, a fundamental insight was the importance of network-level (as opposed to box-level) views and capabilities.

However as IP networks continue to grow in size and heterogeneity, partial solutions and ad hoc mechanisms will undoubtedly perpetuate the substantial problems seen in current networks and will further erode overall robustness. What is needed is a comprehensive solutions, based on sound principles, to ensure the design and operation of robust, evolvable and secure IP networks. The proposed research program addresses these challenges through a large-scale effort, bringing together a team that combines both theoretical and experimental expertise in data network design and operations. Using a clean-slate approach, the team will explore a number of fundamental questions related to network control and management. The focus of the research agenda is on IP (layer-3) networks, though we intend to create networking primitives and services that apply equally well to other technologies, such as layer-2 networks (e.g., Ethernet networks). The starting point for the work is a small set of principles, guiding the control of the network: network-wide views, network-level objectives, and direct control. These principles lead us to a refactoring of network functionality into four components—the data, discovery, dissemination, and decision planes. Via this architecture, which we term the 4D approach to network control and management, the team intends to create, prototype, and demonstrate breakthrough mechanisms that will dramatically simplify and strengthen data networking.

AN ABSTRACTION DRIVEN APPROACH TO CHARACTERIZING AND DESIGNING NETWORKS WITH ANALYZABLE PROPERTIES

Geoffrey C. Xie, Professor
Department of Computer Science
Sponsor: National Science Foundation

OBJECTIVE: We develop a set of network wide abstractions to capture the performance, security, manageableability, and resilience objectives in the design and operation of enterprise networks and evaluate the feasibility of building a top-down network design system that uses the abstractions to model operator intent and derive box level configurations.

SUMMARY: We made the following progress in CY 2010:

Formulated a general theory for reasoning about the safety of complex routing designs where multiple routing protocols instances are deployed.
Developed new methods to significantly reduce the number of probes required for mapping the Internet topology without sacrificing the fidelity.

**PUBLICATIONS:**

*Referred Conference papers*


**BEHAVIOR ANALYSIS OF NETWORK TRAFFIC**

*Geoffrey C. Xie, Professor*

*Department of Computer Science*

*Sponsor: DISA*

**OBJECTIVE:** This research will explore ways of distinguishing the usage of certain applications (e.g., streaming video) from logs of network traffic flows.

**SUMMARY:** We made the following progress in CY 2010:

Developed and tested a method to estimate the amount of HTTP based video streaming traffic on a network from Cisco Netflow traffic records collected on that network.

**THESES DIRECTED:**


**INTEGRATING CELL PHONE TECHNOLOGY WITH MARINE CORPS TACTICAL NETWORKS**

*Geoffrey C. Xie, Professor*

*Department of Computer Science*

*Sponsor: USMC MARCOSYSCOM*

**OBJECTIVE:** This research will explore the idea of wirelessly connecting smart phones to a Marines Corps tactical radio network. The Marine Corps communication infrastructure will be explored mainly due to readily available subject matter expertise; however the results from the research will be applicable to all U.S. military services. Several approaches are possible to incorporate the smart phone capabilities into our current infrastructure. However, each configuration will incur a different cost. The purpose of the research will be to explore the possible solutions and illustrate each option with associated costs.

**SUMMARY:** We made the following progress in CY 2010:

Developed and evaluated four different options for integrating commercial cellular handsets with current tactical radio networks.

Hosted two 2-day workshops to foster the exchange of ideas among commercial technology vendors, program managers from DoD offices, and researchers from universities and DoD laboratories.
PUBLICATIONS:

*Referred Conference papers*


THESES DIRECTED:


COMPUTER SCIENCE


EDITORIALS


BOOKS


CONTRIBUTIONS TO BOOKS


MANUALS & PUBLISHED COMPUTER PROGRAMS

AFFLIB

bulk_extractor

CyberCIEGE

fiwalk

CONFERENCE PUBLICATIONS & PROCEEDINGS


Driskell, S., Murphy, J., Michael, J. B., and Shing, M., “Independent Validation of Software Safety Requirements for


CONFERENCE PRESENTATIONS WITHOUT PAPER


**TECHNICAL REPORTS**


DEFENSE ANALYSIS

OVERVIEW:
The Department of Defense Analysis is home to two unique, interdisciplinary graduate programs, drawing on a wide range of academic specialties. The program provides a focused course of instruction on the dynamics of irregular warfare/sub-state conflict, including terrorism, counter-insurgency, unconventional warfare, stability operations, information operations, and other “high leverage” operations in U.S. defense and foreign policy. The core program also provides every student with a strong background in strategic analysis, international relations and comparative politics, organization theory, and formal analytical methods. The Department’s mission is to prepare the Department of Defense’s future leadership with the critical thinking skills necessary to prepare for the complex operating environments of the 21st century.

CURRICULUM SERVED:
• U.S. Special Operations Forces
• Combating terrorism fellowship program-sponsored international officers
• DoD information operations professionals
• Select U.S. conventional forces officers

DEGREES GRANTED:
• Master of Science in Defense Analysis
• Master of Science in Information Operations

RESEARCH THRUSTS:
• Special Operations
• Irregular Warfare (includes terrorism, counter-insurgency, and unconventional warfare)
• Information Operations
• Defense and Foreign Policy

RESEARCH CENTERS:
• Center on Terrorism and Irregular Warfare
• Common Operational Research Environment (CORE) Lab
• DoD Information Operations Center for Excellence (the Center is affiliated with the Department of Defense Analysis, the Department of Information Sciences and the Cebrowski Institute)

RESEARCH CHAIR:
• Special Operations Chair
• Intelligence Chair
The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Defense Analysis is provided below:
DEFENSE ANALYSIS

Gordon H. McCormick
Chairman
831-656-2933
gmccormick@nps.edu

John Arquilla
Professor
831-656-3450
jarquilla@nps.edu

Michael Freeman
Assistant Professor
831-656-3731
mefreema@nps.edu

Mike Richardson
LTC, USA
Military Faculty
831-656-2991
mrichard@nps.edu

Leo Blanken
Assistant Professor
831-656-7786
lblanken@nps.edu

Frank Giordano
Professor
831-656-7500
friorda@nps.edu

Glenn E. Robinson
Associate Professor
831-656-2710
grobinson@nps.edu

Douglas Borer
Associate Professor
831-656-2117
daborer@nps.edu

Brian Greenshields
Senior Lecturer & Associate Chair
831-656-3998
bhgreens@nps.edu

Hy S. Rothstein
Senior Lecturer
831-656-2203
hsrothst@nps.edu

Nancy Ann Budden
Director, Defense Counter Terrorism Technology
831-656-3332
nbudden@nps.edu

Heather Gregg
Assistant Professor
831-656-3689
hsgregg@nps.edu

Kalev Sepp
Senior Lecturer
831-656-2116
kisepp@nps.edu

Dorothy Denning
Distinguished Professor
831-656-3105
dedenning@nps.edu

Michael Jaye
Associate Professor
831-656-2536
mijaye@nps.edu

Anna Simons
Professor
831-656-1809
asimons@nps.edu

Sean Everton
Assistant Professor
831-656-2023
sfeverto@nps.edu

George Lober
Senior Lecturer
831-656-1019
gwlober@nps.edu

David Tucker
Associate Chairman & Associate Professor
831-656-3754
dtucker@nps.edu

William Fox
Professor
831-656-3753
wpfox@nps.edu

Nancy Roberts
Professor
831-656-2742
nroberts@nps.edu
DEFENSE ANALYSIS

IRANIAN FUTURES WORKSHOP, I
John Arquilla, Professor
Department of Defense Analysis
Sponsor: SOCCENT

OBJECTIVE: The Naval Postgraduate School Information Operations Center and the Department of Defense Analysis faculty will gather a distinguished group of approximately thirty practitioners and scholars in a structured conference to crystallize or thinking on Iran futures. The construct of the conference will be to examine several future scenarios with regards to the Iranian Regime and determine indicators and warnings that would likely have been evident leading up to these future events. This will provide key insights for planners and policy makers as they consider the development future options.

NETWORK WARFARE: WHAT'S NEXT?
John Arquilla, Professor
Department of Defense Analysis
Sponsor: SOCCENT

OBJECTIVE: Networks themselves, the principal drivers of netwar, and relatively new organizational forms that are still not particularly well understood. Yet defeating them requires understanding them, mapping them, and learning how to target their various links and nodes. Like the tip of an iceberg, the visual components of networks may appear insignificant, but there is always plenty going on beneath the surface - both in friendly and hostile networks. One of our principal tasks is to learn to explore these nether regions better, as deeper understanding of our networked foes, and of our own networking capabilities will likely be the key to developing an ability to influence network decision-makers - and will greatly inform and enliven our own strategies.

WINNING IN AFGHANISTAN - SEPARATING ILLUSION FROM REALITY
John Arquilla, Professor
Department of Defense Analysis
Sponsor: DOD Washington Headquarters Services

OBJECTIVE: The purpose of this study is to answer the many questions raised above and more importantly, to develop a range of options to achieve our objectives in Afghanistan effectively and efficiently.

DEFENSE COUNTER TERRORISM TECHNOLOGY
Nancy A. Budden Director, Defense Counter Terrorism Technology
Department of Defense Analysis
Sponsor: Office of the Assistant Secretary of Defense for Homeland Defense

OBJECTIVE: The purpose of this project is to promote and support the development, demonstration, and rapid transition of counter terrorism technologies in response to critical Department of Defense (DoD) requirements. The Naval Postgraduate School will provide a term civil service position to act as the Director for Defense Counter Terrorism Technology (DDCTT) under the Rapid Reaction Technology Office, DDR&E.
OBSTRACT: In the Fall of 2009, I took over from Doug Borer as one of the co-directors of the CORE Lab and continued in this role in 2010. The CORE Lab functions as part of the Center for Terrorism and Irregular Warfare (CTIW) and the Defense Analysis Department. It seeks to support field operatives engaged in irregular warfare through education, research, beta testing of hardware and software and command outreach. While the CORE Lab is involved in several projects, I am actively involved in the following:

CTF Fellowship Program: This project enables CORE to educate international students on the most recent academic methodologies and unclassified analytical technologies available for gaining a broader and deeper understanding of the operational environment. Focused at the strategic and operational level, CORE Lab courses prepare international military officers and government officials to analyze the threats to their country and the resources they have available to combat these threats. Graduates will be able to serve as advisors to decision makers at all levels of the military and government on terrorism and insurgency, and to assist in the design of national, regional, service and unit anti-terrorism, and counter-insurgency plans.

OpenFIST (Open Field Information Support Tool): The Open Field Information Support Tool (OpenFIST), which was developed in the CORE Lab at the Naval Postgraduate School and was recently field tested in Afghanistan, uses form-based data input to guide untrained operators through collection of all types of data, including social network data. These data are then secured by a management information system that enables information to flow from the collection point to analysts in near real-time, regardless of location or physical proximity. The system then exports the data into formats ready for geospatial, link, social network and other types of analysis.

One of the CORE Lab’s former students (CW3 Chad Machiela) recently coordinated the collection of relational, geospatial and other ethnographic data from four different Afghan villages and districts by himself and several other untrained operators using FIST-enabled smart phones over a three-month period as part of the village stability operations in Afghanistan. The resulting dataset includes up-to-date and accurate relational data on several hundred individuals and organizations (i.e., business, kinship, organizational, personal, and tribal affiliations) in addition to standard demographic data.

In a very short period of time (approximately three weeks) their collection efforts in and analysis of the Khahrez District (located in northern Kandahar Province) identified as the community’s most central actor an individual who is a Taliban sympathizer and (not surprisingly) unsympathetic to efforts by the U.S. to reduce the Taliban’s influence in the area. This individual’s centrality was not “news” to the local forces, but our former student was able to identify this individual in a much shorter period of time. Furthermore, the same analysis also provided the local forces with an array of possible non-coercive strategies that would decrease this individual’s influence by elevating the centrality of others in the community who are more sympathetic to the village stability operations. This part of the analysis was “news” to the local forces. The field test was deemed to be so successful that the OpenFIST device will field tested in 20 additional Afghan villages beginning in April of 2011.

IW-Philippines Project: Since 9/11, the United States has pursued two fundamentally distinct military approaches to combat terrorism and insurgencies: direct and indirect. Direct strategies are those that emphasize destruction of an enemy’s capacity to fight, by using kinetic means (the clash of arms) to “find, fix, and finish,” the enemy’s war-making machine (personnel, weapons, communications gear, supplies, etc). Indirect approaches are those that emphasize the degrading of the enemy’s will to fight, by focusing on the material, cultural, and spiritual needs of the relevant population, a population which serves as the fundamental support element for terrorists and insurgents. In the battle against Philippine Islamist extremists (e.g., Jemaah Islamiyah, Abu Sayyaf Group, Raja Solaiman Group, Moro National Liberation Front, Moro Islamic Liberation Front), the Government of the Philippines, strongly supported by the United States, has pursued a mix of both approaches, but to a much greater extent, the emphasis has been on indirect methods rather than direct action. If judged in terms of outcomes, for the most part, the Philippines is a relative success story in the GWOT. JI and ASG have been seriously degraded, most members of RSM have been
DEFENSE ANALYSIS

captured or killed; and on Mindanao, the peace process between the government of the Philippines and the MNLF/MILF has moved forward. However, despite this relative success, this story has not been robustly studied by analysts from either a theoretical or an empirical perspective. The CORE Lab’s Philippine project will do both.

Our goal in this project is to identify and the various determinants (and non-determinants) of conflict and the conditions under which direct and indirect IW strategies are effective. Building upon previous research that collected and analyzed Philippine insurgency data from 2001-2004, this project will eventually analyze an additional 26 years of additional data from the Philippines, affording us thirty years of temporal data (1978-2008). In addition, relational and geospatial data at the individual and insurgency level will enable us to combine various types of analytic approaches. In particular, such data will allow us to test alternative theories of irregular warfare through statistical analysis (e.g., pooled time series, survival analysis), empirical investigation (e.g., social network analysis) and comparative case studies.

The project’s first analysis was presented by myself and two CORE Lab RAs in February 2011 at Sunbelt XXXI, the annual meeting of the International Network for Social Network Analysis (much of the preparation occurred in 2010).

In addition, I served as a regular reviewer of manuscripts for the journal, Sociological Perspectives and joined the journal’s editorial board in January 2010.

MODELING POSITIVE DONORS FOR A BONE AND TISSUE BANK
William P. Fox, Professor
Department of Defense Analysis
Sponsor: Unfunded

OBJECTIVE: To determine the probability of a positive outcome at the bone and tissue bank.

SUMMARY: Data was provided on numerous variables of 1053 donors. Among these variables were gender, age, body mass index, race, trauma, postmortem, positive or negative results among many tests of blood, tissue, and bone. The purpose of this model is to provide a probability for a donor having positive results based upon this sample of donors. More specially, a 95% confidence interval is provided for this probability estimate. Doctors and directors of donor banks are expected to interpret the results of the model. The model provides quantitative information to enable the call as to whether or not to proceed to harvest the donated items.

RENAAL CELL CASE STUDY FOR SURVIVABILITY
William P. Fox, Professor
Department of Defense Analysis
Sponsor: Unfunded

OBJECTIVE: To build a mathematical model for the survivability of patients with renal cancer

SUMMARY: In survival analysis we are interested in the time interval between entry into the study and an event. The outcome of interest is time to an event. Survival analysis was originally developed for studying time from commencement of treatment until death. This was commonly used for evaluating treatment efficacy in fatal conditions like cancer. Hence the name. But survival analysis is applicable to many other situations in addition to mortality. For example, commencement of Hormone Replacement Therapy and thrombotic episode; time to exercise to maximum tolerance; exclusive breast feeding and time to another pregnancy; time for leg fracture to heal; and so on. By convention one mentions survival data and survival analysis in all such cases regardless of the nature of the event. In industry the same approach is used to test the reliability of appliances. Here the outcome of interest is time to breakdown. Hence some computer packages (e.g. Minitab) refer to the procedure as reliability analysis.
DEFENSE ANALYSIS

LINEAR AND NONLINEAR OPTIMIZATION IN NON-ZERO SUM GAMES IN GAME THEORY

William P. Fox, Professor
Department of Defense Analysis
Sponsor: Unfunded

OBJECTIVE: To show how to use Linear Programming in Non-Zero sum games and how to apply the Kuhn-Tucker conditions to obtain the Nash Arbitration point. After asking Dr. Nash a few question followed by emails of my idea to John Nash and an email with Harold Kuhn (from KT Conditions fame) I wrote the paper and had it published. LP has been used for Zero-Sum games but not Non-Zero sum games. I created the LP formulation for each player and discuss how to solve the game. This is valuable for larger or complicated games. Further, I employed non-linear programming to solve the Nash Arbitration.

SENSING AND IDENTIFICATION OF PERSONS AND/OR ANIMALS WEARING WIRES FOR DETONATION

William P. Fox, Professor
Department of Defense Analysis
Sponsor: Unfunded

OBJECTIVE: Our objective was to build mathematical models to show the feasibility of detecting person wearing wires for detonation.

SUMMARY: This Joint IED Defeat Organization research project jointly executed by the Naval Postgraduate School and the University of California-Santa Cruz examined the ability to sense and identify people carrying wires on their body for IED detonation. Previous Army Research Laboratory research on sensing people with weapons behind walls as instrumental in providing a framework for analysis.

Our research effort began with background research into the problem not from the standpoint of suicide bombing but from the direction of using radars as a detection device for humans wearing wires. ARL research showed ways to use radar backscatter to detect humans with weapons behind walls.

We spent a lot of time developing NEC simulations for the human body and tested theory. We used a GunnPlexer Doppler radar to collect experimental data from a standoff distance of approximately 50 meters so human subjects, human subjects wearing a wire loop, human subjects wearing a simulated vest with wire loops. We performed numerous experiments and analyzed the data after each experimental run.

One purpose of this experimental data collection analysis was to find metrics that could be used in building models to test detection rates. We found several metric that improved one’s ability to detect person’s wearing wires. The best metric was the VV/HH ratio of radar cross section. From our empirical modeling, we found that the ratio for people wearing wires was statistically different from people without wires at a level of significance $\alpha = 0.05$. Using that metric, we build a simulation model that generated a crowd of people and randomly picked those with wires on their person. We used our metric and a threshold value, which we determined experimentally, to distinguish the persons with wires form those without wires. The simulation picked the person with wires with a success rate of 0.834 or 83.4% based from running 1,000 trail runs thirty six times. The rate of false alarms, the model picking people who were not wearing wires as suspects wearing wires was about 0.22 or 22% of the time. We also found that a frequencies near 1 GHz radar cross section was a useful metric.

THESES DIRECTED:

DEFENSE ANALYSIS

ANALYSIS OF RESPONSE TIME FOR BEHAVIORS
William P. Fox, Professor
Department of Defense Analysis
Sponsor: Unfunded

OBJECTIVE: Our objective was to build mathematical models to show if the response times were different.

SUMMARY: Built two statistical models to help prove the hypothesis and analysis of the data for MUSC. Work done with Dr. James B. Fox, Chief Resident.

WIKI-BASED SOCIAL NETWORKING FOR COMBATING TERRORISM PROFESSIONALS
Michael Freeman, Assistant Professor
Department of Defense Analysis
Sponsor: OSD, Combating Terrorism Fellowship Program

OBJECTIVE: Assist the United States government’s ongoing effort to address the challenges of global security by providing the world’s leading forum for state-of-the-art knowledge about all aspects of combating global terrorism, discussing international best practices and current events in global defense and security, and providing the host social and professional networking tools to international defense and security professionals. This forum will be fully integrated with the Combating Terrorism Fellowship Program (CTFP), and be accessible to defense and security professionals from all over the world, including locations with limited bandwidth and limited computing capabilities.

BUILDING AND SUSTAINING INTERNATIONAL SECURITY RELATIONSHIPS THROUGH WIKI-BASED SOCIAL NETWORKING AND INSTANT INTERACTIVE APPLICATIONS
Michael Freeman, Assistant Professor
Department of Defense Analysis
Sponsor: OSD, Combating Terrorism Fellowship Program

OBJECTIVE: To develop and deliver a fully functional and secure online forum devoted to attracting and retaining the involvement of international defense and security professionals (military and civilian) that utilizes user input to continually embody worldwide state-of-the-art knowledge about combating terrorism.

3RD ANNUAL CTFP/NPS ALUMNI EVENT AND CONFERENCE
Brian Greenshields, Senior Lecturer
Department of Defense Analysis
Sponsor: Counter Terrorism Fellowship Program/NETSAFA - Country Program Manager

OBJECTIVE: The academic purpose of the symposium is to re-engage CTFP alumni from the USCENTCOM, USAFRICOM, and USEUCOM regions in dialogue on key issues affecting the global CT campaign.
DEFENSE ANALYSIS

IDENTITY AND DATABASE CHALLENGES FOR FORCE PROTECTION
Brian Greenshields, Senior Lecturer
Department of Defense Analysis
Sponsor: Defense Manpower Data Center

OBJECTIVE: The Defense Manpower Data Center (DMDC) maintains records on Department of Defense personnel in dozens of databases containing over 40 million records. Threats to DMDC data are external and internal, some intentional, and some inadvertent. This research, under the auspices of Team Monterey Phase II, at NPS will focus on three primary areas: the identification of threats to selected subgroups of individuals for whom records are maintained in the DMDC databases, analysis of the costs of data and transitively population exposure, and threat mitigation through a combination of technical and procedural countermeasures.

DATA, ANALYSIS, AND IMPLEMENTATION OF HUMINT IN THE CULTURAL GEOGRAPHY MODEL
Heather Gregg, Assistant Professor
Department of Defense Analysis
Sponsor: TRAC Monterey

OBJECTIVE: This research plans to use interviews with military personnel who have worked with gathering, vetting, or using human intelligence (HUMINT) to build algorithms into TRAC-Monterey’s Cultural Geography (CG) computer simulation model. The CG model aims to improve war-gaming for Irregular Warfare (IW) and, in particular, better predict populations’ behavior and actions in IW, including the conditions under which the population is willing to provide actionable HUMINT.

DEFENSE ANALYSIS INSURGENCY AND MANHUNTING PROJECTS
Gordon H. McCormick, Professor
Department of Defense Analysis
Sponsor: Deputy Undersecretary for Rapid Technology

OBJECTIVE: This project builds a dynamic model of insurgency that clearly defines the variables, parameters, and relationships that shape the outcome of insurgent competitions.

GAME-THEORETIC APPROACHES TO DETERRENCE
Gordon H. McCormick, Professor
Department of Defense Analysis
Sponsor: AFORSR/NL

OBJECTIVE: We propose to examine the problem of deterring state actors. We are interested in several sets of problems that have not been closely considered in the deterrence literature: 1) the ways in which the deterrence problem is complicated when one is facing three or more players, 2) the ways in which cultural and other player specific attributes can influence the expected success of a deterrence program, and 3, the role that bluffing plays in the strategies of players who wish to both implement and circumvent deterrent threats. Our approach has a theoretical, empirical, and experimental component. The resulting products will advance our understanding of deterrence in complex environments.
DEFENSE ANALYSIS

COMMON OPERATIONAL RESEARCH ENVIRONMENT (CORE) LAB PROGRAM
Nancy Roberts, Professor
Department of Defense Analysis
Sponsor: Deputy Undersecretary of Defense for Rapid Technology

OBJECTIVE: NPS proposes to establish a Common Operational Research Environment (CORE) program within the Center for Terrorism and Irregular Warfare (CTIW). The intent of this program is to leverage analytical technologies to educate the officer corps on how to apply theoretical concepts to the problems of terrorism and irregular warfare.

CORE LAB AND SKOPE SEMINAR SUPPORT
Nancy Roberts, Professor
Department of Defense Analysis
Sponsor: SAF/FMBIB

OBJECTIVE: SKOPE would like to partner with CORE Lab to support continued research and seminars in support of its mission.

MINING AFGHAN LESSONS FROM THE SOVIET ERA
Nancy Roberts, Professor
Department of Defense Analysis
Sponsor: ONR

OBJECTIVE: We propose to conduct a systematic analysis of formerly classified Soviet government Afghan war records -- now available at Stanford University’s Hoover Institution Library and Archives -- to provide US commanders with operationally useful practical insights. Results will elucidate what worked and did not, mistakes to avoid, how ongoing socio-political and battlefield situation as well as insurgent, population, government and other players have evolved, and what may be expected in ongoing situation based on the dynamics and lessons learned. The work will inform US operations and policy efforts toward ultimately supporting a US and ISAF success and ensuring that a lasting solution for peaceful and stable Afghanistan is achieved.

THREE CIRCLES OF WAR IN IRAQ
Glenn E. Robinson, Associate Professor
Department of Defense Analysis
Sponsor: OSD – Rapid Response and Technology Office

OBJECTIVE: My contribution to this project was to analyze identity politics in Iraq and how the 2003 conflict changed and was changed by the fluid nature of identity groups.

SUMMARY: Phase II of this project was to convert the research into book form, published by Potomac Books.

PUBLICATIONS:

“Iraq’s Insurgencies in Comparative Perspective” in Amy L. Freedman, ed., The Internationalization of Domestic Conflict.
DEFENSE ANALYSIS

JIHADI INFORMATION STRATEGY
Glenn E. Robinson, Associate Professor
Department of Defense Analysis
Sponsors: Joint Information Operations Curriculum

OBJECTIVE: To analyze jihadi information strategy, present findings in different forums, culminating in a Stanford University Press book.


PUBLICATIONS: Conference proceedings: MESA conference paper.

PALESTINIAN POLITICS
Glenn E. Robinson, Associate Professor
Department of Defense Analysis
Sponsor: Unfunded

OBJECTIVE: Continuing analysis of Palestinian politics.

SUMMARY: Three relevant publications on topic during CY 2009

PUBLICATIONS:

Book chapters:


Journal Article:

“Al-Aqsa Intifada 10 Years Later”, ForeignPolicy.com, October 18, 2010.

Review:


INFORMATION OPERATION (IO) RESEARCH, ANALYSIS AND OPERATIONAL SUPPORT TO OEF
Hy S. Rothstein, Senior Lecturer
Department of Defense Analysis
Sponsor: Office of Naval Research

OBJECTIVE: During the last year the US has sustained its greatest losses in Afghanistan since the war started in 2001. Monthly casualty rates in Afghanistan now exceed those in Iraq. This project involves developing and implementing IO through direct and frequent interaction with special operations units deployed for OEF. The ultimate goal is to undermine enemy operations and ensure U.S. forces maintain the initiative.
DEFENSE ANALYSIS

INFORMATION OPERATIONS (IO) TO DEFEAT COALITION ENEMIES IN OEF
FY09
Hy S. Rothstein, Senior Lecturer
Department of Defense Analysis
Sponsor: Deputy Undersecretary of Defense for Rapid Technology

OBJECTIVE: During the last year the US has sustained its greatest losses in Afghanistan since the war started in 2001. Monthly casualty rates in Afghanistan now exceed those in Iraq. This project involves developing and implementing IO through direct and frequent interaction with special operations units deported for OEF. The ultimate goal is to undermine enemy operations and ensure U.S. forces maintain the initiative.

IDENTITY AND DATABASE CHALLENGES FOR FORCE PROTECTION
David Tucker, Associate Professor
Department of Defense Analysis
Sponsor: Defense Manpower Data Center

OBJECTIVE: The Defense Manpower Data Center (DMDC) maintains records on Department of Defense personnel in dozens of databases containing over 40 million records. Threats to DMDC data are external and internal, some intentional, and some inadvertent. This research, under the auspices of Team Monterey Phase II, at NPS will focus on three primary areas: the identification of databases, analysis of the costs of data and transitively population exposure, and threat mitigation through a combination of technical and procedural countermeasures.

TEAM MONTEREY: ANALYSIS OF IDM SECURITY FOR GROUPS
RED TEAMING ADVERSARY CAPABILITIES AND MOTIVATIONS
David Tucker, Associate Professor
Department of Defense Analysis
Sponsor: Defense Manpower Data Center

OBJECTIVE: The Red Team effort will look at all adversarial threats to DMDC data. It will look at non-state actors (NSAs), both criminal and political (i.e., terrorists) and at state actors. In all cases, it will consider the insider threat.

SUMMARY: Phase 1 examined the non-state actor threat, both criminal and political. Phase 2 examined the value to DoD and its components of personnel data held by the Defense Manpower Data Center. The research report was classified at the request of the sponsor.
DEPARTMENT OF DEFENSE ANALYSIS

2010
Faculty Publications and Presentations
Arquilla, “The New Rules of War,” Foreign Policy (March-April)


DEFENSE ANALYSIS

EDITORIALS


BOOKS


CONTRIBUTIONS TO BOOKS


DEFENSE ANALYSIS


BOOK REVIEWS


MONOGRAPHS

Simons, A. Got Vision? Unity of Vision in Policy and Strategy: what it is, and why we need it, Strategic Studies Institute, July 2010.

CONFERENCE PUBLICATIONS & PROCEEDINGS


CONFERENCE PRESENTATIONS


Fox, W.P. “Sensing and Identifying People wearing wires for IED Detonation” (Update), Mathematical Association of America Joint Meeting, San Francisco, CA, January, 2010.


Fox, W.P. “Methodology for using existing technologies to detect suicide bombers” (with Binstock, Minutas), INFORMS, Austin, TX, November 8, 2010.

Fox, W.P. “Detecting Suicide Bombers Models” (with Vesecky, Laws), INFORMS, Austin, TX, November 9, 2010.

Fox, W.P. “Sensing and Identifying People wearing wires for IED Detonation” (Update), Mathematical Association of
DEFENSE ANALYSIS


Fox, W.P. “Modeling & Optimization with Game Theory”, ICTCM, March 2010


Fox, W.P. “Methodology for using existing technologies to detect suicide bombers” (with Binstock, Minutas), INFORMS, Austin, TX, November 8, 2010.

Fox, W.P. “Detecting Suicide Bombers Models” (with Vesecky, Laws), INFORMS, Austin, TX, November 9, 2010.


Jaye, M. “Docking Two Models of Insurgency Growth”, INFORMS, Dallas, TX.

Jaye, M. “Conceptual and Operational Validation of Two Insurgency Theories”, Human Social Culture Behavior (HSCB) Conference, Chantilly, VA.

Simons, A. “Asymmetries, Anthropology, and War,” Small Wars Workshop [prepared, not delivered] (Singapore)


Simons, A. “Rethinking Civic Action,” Reducing Insecurity in Africa conference (NPS)

MEETING ABSTRACT


DEFENSE ANALYSIS

DISCUSSANT


RESEARCH REPORTS

Simons, A. “Interoperability in an Irregular Warfare World” submitted to CTFP/OSD

PATENTS

INFORMATION SCIENCE

OVERVIEW:

The mission of the Department of Information Sciences is:

- To provide in-residence graduate education, as well as a continuum of career-long learning opportunities, in support of defense requirements in the areas of information sciences, systems, and operations.
- To maintain an internationally respected research program in selected areas of information sciences, systems, and operations and to develop research programs in additional areas of information sciences that are required to support graduate education.
- To provide expertise and support to the Department of Defense in all areas of information sciences, systems, and operations.

Some of the department’s research projects are as follows:

- C3F Science Advisor
- Forcenet Innovation and Research Enterprise (FIRE)
- Edison VKR TXC Web Service Integration
- Center for Edge Power
- Acquisition Research Program
- Joint Intelligence Virtual University (JIVU)
- Employing Community Models to Deliver Valued Information at the Right Time (VIRT)
- Community Models, Model-Based Communication, and VIRT
- High Precision UAV Target Location Refinement Experiment
- Terrain Database Generation Product Publication
- Coalition Operating Area Surveillance and Targeting System (COASTS)
- Iraqi Enrollment Voice Authentication Program (IEVAP)
- Collaborative Competence
- Management Value Added
- KVA+RO Analysis of Open Architecture Approach
- KVA+RO Software Implementation
- Cognitive Task Analysis of Intelligence Analysts
- Adaptive Architectures for Command and Control
- Joint Intelligence Interoperability Board System Baseline Assessment Project (JSBA)
- Network Centric warfare Acceleration (NCWA)
- Trident Warrior Fleet Experimentation (TW FLEX)
- Trident Warrior Sea Trials (TW ST)
- Joint Intelligence Operational Command (JIOC)

RESEARCH CHAIR:

- Command and Control Research Chair
The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Information Sciences is provided below:
INFORMATION SCIENCE

Daniel C. Boger
Chairman
831-656-3671
dboger@nps.edu

Tarek Abdel-Hamid
Professor
831-656-2678
tkabdelh@nps.edu

Wolfgang Baer
Research Associate Professor
831-656-2209
baer@nps.edu

Albert Barreto
Lecturer
831-656-3072
abarreto@nps.edu

Gregory Belli
Research Assistant
gbelli@nps.edu

Richard Bergin
Visiting Assistant Professor
831-521-6613
rdbergin@nps.edu

Alexander Bordetsky
Associate Professor
831-656-2287
abordets@nps.edu

Donald P. Brutzman
Associate Professor
831-656-2149
brutzman@nps.edu

Aaron Budgor
Research Professor

Raymond R. Buettner, Jr.
Associate Professor
831-656-3387
rrbuetttn@nps.edu

Glenn Cook
Senior Lecturer
831-656-2778
cgrcook@nps.edu

Dale M. Courtney
Lecturer
831-214-4353
courtney@nps.edu

Gus Crissman
Research Associate
757-836-7335
dccrissm@nps.edu

James Ehlerl
Research Associate & Director,
COASTS International Field
Experimentation Program
831-656-3002
jfehlert@nps.edu

Ray Elliott
Lecturer
831-656-2433
raelliott@nps.edu

Edward Fisher
Lecturer
831-656-3000
elfisher@nps.edu

Shelley P. Gallup
Research Associate Professor
831-656-1040
spgallup@nps.edu

Victor Garza
Lecturer
831-656-3608
vrgarza@nps.edu

Joshua Green
LTCOL, USAF
Lecturer
831-656-3635
jdggreen@nps.edu

Christopher Gunderson
Research Associate Professor
cgunderson@nps.edu

Rick Hayes-Roth
Professor
831-656-3983
fahayesr@nps.edu

Susan Higgins
Lecturer & Deputy Director
Cebrowski Institute
831-656-3596
shiggin@nps.edu

Fenn Horton
Research Professor
408-891-6132
fchorton@nps.edu

Thomas J. Housel
Professor
831-656-7657
fjhouesel@nps.edu

Susan Hutchins
Research Assistant Professor
831-656-3768
shutchins@nps.edu

Steven Iatrou
Senior Lecturer
831-656-3770
sjiatrou@nps.edu

Nelson J. Irvine
Research Assistant Professor
831-656-1007
njirvine@nps.edu

Erik Jansen
Senior Lecturer
831-656-2623
ejansen@nps.edu

Carl R. Jones
Professor Emeritus
831-656-2995
cjones@nps.edu

Magdi N. Kamel
Associate Professor
831-656-2494
mkkamel@nps.edu

Valery Kanevsky
Research Professor
831-656-7657
vakanevs@nps.edu
Anthony Kendall
Lecturer
831-656-3146
wakendal@nps.edu

David L. Kleinman
Research Professor
831-656-7627
dlkleinm@nps.edu

Erik Lowney
Research Assistant
831-656-2931
eslowney@nps.edu

Douglas J. MacKinnon
Research Associate Professor 831-656-1005
djmackin@nps.edu

William R. Maule
Visiting Assistant Professor
831-656-3376
rwmaule@nps.edu

Michael McAneny
Research Associate
703-601-0084
mcmcanen@nps.edu

Bryan McClain
Research Assistant
831-656-3737
bjmclain@nps.edu

Scott McKenzie
Research Associate
831-656-2931
samckenz@nps.edu

Sharon McNally
Research Assistant
831-656-7796
smcnall@nps.edu

Mark E. Nissen
Professor, Command and Control
Research Chair, & Director Center for Edge Power
831-656-3570
mnissen@nps.edu

Carl L. Oros
LTCOL, USMC
Research Associate
831-656-3554
cloros@nps.edu

John S. Osmundson
Research Associate Professor
831-656-3775
josmundson@nps.edu

William (David) Place
Research Associate
831-656-7796
wdplace@nps.edu

Karl D. Pfeiffer
LTCOL, USAF
Visiting Professor
831-656-3635
kdpfeiff@nps.edu

Waymond Rodgers
Research Professor
943-300-7766
wrodgers@nps.edu

William (Bill) Roeting
Research Associate Professor
412-716-4189
broeting@nps.edu

Robert Schulz
Research Assistant
310-738-2061
dsmith@nps.edu

Riqui Schwamm
Research Assistant
rschwamm@nps.edu

Kishore Sengupta
Associate Professor
831-656-3212
kishore@nps.edu
INFORMATION SCIENCE

INFORMATION SHARING FOR MEDICAL TRIAGE TASKING DURING MASS CASUALTY AND HUMANITARIAN OPERATIONS

LCDR Lillian A. Aebuan, USN, Information Science Student
Department of Information Science
Sponsor: Space and Naval Warfare Systems Center-San Diego

OBJECTIVE: This thesis will focus on testing and evaluating the capabilities of smartphone-based system and associated equipment for “First Responder Networking.” With the use of smartphones as personal servers, data is instantly captured and disseminated in support of first responder operations during humanitarian and mass casualty operations. By using this handheld based infrastructure, patient information and records can be rapidly passed to those involved within the Mobile Emergency Command Post unit and the Joint Operations Command Center for further backhaul communications from the disaster site to other medical facilities across a globally distributed network, for example, lead based military medical units. Naval hospital ships, stateside medical centers via tele-medicine, etc.

This thesis will concentrate on identifying information sharing requirements for supporting a medical triage tasking during mass casualty and humanitarian operations. These requirements will be implemented, tested and evaluated through the capabilities of the TwiddleNet system from secure passing/sharing of patient information and records for further packhaul communications from the disaster site to other medical facilities across a globally distributed network. The applicability of these efforts to the DoD will be specifically tested as an integrated experiment in the Cooperative Operations and Applied Science & Technology Studies (COASTS) 2009. Students and faculty from the Naval Postgraduate School (NPS), supported by the Office of Naval Research Reservist and numerous commercial partners, hosted by international organizations from South East Asia, will conduct a series of experiments and demonstrations in the United States and Thailand in support of all Coasts humanitarian operations / mass casualty scenarios.

IMPROVED TERRAIN GENERATION FROM UAV SENSORS

Wolfgang Baer, Research Associate Professor
Department of Information Science
Sponsor: Navy Modeling and Simulation Office

OBJECTIVE: This project enables augmented reality applications in tactical environments by solving the image geo-registration problem using a unique and newly developed model-image feedback algorithm to achieve sub-meter accuracies between current and new data. The task supplies a method for enhancing old terrain representations with new data derived from inexpensive UAV or helicopter mounted sensors. In addition the technique will provide a rapid general method for accurately comparing new imagery with old pictures by correcting for lighting, position and aspect distortions inevitably found in successive ISR sensor scans.

INTEROPERABILITY STANDARDS COST EFFECTIVENESS ANALYSIS TOOL (PHASE II)

Wolfgang Baer, Research Associate Professor
Department of Information Science
Sponsor: Navy Modeling and Simulation Office

OBJECTIVE: There is an absence of quantitative metrics and measures that can help us evaluate the cost effectiveness of implementing interoperability standards. In the absence of such metrics standards are being implemented because “we all know they are good and necessary” not because we have a clear guide as to when and how such implementations will save us time and money. The first phase of this research has provided a mathematical cost model for standards implementation along with a set of standards criteria required to execute the model.

The goal of this phase II research is twofold First, to test a cost and benefits model that has been developed in previous years against a set of actual standards and verify the accuracy of the cost estimates as well as the algorithmic ease of use for the questions and parameter defined in that model. Second, to expand the cost model include the case of
adding a single node to an existing standard. Thirdly, to automate the mathematical calculations and criteria gathering tasks in a prototype software tool that can be applied by decision makers in order to help them evaluate the cost of implementing specific interoperability standards.

**IMAGE EXPLOITATION AND UAV MISSION CONTROL SYSTEM**

_**Wolfgang Baer, Research Associate Professor**_

_Department of Information Science_

_Sponsor: U.S. Joint Forces Command_

**OBJECTIVE:** This project provided prototype integration, enhancement, and testing the PVNT (Perspective View Nascent Technologies) image exploitation systems to perform battlefield database update, ISR, and multiple UAV mission control functions. This system controls UAV image gathering missions and exploits the resulting data stream for target identification, tracking, and data product generation to operational systems in the field. Of equal importance is the testing and extension of software functions required to deliver UAV support to tactical ground units in the form of Call-in, Forward Observer, Convoy commander, ISR and look-ahead services for dismounted operations. Included in our proposal is the continued development of UAV simulator and training system designed to generate realistic UAV image and telemetry reports required to test downstream command and control equipment.

**CAL FIRE MESH NETWORKING & FIRE BOUNDARY TRACKING**

_**Alex Bordetsky, Associate Professor**_

_Department of Information Science_

_Sponsor: DHS_

**SUMMARY:** Explore feasibility and major constraints related to developing:

- Situational Awareness on firefighter and boundary locations and mesh networking with firefighters,
- Collaboration between the Incident Command Center and National Center with fire dispersion modeling capabilities,
- Integrated aerial video, ground tag, and weather sensor based awareness on fire boundary dynamics.

**CENETIX-TNT EXPERIMENTATION SUPPORT AND NETWORK MANAGEMENT FOR USMC RPV PROJECT**

_**Alex Bordetsky, Associate Professor**_

_Department of Information Science_

_Sponsor: USMC - MARCORSYS_

**SUMMARY:** The primary objective for this project is to provide tactical level experimentation infrastructure for the PISR-RPV system, and conduct first RPV focused field experiment based on CENETIX TNT testbed and quarterly experiments. The second goal is to start developing Adaptive Network Management and Control Architecture in accordance with 8th Layer concept and RPIVT functional attribute requirements.

**FIELD EXP PROGRAM – USSOCOM (FEPSO)**

_**Alex Bordetsky, Associate Professor**_

_Department of Information Science_

_Sponsor: USSOCOM_

**SUMMARY:** Integrating and operating TNT testbed, conducting tactical cellular, bandwidth adaptation, battlefield medical, and network-controlled parafoil experiments. Supporting SOCOM Mission-Based and Capability-Based integrated scenarios.
INFORMATION SCIENCE

FIELD EXPERIMENTATION PROGRAM - IT
Alex Bordetsky, Associate Professor
Department of Information Science
Sponsor: USSOCOM

SUMMARY: Integrating and operating TNT testbed, supporting number of sensor-unmanned systems-operator experiments.

LOW VISIBILITY DETECTOR NETWORKING
Alex Bordetsky, Associate Professor
Department of Information Science
Sponsor: Defense Threat Reduction Agency

OBJECTIVE: The main objective for this project is to explore new operationally viable solutions for integrating nuclear radiological detection with low visibility self-forming mesh networking capabilities. It is expected that NPS graduate students experienced in Maritime Interdiction Operations and ISR missions will be conducting this study through field experimentation and under the guidance from Naval Postgraduate School (NPS) faculty and Lawrence Livermore National Laboratory (LLNL). The proposed research should address technology integration and operational challenges of ubiquitous low visibility networking with detectors, integration with mobile self-forming mesh networks, communications in denied areas, and encryption for low visibility communications. The research should also address challenges of maintaining persistent ISR to Maritime Domain Awareness by means of micro satellites and other ad hoc transient networks.

The goal is to establish multiple year sustainable student research, with first year of study focused on Ultra WideBand (UWB) networking with detectors, second year on integration with unmanned systems, and their year focused on transient networking solutions in both, Maritime and Urban domains. It is envisioned by the sponsor as a three year long project with 120K per year.

TNT – CENETIX STUDENT RESEARCH FOR USSOCOM
Alex Bordetsky, Associate Professor
Department of Information Science
Sponsor: USSOCOM

SUMMARY: This is the final phase of the earlier established project focused on transitioning findings of TNT and other SOCOM driven experimentation venues to the operational environment of SOCOM S&T Collaborative Network, ISR missions, and SONC GNCC battlefield network operation tasks.

TNT – MIO EXPERIMENTATION
Alex Bordetsky, Associate Professor
Department of Information Science
Sponsor: DHS/MDSRP

SUMMARY: The project goal is to continue exploring use of networks, advanced sensors, and collaborative technology for supporting integrated detection and interagency collaboration to counter small craft sourced nuclear radiological threat. From the technical standpoint, the experiment represents next step in the collective field studies of:
- Ad hoc mobile networking architecture, which integrates front line officers using hand-held, portable, and unmanned system based detectors with geographically distributed experts and data fusion centers,
- Information management architecture for sharing alerts on threats brought by small maritime craft or between land/ports of entry borders and translation of active and passive detection alerts into the shared situational awareness events.
INFORMATION SCIENCE

- The surveillance techniques enabling tagging the small craft carrying the illicit material, location and tracking of its global movement,
- Operational constraints and search models for stand-off and drive detection at high-speed, in combination with remotely network-controlled unmanned surface, aerial, and ground systems.

USMC M252X SYSTEM ANALYSIS
Alex Bordetsky, Associate Professor
Department of Information Science
Sponsor: USMC - MARCORSYS

SUMMARY: Apply CENETIX developed multiple criteria (PSI) technique for field experimentation results analysis, to study of the design gap in M252X system composition. Identify the critical factors leading to loss of structural strength during the field tests.

COASTS INTERNATIONAL FIELD EXPERIMENTATION PROGRAM
James Ehlert, Research Associate
Department of Information Science
Sponsor: U.S. Army Corp of Engineers (USACE)

SUMMARY: COASTS is a combined Indonesian-Malaysian-Singaporean-Thai-American research and development effort to test commercial-off-the-shelf command and control, communications computers and intelligence, surveillance and reconnaissance technologies to provide real-time situational awareness for multi-national, tactical and remote decision makers. The COASTS program also provides Use Case opportunities for technology field testing relevant to USACE in both domestic and international venues.

FIELD INFORMATION SUPPORT TOOL (FIST) PHILIPPINES
James Ehlert, Research Associate
Department of Information Science
Sponsor: Naval Sea Systems Command

SUMMARY: The FIST Philippines (FIST PH) project is a focused effort based on gathering and analyzing information to guide U.S. and Philippine actions for maintaining local security and stability and denying development of hostile activity as per a SOCPAC Capability Needs Statement. As per sponsor guidance, FIST PH will focus the initial application goals to include real-time and remote data collection for analysis of Military Geography (MG) including social network modeling, CA including infrastructure inspection, disaster preparedness and a popular assessment of U.S. funded in-country infrastructure via the USAID Tactical Conflict Assessment and Planning Framework (TCAPF).

FLEXIBLE ARCHITECTURE & SENSOR TOPOLOGY LICENSE PLATE RECOGNITION II (FAST LPR2)
James Ehlert, Research Associate
Department of Information Science
Sponsor: NSWC Dahlgren Division

SUMMARY: The increasing need for effective and easily dispersed measures to support tactical operations, counter-narcotic efforts and access control to borders and infrastructure will benefit from mobile and synergized multifunctional identity management capabilities including biometrics, asset/vehicle logging, force protection and alarming of suspicious elements.

This project will address how to fully integrate man portable biometric collection devices to a mobile, rapid deploy
identity management checkpoint solution to collect data on individuals with fusion to vehicles and assets. Additionally, and alarming capability for notifying a Tactical Operations Centers will be included. This proposal addresses two areas of interest to CNTPO underpinning a counter-narcotic nexus to include (1) License Plate Recognition, and (2) Mobile Tactical / Biometric Devices.

**PACIFIC ENDEAVOR 2010**  
James Ehlert, Research Associate  
Department of Information Science  
Sponsor: U.S. Pacific Command

**SUMMARY:** The NPS Pacific team, in partnership with staff elements across the USPACOM, will customize and deploy the Field Information Support Tool (FIST) in support of exercise PACIFIC ENDEAVOR 2010. The goal is to allow a multinational military first responder team (9 nations) to collect, aggregate, and disseminate field data from smartphones, i.e. pictures/video of the disaster area, location of hospitals and quantity of available beds, biometric data from victims, and etc., to a multinational command center to enable better crisis management and disaster response.

**C3F SEA TRIAL EXPERIMENTATION SUPPORT**  
Shelley P. Gallup, Research Associate Professor  
Department of Information Science  
Sponsor: U.S. Pacific Fleet

**OBJECTIVE:** The Department of Information Science, Naval Postgraduate School (hereafter, “Principal and Co-Investigators” or “NPS”) shall provide subject matter expertise to Commander Third Fleet during research and development of all aspects of material/concepts related to Sea Trial Experimentation.

**JOINT EXPEDITIONARY FORCES EXPERIMENT 2010-3 (JEFX10-3)**  
Shelley Gallup, Research Associate Professor  
Department of Information Science  
Sponsor: US Joint Forces Command (USJFCOM)

**OBJECTIVE:** The Naval Postgraduate School’s Distributed Information Systems Experimentation Group (NPS - DISE) is pleased to provide the Joint Battlespace Awareness ISR Integration Capability (JBAIIC) Test Bed support of the Air Force - Global Cyberspace Integration Center’s (GCIC) - Joint Fighting Information to the Tactical Edge (J-FITE) initiative for the Joint Expeditionary Forces Experiment 2010-3 (JEFX10-3) at the Dugway Proving Grounds (DPG) from 05 April 2010 to 30 April 2010.

**JOINT INTELLIGENCE OPERATIONS CENTER (JIOC) BUSINESS PROCESS MODEL**  
Shelley P. Gallup, Research Associate Professor  
Department of Information Science  
Sponsor: Naval Air Systems Command

**OBJECTIVE:** The Department of information Science, Naval Postgraduate School (hereafter, “Principal Investigator” or “NPS”) shall: research the current Joint Intelligence Operations Center (JIOC) enterprise requirements and concepts of employment, document JIOC information flow and products produced and perform a detailed architecture decomposition of a JIOC organization and develop a swim lane process model that highlights.
INFORMATION SCIENCE

JOINT INTELLIGENCE OPERATIONS CENTER (JIOC) OPERATIONAL USERS STEERING GROUP SUPPORT (OUSG)
Shelley P. Gallup, Research Associate Professor
Department of Information Science
Sponsor: Defense Intelligence Agency

OBJECTIVE: The Department of Information Science, Naval Postgraduate School (hereafter, “Principal Investigator” or “NPS”) shall support the JIOC OUSG to include: research, analyze, and prioritize JIOC operational requirements. In addition, NPS will work with the OUSG to define an end state capability and will utilize expertise to validate best practices and varying business processes across the JIOC enterprise.

JOINT MULTI-MISSION ELECTRO-OPTIC SYSTEMS (JMMES) OPERATIONAL TEST AGENT (OTA)
Shelley Gallup, Research Associate Professor
Department of Information Science
Sponsor: COMTHIRDFLT J9

OBJECTIVE: The Department of Information Science, Naval Postgraduate School (hereafter, “Principal Investigator” or “NPS”) shall perform Operational Test Agent (OTA) duties during research and development for the Joint Multi-Mission Electro-Optic System (JMMES) Joint Capability Technology Demonstration (JCTD) project.

NAVNETWARCOM INNOVATION AND EXPERIMENTATION PROGRAM
FORCENET LABORATORY EXPERIMENTS (FY 09-10)
Shelley Gallup, Research Associate Professor
Department of Information Science
Sponsor: Naval Network Warfare Command (NAVNETWARCOM)

OBJECTIVE: This proposal is to support NETWARCOM extension of FORCEnet Sea Trial experimentation to include Laboratory-based exercises. Two (2) experiments are currently scheduled, to be collectively referred to as Laboratory Experiments. The first experiment takes place in the Fall of 2009 with objectives development to begin 1 June. The second experiment will take place in the Spring of 2010. NPS will serve as the analysis lead for the experiments and this proposal is to support this effort.

JOINT MULTI-MISSION ELECTRO-OPTIC SYSTEMS (JMMES) OPERATIONAL MANAGER SUPPORT TO C3F
Shelley P. Gallup, Research Associate Professor
Department of Information Science
Sponsor: Naval Air Systems Command

OBJECTIVE: The Department of Information Science, Naval Postgraduate School (hereafter, “Principal Investigator” or “NPS”) shall perform Operational Manager (OM) duties for Commander Third Fleet during research and development for the Joint Multi-Mission Electro-Optics System (JMMES) Joint Capability Technology Demonstration (JCTD) project.
OBJECTIVE: The Department of Information Science, Naval Postgraduate School (hereafter, “Principal Investigator” or “NPS”) shall: assess JSBA-related study requirements and methodologies; research and develop the required JSBA architecture analyses; design, develop, organize, and maintain JSBA process model(s) and tools, and the associated data; execute model run activities, and analyze results. The Principal Investigator shall support development of mission threads & use cases for test and evaluation and provide analytical support to the JSBA team -ISR/Targeting architecture research and process model development that provides direct analyses for a variety of Intelligence, Surveillance, and Reconnaissance assessments as part of JSBA efforts.

NAVNETWARCOM INNOVATION AND EXPERIMENTATION PROGRAM, TRIDENT WARRIOR AND LIMITED OBJECTIVE EXPERIMENTS (FY 09)
Shelley Gallup, Research Associate Professor
Department of Information Science
Sponsor: Naval Network Warfare Command (NAVNETWARCOM)

OBJECTIVE: The Naval Postgraduate School (NPS) has provided direct support for experimentation and analysis in FORCEnet experimentation since 2003. This includes experiment design, planning, analysis, and reporting to the NETWARCOM FORCEnet Innovation and Experimentation Branch. This support has included collaborating with the FORCEnet Execution Center, N6F, SPAWAR, and Trident Warrior Initiative (Focus Area) Leads in the development of a detailed Trident Warrior Experimentation Process that ensures completeness and consistence across: objective development, experimentation questions to be answered, experiment design, metrics, scenarios, scenario events, data collection, experiment execution, analysis, reporting, and military utility assessment. In addition, NPS has developed and implemented a leading edge collaboration and enterprise capability, the FORCEnet Innovation and Research Enterprise (FIRE), to support experiment development, execution and reporting processes with effective knowledge management. A FORCEnet Functional Concept, various capabilities based assessments, and gaps provide a basis for FORCEnet analytic efforts. NPS is continuously involved in experimentation development, with NETWARCOM, OPNAV, SPAWAR and other stakeholders, to feed results from FORCEnet Sea Trial experimentation into the FORCEnet POM assessment, NCDP and JCIDS processes. NPS archives all FORCEnet experimentation data and results in FIRE, and makes FIRE data queries available to in the wider USN and military experimentation, research and acquisition community.

NETWORK-CENTRIC WARFARE ACCELERATION
Shelley Gallup, Research Associate Professor
Department of Information Science
Sponsor: OPNAV N6F

OBJECTIVE: The Office of the Chief of Naval Operations, Integration, Interoperability, and Transformation Branch (OPNAV N6F4) is focused on accelerating network centric warfare from concept to deployment. Informed by an understanding of the existing technical challenges and capability gaps, OPNAV N6F4 is responsible for shaping the Navy’s investment strategy in existing Communications and Computer Intelligence Surveillance & Reconnaissance (C4ISR) programs of record. Additionally, OPNAV N6F4 is responsible for identifying C4ISR technologies that are mature enough to move from the concept exploration/development stage to system demonstration and experimentation. The following tasks are in direct support of OPNAV N6F4.
INFORMATION SCIENCE

SAO FIELD EXPERIMENTATION
Shelley Gallup, Research Associate Professor
Department of Information Science
Sponsor: National Reconnaissance Office

OBJECTIVE: Task 1: Enhance the Field Research, Experimentation, and Analysis capability of SAO Field Experimentation Division through the application of rigorous knowledge management principals and methodologies as well as analytical best practices. Task 2: Maximize the exposure of current and future National Technical Means (NTM) capabilities at experimentation venues, e.g., Trident Warrior, Empire Challenge, Trident Spectre, Joint Expeditionary Forces Experimentation (JEFX), Bold Quest (BQ), etc. Task 3: Promote the use of NTM systems/data within the DoD and IC to satisfy their capabilities and requirements. Initial focus will be on tactical users. For this particular task, Mr. Roeting will report to the SAO Deputy Director. Task 4: Participate at the national level at the OSD Technical Support Working Group (TSWG) in support of Task 2 and 3. Task 5: Promote and coordinate NTM thesis research for Naval Postgraduate School graduate students.

TRANSNATIONAL INFORMATION SHARING COOPERATION (TISC) JOINT CAPABILITY TECHNOLOGY DEMONSTRATIONS (JCTD)
Shelley Gallup, Research Associate Professor
Department of Information Science
Sponsor: United States Southern Command

OBJECTIVE: The Department of Information Science, Naval Postgraduate School shall perform Transnational Information Sharing Cooperation (TISC) Joint Capabilities Technology Demonstration (JCTD) Operational Test Agent (OTA) responsibilities for the TISC Operational Manager (US Southern Command) and the TISC JCTD Integrated Planning Team (IPT)/Integrated Management Team (IMT) during research and development of the TISC project. This project extends through the remainder of FY 10.

TRIDENT WARRIOR 2010 EXPERIMENTATION (FLEET SUPPORT)
Shelley Gallup, Research Associate Professor
Department of Information Science
Sponsors: NETWARCOM / Fleet Forces Command / SPAWAR Systems Center – San Diego

OBJECTIVE: Filed experimentation for Fleet enabling technologies.

SUMMARY: Research methodology development including objectives, questions, measurements, and analysis framework for over 60 technologies. Included test sequence oversight, data collection, and analysis/reporting.

TRIDENT WARRIOR FY11 (EXPERIMENTATION, FLEET SUPPORT, SEA TRIALS)
Shelley Gallup, Research Associate Professor
Department of Information Science
Sponsors: NETWARCOM / Fleet Forces Command / SPAWAR Systems Center – San Diego

OBJECTIVE: This proposal includes activities related to all efforts in experiment design, data planning requirements, data collection, execution, analysis and reporting of Trident Warrior 2011 (TW-11) related experiments. Limited Objective Experiments and support activities. The Trident Warrior Experimentation Process developed to date will be further refined based on the TW-03 through TW-10 experience, and will provide the organizing framework for TW-11 design, planning, execution, data collection, analysis, reporting, and assessment.

140
INFORMATION SCIENCE

A significant portion of this work is interdisciplinary; with collaboration between NPS institutes (including faculty and student), SPAWAR, NAVSEA, ONR, NRL and other agencies, department and industrial partners engaged in Sea Trial experimentation through Trident Warrior.

RAPID PROTOTYPING VIRT: A PRODUCT-LINE ARCHITECTURE FOR PERSISTENT ISR SYSTEMS (DONE FOR MARCORSYSCOM)

Rick Hayes-Roth, Professor
Department of Information Science

Sponsor: Naval Research Laboratory (NRL) Comprehensive Maritime Awareness (CMA) JCTD

OBJECTIVE: 1. Assess and improve the CMA JCTD architecture and implementation. 2. Assess and improve the MIEM. 3. Assess and improve the methods for sharing maritime information within and between different agencies and international partners. 4. Assist in formulating, implementing, and improving alternative methods and technical approaches to high-risk research challenges in the CMA arena, including especially collaborative development of fusion case files.

MIEM TRANSITION AND MIEM EDITOR SUPPORT

Rick Hayes-Roth, Professor
Department of Information Science

Sponsor: SPAWARSYSCEN - San Diego

OBJECTIVE: NPS will support the SPAWAR-led team implementing the MIEM in enhancing the model, documenting it, adapting it for use with the NIEM, and making it effective for user communities. We will design, develop, and demonstrate tools for reading and editing MIEM documents to support intelligence analysts working in the MDA arena. We will provide these tools for users chosen in conjunction with SPAWAR. We will evaluate the usability and effectiveness of these tools and recommend appropriate follow-on tasks as appropriate.

SUMMARY: NPS will support the MIEM team at SPAWAR in transitioning the MIEM into successful use by customers designated by the transition team or SPAWAR. NPS will also support the MIEM team at SPAWAR in transitioning the MIEM into the maritime domain model of the NIEM, working in conjunction with collaborators designated by the NIEM Program Office. NPS will interact with various users of shared maritime intelligence information to improve our conceptual model and information sharing processes, as appropriate. NPS will design, develop, demonstrate and deliver to MIEM users tools for creating standardized MDA business documents based on MIEM and for viewing and editing those documents. This will include ways to profile and tailor the MIEM for specialized purposes, ways to construct business document templates, and ways to editing and share specific documents that are instances of those templates. This will support collaborative intelligence sharing of maritime intelligence. We will work with users designated by the MDA COI or SPAWAR to perform Beta testing and continuous improvement on these tools. We will support those users and evaluate their experiences. Based on lessons learned, we will improve the tools and recommend any appropriate follow-on developments. We will develop a specialized editor for USCG Targeting Packages working with users at MIFC PAC in Alameda.
EVALUATION AND IMPLEMENTATION OF THE RAPIDS POINTING MODULE (RPM) FOR IMPROVED THROUGHPUT/VIDEO QUALITY AND RANGE OF A SMALL UNMANNED AERIAL VEHICLE (SUAV)

Justin Hayward, Information Science Student
Department of Information Science
Sponsor: Space and Naval Warfare Systems Center-San Diego

OBJECTIVE: This thesis will be a system-level test and evaluation of the RAPIDS Pointing Module (RPM) to determine the throughput/video quality and range improvements of a Small Unmanned Aerial Vehicles (SUAV) operating in varied terrain, varied flight paths, and harsh climatic conditions. The RPM is used for directional alignment of antennas, cameras, and other sensors. This improved and inherently secure communication path will better support the ability of SUAV sensor systems (video) to provide more accurate, higher quality data in the area of interest. This thesis project will utilize a high gain directional narrow beam antenna to significantly reduce the RF footprint and decrease an enemy’s ability to intercept video/data transferred within a fast deployed network. The exploration of the capability to continuously track and align towards a SUAV while extending the range with a static or dynamic ground control station provides a tremendous benefit. It will offer persistent, real-time battlefield surveillance and target identification to improve battle situational awareness and operational responsiveness. All video and data retrieved by an SUAV, HUMVEE, mobile war fighter and various sensors will be disseminated within the situational display system RAPIDS.

DATA COLLECTION/CODING/CLEANSING PROCESS
Tom Housel, Professor
Department of Information Science
Sponsor: SPAWAR

OBJECTIVE: Develop and integrate a quick-reaction signal acquisition capability to enable a rapid transition of available COTS/GOTS technologies to fleet requirements in support of cryptologic carry on program subsystems.

IMPLEMENTING A CCOPS PERFORMANCE ACCOUNTING DATA COLLECTION TOOL TO SUPPORT OPNAV BUDGETING ALLOCATION FOR SIGNAL INTELLIGENCE COLLECTION SYSTEMS
Tom Housel, Professor
Department of Information Science
Sponsor: SPAWAR

SUMMARY: This is a continuation of current work on implementing a performance accounting system for the signal intelligence collection process that will provide routine return on investment (ROI) estimates for CCOP equipment. The goal of this project was to conduct a trial implementation of a performance accounting software that will support collection, ROI reporting, and portfolio optimization for the ongoing performance of Navy signal intelligence collection systems. The specific goal of this research is to provide data on the operational performance of CCOPs to SPAWAR executive management (i.e. Wayne Bratt and his CCOPs team). Additionally, the results of this continuation of the trial implementation will ultimately aid OPNAV N 20 and SPAWAR executives in making decisions during the POM/budgeting process for signal intelligence systems.
INTEGRATING SYSTEM DYNAMICS MODELING AND KNOWLEDGE VALUE ADDED FOR IMPROVED ANALYSIS OF ALTERNATIVES: A PROOF OF CONCEPT STUDY

Tom Housel, Professor
Department of Information Science
Sponsor: Unavailable

SUMMARY: The current work addresses the need to improve the use of benefits in AoA by building a system dynamics model of a military operation and integrating it with the Knowledge Value Added (KVA) methodology.

A notional mobile weapon system was modeled and calibrated to reflect four weaponized Unmanned Aerial Vehicles (UAV). Modeling a hypothetical AoA for upgrading one of the UAV indicated that there were potentially significant synergies that can increase the number of alternatives that could be analyzed, establishing common units of benefit estimates for an AoA, improved reliability of an AoA, and improved justification of AoA results. These can improve alternative selection, thereby improving final materiel effectiveness, thereby improving DoD acquisition processes.

KVA+RO+SD TO CREATE FLEXIBILITY: SUCCESS AND FAILURE CASES IN USE OF 3DVIS AND COLLABORATIVE PLM TOOLS TO SUPPORT SHIPMAIN

Tom Housel, Professor
Department of Information Science
Sponsor: OSD-Defense Research and Engineering/Systems Engineering

OBJECTIVE: The long-term goal of this two phased research project is to quantify and monetize the benefits of flexibility in the ship maintenance (i.e., ship alteration) process of the Navy’s approach to the life cycle management of their ships. Specifically, we will produce two case studies that:

1. Demonstrate the failure of the current ship maintenance process to take advantage of production learning curves when performing the same ship alterations to a class of ships (e.g., Cruisers - DDGs)

2. Demonstrate the value of flexibility in the form of 3D visualization and collaborative product life cycle management tools used to support the SHIPMAIN entitled (i.e., standardized ship alteration process)

3. These two cases will be modeled using a systems dynamics approach to compare estimates of the potential benefits that can be realized from the use of software tools to create flexibility in the ship alteration process.

REDUCING THE COST OF COMPLEX SYSTEMS TESTING USING RISK-BASED INFORMATION-DRIVEN STRATEGIES UNDER FIXED-COST CONSTRAINTS

Tom Housel, Professor
Department of Information Science
Sponsor: Unavailable

SUMMARY: This is a continuation of work on test-retest system component reliability with development of a refined risk-cost estimating algorithm. This study treats testing as a unified activity, with risk and cost as the common parameters for estimating the amount of testing required to achieve a desired level of risk reduction. From a fault-diagnosis perspective, both the cost of software module replacement and the cost of testing are taken into account in the decision to continue or cease testing. We want to replace the fewest number of components as quickly as possible while ensuring the system is restored to perfect functionality. From a regression testing perspective, particularly with the open architectures employed within the Integrated Warfare System, following component upgrade we want to conduct enough testing to verify that the system remains in perfect function. The element of risk is that costs incurred for perfect knowledge may approach infinity. From a practical perspective, then, we accept with some level of confidence (e.g. 99%, 95%) that our diagnosis or prognosis is correct.
OBJECTIVE: The main objective for Task 1 is to examine how planning teams employ perishable and uncertain information in the operational planning process. We will investigate both information structure and information richness in order to assess how they impact organizational planning. Information structure in this context refers to the degree of interaction planners have with the available information. METOC specialists in the Navy are available to operators and planners for consultation, though much of this information (e.g. weather forecasts, sea-state assessments) is available on-demand through web-based services. The complex and uncertain nature of METOC information, coupled with the sensitivity of the operation at hand, may require more consultation with human specialists instead of -- or in addition to -- simple web-based inquiries. One of the outcomes of this work, then, is to gain some insight for improving the combination of human and automated support for planning.

The objectives for Task 2 are to develop an understanding of the human and team challenges associated with using the Command and Control Rapid Prototype Continuum (C2RPC) by conducting a cognitive task analysis (CTA) of operational planners’ decision making.

SUMMARY: As part of the Office of Naval Research (ONR) Adaptive Architectures for Command and Control (A2C2) program, the Naval Postgraduate School (NPS) has been conducting empirical research to design and analyze adaptive C2 structures for future U.S. Navy and Joint forces. Through the integration of analytical modeling, human-in-the-loop experimentation and computer simulation, this research has followed a “model-test-model-experiment” paradigm wherein models and associated simulations define and guide experiments, and the results from the experiments are fed back to improve and enhance the models.

A Maritime Operations Center (MOC) empirical research campaign is underway where the emphasis is on operational versus tactical activities, and planning versus reacting. Because of its complexity, its mission to oversee large operations, and its dynamic structure, the MOC is an ideal organization for research on organizational structure, C2, and the process of mission planning. Since the MOC was designed to effectively integrate the planning elements of Current and Future Operations (COPS and FOPS) to provide more rapid and accurate resource allocations that are consistent with mission requirements, our first experiment focused on the MOC with emphasis on intelligence, surveillance, and reconnaissance (ISR).

MOC staff simultaneously participates in the planning effort, while executing the current operation, and supporting headquarters during planning and execution. Frequently, an operational planning team (OPT), a task-organized team formed to conduct integrated planning for a specific mission is formed by the MOC because it offers the advantage of a focused group of subject matter experts approaching the problem in an integrated manner. However performance problems may be realized with the OPT being isolated in situations that require the OPT to coordinate closely with the rest of the MOC. An experiment was conducted in which the MOC planned with either an integrated or an isolated planning team where the (1) FOPS team was supported by a decision aid/ planning tool that fosters coordination or (2) FOPS team plans with a planning tool with a reduced coordination capability.

Among the most salient scientific contributions of the A2C2 program to C2 research is the conduct of model-based experimentation. Analytical models are used to guide experiments via a priori predictions of performance and process measures across alternative C2 structures, and by conducting sensitivity analyses to suggest values for design parameters so that the experiments are conducted in regions where the dependent variables (DVs) are sensitive to changes in the independent variables (IVs). Models are also used as a reference or guidepost for examining the DVs
and collected data, primarily via model-data comparisons. This year NPS maintained its research objective to evaluate, via empirical study, alternative C2 concepts for the MOC at the operational level of war. Our approach utilized model-based experimentation, with particular emphasis on simulator-embedded models for decision aids and agents to assist and augment human participants.

**COLLABORATION AND KNOWLEDGE INTEGRATION**

Susan G. Hutchins, Research Associate
Department of Information Science
Sponsor: Office of Naval Research

**SUMMARY:** The framework of collaborative problem solving developed as part of the Office of Naval Research Collaboration and Knowledge Integration (CKI) Program provided the conceptual foundation for this research. The objective of the CKI program is to respond to emerging needs in both the military and business environments to better understand and improve the effectiveness of team decision making in complex, data-rich situations. As part of this effort, a model of team collaboration was developed that emphasizes the cognitive aspects of team collaboration and includes the major human decision-making processes used during team collaboration.

Macrocognition is an emerging field within the area of cognitive engineering that describes the way cognition occurs in naturalistic, or real-world, decision-making events. When studying macrocognition, the focus is on the mental activities that must be successfully accomplished to perform a task or achieve a goal. These cognitive functions are generally performed during collaborative team problem solving, where the emphasis is on building new knowledge.

The goal for the NPS Testbed for Team Collaboration Model Validation project is to understand the role of cognition in teams who are collaborating to solve one-of-a-kind, knowledge-intensive, challenging, ambiguous problems. This is a continuing project, where the objectives for this year’s effort were threefold, to: (1) empirically evaluate the model of team collaboration based on analysis of real-world complex decision-making events, (2) determine which macrocognitive processes are used and help refine the model based on empirical analysis, and (3) determine how the macrocognitive processes in the model contribute to team performance.

A cognitive model of team collaboration emphasizing the human decision-making processes used during team collaboration includes collaboration stages, macrocognitive processes and their definitions, and associated metrics. Definitions of the macrocognitive processes included in the measurement model of team collaboration were applied to the team communications that transpired during an Air Force Air Operations Center (AOC) training exercise on dynamic planning and execution involving time-sensitive targeting and a UAV execution and dynamic replanning task during an experiment.

The most significant finding was that a new macrocognitive process emerged during the coding process: Decision to take action. Deciding to take action is viewed as both a macrocognitive process and a product of team collaboration. High inter-rater reliability was found for both pairs of coders.

**JOINT IMPROVISED EXPLOSIVE DEVICE DEFEAT ORGANIZATION**

Susan G. Hutchins, Research Associate
Department of Information Science
Sponsor: Unavailable

**SUMMARY:** The goal for this research is to develop recommendations to improve the Joint Improvised Explosive Device Defeat Organization (JIEDDO) Test Board (JTB) enterprise test process through enhanced information sharing. Due to the complexity of the environment, structure of the organization, socio-cultural factors, and lack of incentive to share knowledge among test conductors, the JTB is currently not accomplishing its mission as efficiently as possible.

We conducted a knowledge engineering effort that was conducted on the critical tasks performed by users and the associated critical information that will contribute to increasing the efficiency of information flow between personnel.
INFORMATION SCIENCE

in the JTB, working groups, test ranges, research facilities, and JIEDDO itself. The focus for this effort is on the following questions: What types of information are they seeking when using the JTB portal?; What types of questions are they trying to answer during their daily tasks, and how is this information obtained?; What types of products are produced?; and What procedural improvements can be implemented to enhance knowledge sharing? Improvements are needed to facilitate sharing results reported in capabilities and limitations documents in terms of how well the testing process supports the operational environment.

Implementing improvements in the form of new procedures and enhanced processes for information sharing should yield a better understanding of the capabilities and limitations for the various IED defeat products, and in turn, lead to more effective IED mitigation in forward operating areas (FOAs). Moreover, better coordination with program managers, other service and agency CIED initiatives, as well as coalition efforts, would also provide more effective management of the DOD CIED test and evaluation process.

NPS TESTBED FOR TEAM COLLABORATION MODEL VALIDATION
Susan G. Hutchins, Research Associate
Department of Information Science
Sponsor: Office of Naval Research

OBJECTIVE: The purpose of this research is to assist in refining the model of team collaboration developed by Warner, Letsky, and Cowen (2004). The goal is to gain insight into where the model can be improved and determine how these processes contribute to team performance. The model emphasizes the cognitive aspects of team collaboration and includes the major human decision making processes used during team collaboration. The goal of this effort is to validate the model by analyzing complex decision making tasks.

HUMAN TERRAIN ANALYSIS COLLECTION SYSTEM
Capt Carrick Longley, USMC, Information Science Student
Department of Information Science
Sponsor: Space and Naval Warfare Systems Center-San Diego

OBJECTIVE: The objective of this thesis is to develop a software application for an iPhone / iPod touch by integrating commercially available software and hardware technologies to enhance the collection of information that can be used to accurately represent the human terrain - the social, ethnographic, cultural, economic, and political elements of the people among whom a force is operating - in a geographic area. Utilizing location-aware mobile devices with the power of social networking, this thesis focuses on the aggregation of geo-referenced data to build a more robust common operational picture and map the human terrain. Furthermore, the data obtained from the HTACS devices can be used to generate customized reports based on quantifiable, field collected attributes. In conjunction with researchers in the CORE Lab, the HTACS system looks to provide the front-end collection capability for link and social network analysis. Commercial of the shelf (COTS) and government off the shelf (GOTS) technologies and software solutions will also be researched to ensure more robust, well-rounded technical solution is developed. This thesis aims to provide a technical solution to one of the problems faced by military personnel in the field today -- how to collect data in order to quantifiably depict human activities, interactions, and behaviors.

This research is part of a student led these research project involving Capt Carrick Longley, USMC, and CPT Jim Torres, USA, as part of the requirements for the Information Warfare Systems Engineering degree, in conjunction with the researchers from the Common Operational Research Environment (CORE) and the Defense Analysis (DA) department at the Naval Postgraduate School. The CORE lab brings analysts and professors with social network analysis expertise, giving us unique leverage to develop software with the analysts who use the data.
IMPROVING HEALTH CARE DELIVERY FOR PTSD: AN INTEGRATED APPROACH LEVERAGING SYSTEMS ENGINEERING AND ORGANIZATIONAL DESIGN
Douglas J. MacKinnon, Research Associate Professor
Shelley Gallup, Research Associate Professor
Department of Information Science
Sponsor: Veteran’s Administration (VA)

OBJECTIVE: We propose to use a phased, systems engineering approach to develop a model a VA health care delivery for PTSD as an informative case study. The outcome of the study is specifically intended to improve the system of PTSD health care delivery around measures of performance related to two general areas:

- Treatment assignment and tracking of patients with PTSD
  - Efficiency of patient assignment to appropriate health care provider
  - Comprehensive tracking of patients from inpatient to outpatient care
- Staffing clinic to optimize the delivery of evidence-based care for patients with PTSD:
  - Efficiency of care delivery, e.g., substantially decreasing wait-times
  - The quality of patient outcomes
  - The use of VA therapy resources

OPNAV SERVICE ORIENTED ARCHITECTURE (SOA)
William Randy Maule, Research Associate Professor
Department of Information Science
Sponsors: OPNAV N2/N61, OPNAV N81

OBJECTIVE: Develop and test SOA infrastructure to determine how SOA-based applications and web services will work in distributed asynchronous and synchronous Fleet operations. Model tested architecture to support comprehensive Fleet enterprise SOA.

SUMMARY: Determine SOA components pertinent to Navy operations: derive measurable variables and metrics for these components, and model optimal architecture. Experimental context selected from SOA-based simulation of communications: (a) on shore to GIG backbone, (b) between shore and ship, (c) within a ship and between ships in a Battle Group, (d) shore teams and littoral operations, (e) disconnected communications and satellite-denied environments.

TRIDENT WARRIOR 2010 LABORATORY-BASED EXPERIMENTATION (FLEET SUPPORT)
William Randy Maule, Research Associate Professor
Department of Information Science
Sponsors: NETWARCOM / Fleet Forces Command / SPAWAR Systems Center – San Diego

OBJECTIVE: Laboratory-based experimentation for Fleet early TRL technologies.

SUMMARY: Research methodology development including objectives, hypothesis/questions, measurements, and analysis framework for over 20 technologies. Included test sequence oversight, data collection, and analysis/reporting.
OBJECTIVE: The primary objective of this research is to foster, coordinate, and promote multidisciplinary research on all elements of network-centric operations (e.g., including concepts, organization, command and control, management, doctrine, personnel, technology).

SUMMARY: In FY04, the Department of Defense (DoD) Command and Control Research Program (CCRP) launched a set of related initiatives designed to explore innovative behaviors, organizations, technologies and their implications for command and control (C2). One of these initiatives established the Virtual Edge Institute: a network of research centers located at colleges, universities, and research organizations both within DoD and in the Private Sector. The first of these Centers—the Center for Edge Power—was established, through funding from the Office of the Assistant Secretary of Defense for Networks and Information Integration (OASD-NII), for innovative C2 research at the Naval Postgraduate School (NPS). Professor Mark Nissen serves as Director.

The Center for Edge Power fosters, coordinates, and promotes multidisciplinary research on all elements of network-centric operations (e.g., including concepts, organization, command and control, management, doctrine, personnel, technology). The term edge derives from the seminal book entitled Power to the Edge (Alberts and Hayes, 2003), which depicts new ways of organizing military forces and of enabling more powerful warfare by leveraging shared awareness and dynamic knowledge. The central premise is that power (i.e., the capability to accomplish intended actions) needs to flow from the “centers” of military organizations to their “edges.” Using this metaphor, center refers principally to headquarters (e.g., where decision makers request information from the field), and edge refers principally to front lines (e.g., where combatants—at the pointy end of the metaphorical spear—fight wars). The concept clearly involves more than simply realigning organization charts and reallocating decision rights. People at the edges of organizations must: be aware of command intent; know how to accomplish tasks, activities, and processes; and be able to self-organize and self-synchronize to achieve the desired effects.

Although the Center for Edge Power focuses on military organizations and problems, the edge concept applies well to business, government, and other organizational domains also. For instance, the edge of a business organization is where customer interactions take place. Approaches to work, organization, management, and technology other than the Edge will be conceived, investigated, and refined as well, and a fluid flow of concepts and applications, both to and from public- and private-sector organizations, is envisioned to occur.

OBJECTIVE: The objective is for the US Marine Corps Information Management Community to develop an action plan for KM integration.
INFORMATION SCIENCE

NEXT GENERATION COMMAND AND CONTROL (NGC2)

LtCol Carl L. Oros, USMC, Research Associate
Department of Information Science
Sponsor: Marine Corps Warfighting Lab (MCWL)

OBJECTIVE: The NGC2 project will focus on emerging candidate networking technologies applicable for operational integration at the Company level and below. NPS will explore the network management and formal analysis of these technologies and their implications for small unit tactical networking through both lab and field research (TNT experiments). Further, building previous channel experiments, NPS will continue to investigate the physical layer attributes of these technologies as they are made available.

COLLABORATIVE SYSTEMS RESEARCH

John S. Osmundson, Research Associate Professor
Department of Information Science
Sponsor: SPAWAR

OBJECTIVE: The objective of this research is to identify the factors that enable the design and implementation of systems which achieve collaborative behavior amongst a group of users, to design a specific implementation of a collaborative online system to serve the community associated with the U.S. Navy’s Military SATCOM terminal, the Navy Multiband Terminal (NMT), and to assist the project sponsor in the development of a prototype of an online collaborative systems for the NMT community.

ADAPTIVE ARCHITECTURES FOR COMMAND AND CONTROL

Karl D. Pfeiffer, Visiting Professor
Susan G. Hutchins, Research Associate
Department of Information Science
Sponsor: Office of Naval Research

SUMMARY: As part of the Office of Naval Research (ONR) Adaptive Architectures for Command and Control (A2C2) program, the Naval Postgraduate School (NPS) has been conducting empirical research to design and analyze adaptive C2 structures for future U.S. Navy and Joint forces. Through the integration of analytical modeling, human-in-the-loop experimentation and computer simulation, this research has followed a “model-test-model-experiment” paradigm wherein models and associated simulations define and guide experiments, and the results from the experiments are fed back to improve and enhance the models.

A Maritime Operations Center (MOC) empirical research campaign is underway where the emphasis is on operational versus tactical activities, and planning versus reacting. Because of its complexity, its mission to oversee large operations, and its dynamic structure, the MOC is an ideal organization for research on organizational structure, C2, and the process of mission planning. Since the MOC was designed to effectively integrate the planning elements of Current and Future Operations (COPS and FOPS) to provide more rapid and accurate resource allocations that are consistent with mission requirements, our first experiment focused on the MOC with emphasis on intelligence, surveillance, and reconnaissance (ISR).

The MOC was designed to effectively integrate the planning elements of Future Operations (FOPS) to provide more rapid, accurate resource allocations that are consistent with the vision of the Commander. The MOC staff simultaneously participates in the planning effort, while executing the current operation, and supporting headquarters during planning and execution. Frequently, an operational planning team (OPT), a task-organized team formed to conduct integrated planning for a specific mission is formed by the MOC because it offers the advantage of a focused group of subject matter experts approaching the problem in an integrated manner. However performance problems may be realized with the OPT being isolated in situations that require the OPT to coordinate closely with the rest of the MOC. An experiment was conducted in which the MOC planned with either an integrated or an isolated planning
Among the most salient scientific contributions of the A2C2 program to C2 research is the conduct of model-based experimentation. Analytical models are used to guide experiments via a priori predictions of performance and process measures across alternative C2 structures, and by conducting sensitivity analyses to suggest values for design parameters so that the experiments are conducted in regions where the dependent variables (DVs) are sensitive to changes in the independent variables (IVs). Models are also used as a reference or guidepost for examining the DVs and collected data, primarily via model-data comparisons. This year NPS maintained its research objective to evaluate, via empirical study, alternative C2 concepts for the MOC at the operational level of war. Our approach utilized model-based experimentation, with particular emphasis on simulator-embedded models for decision aids and agents to assist and augment human participants.

COLLABORATIVE ARCHITECTURE SIMULATION ENVIRONMENTS FOR MODELING AND SIMULATION, SOFTWARE ENGINEERING AND INFORMATION ASSURANCE MANAGEMENT

Karl D. Pfeiffer, Assistant Professor
Department of Information Science
Sponsor: PEO IWS 7E

OBJECTIVE: IWS 7E has been assigned responsibility for coordination of Enterprise-Wide Modeling and Simulation (M&S) and Information Assurance (IA) and development of Collaborative Architecture Simulation Environment (CAS), to include assessments in support of PEO IWS programs.

M&S/IA/CASE tasking includes, but not limited to, threat research, interpretation/development of policy, evaluation of existing procedures, facilitation of technical reviews, requirements analysis, standardization of program documentations, and review and update of Enterprise-Wide Plans, to ensure all program risk has been adequately addressed. Tasking also includes engineering, oversight, and integration of M&S/CASE.

Additionally, this task supports the necessary coordination of PEO IWS Warfare Systems Readiness Division participation in the various studies and analysis directed by Navy Leadership to: identify gaps in current warfighting capabilities; develop systems engineering solutions to the current and advance threats; identify threshold and objective values for new systems; and support cost benefits-trades analyses.

LIGHTNING WARNING OVERLAP AND OPTIMUM LIGHTNING AREAS

Karl D. Pfeiffer, Assistant Professor
Department of Information Science
Sponsor: 45th Weather Squadron (45th Operations Group)

OBJECTIVE: Determine the frequency with which 45th Weather Squadron lightning warnings and watches overlap in time for all pairs, triplets, and higher combinations of the 45 WS lightning warning areas, emphasizing the areas that overlap in space on CCAFS/KSC. Based on the above analysis, recommend optimum lightning warning areas for 45 WS. The optimum areas may be combinations of the current five nautical mile lightning warnings circles or new proposed solutions.
INFORMATION SCIENCE

UNMANNED AIRCRAFT SYSTEMS SUPPORT TO OSD UAS TASK FORCE
William David Place, Research Associate
Department of Information Science
Sponsor: OUSD (AT&L) UAS Programs Lead

OBJECTIVE: The Department of Information Science, Naval Postgraduate School (hereafter, “Principal and Co-Investigators” or “NPS”) shall provide subject matter expertise to OUSD (AT&L) during the research and development of all aspects of material/concepts related to Unmanned Aircraft Systems.

INFORMATION WARFARE CURRICULUM 595 SUPPORT
LCDR Dave Roberts, Visiting Professor
Department of Information Science
Sponsor: Navy Cyber Forces Command

OBJECTIVE: The FY10 IO/IW funding provided by NNWC to the Naval Postgraduate School will be used for both faculty and student thesis research. Currently, the IW faculty is comprised of a mix of military and civilian faculty, funding is required to support faculty labor, as required, for teaching, travel in support of IO course development and thesis advising. Students will use funding provided for experience tour travel and thesis research which includes purchasing of hardware/software and equipment for lab facilities to support experimentation and research. Areas of study and research for faculty and students are EW antennae design, Radar and Communications Electronic attack, Wireless Networking Influence Operations, Software decoys, Influence Modeling, Web based influence ops, modeling and simulation in IO, and Information Assurance. Lab facilities include the NPS Wireless warfare lab and the Nemesis Mobile Research facility.

JOINT BATTLESPACE AWARENESS INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE INTEGRATION CAPABILITY (JBAIIC) KNOWLEDGE MANAGEMENT & EXPERIMENTATION (KME) PROJECT
William Roeting, Research Associate
Department of Information Science
Sponsor: U.S. Joint Forces Command

OBJECTIVE: The NPS JBAIIC KME Project, in support of the Field Test and Operations Branch of the Innovation and Experimentation Division of JTC-I, shall provide a Knowledge Management and Experimentation Enterprise that will hypothesize, design, and investigate net-centric ISR integration concepts in support of improved Battlespace Awareness to facilitate the provision on actionable intelligence to commanders and warfighters at the strategic, operational and tactical levels of war. To this end, the NPS J-BAIIC KME Project will proved Joint ISR transformation and concept planning; and Joint ISR experiment planning, execution, management, data collection, analyses, and assessment reporting.
DEPARTMENT OF INFORMATION SCIENCES

2010
Faculty Publications and Presentations
INFORMATION SCIENCE

JOURNALS


CONTRIBUTIONS TO BOOKS


CONFERENCE PUBLICATIONS & PROCEEDINGS


INFORMATION SCIENCE


Housel, Thomas J. Measuring to Manage Knowledge. Third Annual Conference on Knowledge Management in South America Key Note address. Bogota, June 2010.


Nissen, M., Powley, N. and Seykora, J. “Study of Trust as an Organizational Contingency, Part II: Examining Four Dimensions of Trust in ELICIT Experimentation,” Proceedings International Command & Control Research & Technology Symposium, Santa Monica, CA (June 2010).

INFORMATION SCIENCE


CONFERENCE PRESENTATIONS


Baer, W. *The Physics of “I am a Strange Loop”*, SCIENCE AND NONDUALITY CONFERENCE. October 20-24, 2010. Embassy Suites/Marin Civic Center San Rafael, California


MacKinnon, D.J. “Joint Reconfigurable Vehicle (JRV): Its capabilities and Missions,” invited presentation to California State University Monterey Bay (CSUMB) and the Joint Forces Command (JFCOM) Special Operations Symposium, 12 Feb 2010.


MacKinnon, D.J. “DISE Research in FY10,” invited presentation to the Assistant Chief of Staff for Command and Control, Communications, Computers, and Combat Systems (C5) for Carrier Strike Group Two, CAPT Barrett, hosted by the Cebrowski Institute at the Naval Postgraduate School, Monterey, CA, 07 Jan 2010.

Nissen, M. “Agent-Based C2 Modeling and Simulation with POWer,” invited presentation, MOVES Seminar, Monterey, CA (July 2010).

Nissen, M. “Application Services for Command & Control,” invited presentation, Naval Postgraduate School C4I Workshop, Monterey, CA (June 2010).

Nissen, M. “Knowledge Dynamics: Key Principles for Afloat Knowledge Managers,” invited presentation, Navy
INFORMATION SCIENCE

Afloat Knowledge Managers Course, Dam Neck, VA (May 2010).


Zhao, Y., Gallup, S.P. and MacKinnon, D.J. “Integrated Demonstration System Self-awareness and Lexical Link Analysis (LLA),” given at the Office of Naval Research (ONR) Science and Technology Symposium, Crystal City, VA, 10 November 2010.

TECHNICAL REPORTS


WORKING PAPER

Bordetsky, Bourakov, and Yakimenko. “Method and System for Control of Autonomous Aerial System via GSM Cellular Network” was filed with the USPTO, April 13, 2010. The provisional patent application was assigned serial no. 61/323,792.

Bordetsky, Bourakov, and Yakimenko “Method and System for Establishing a Short-term Network Mesh Using Miniature Autonomously Guided Parafoils” was filed with the USPTO, April 13, 2010. The provisional patent application was assigned serial no. 61/323,750.

Bordetsky, Bourakov, Hewgly, and Yakimenko “Method and System for Vertical Replenishment of Naval Vessels Via Precision Guided Airdrop” was filed with the USPTO, April 13, 2010. The provisional patent application was assigned serial no. 61/323,675.

Bordetsky, Bourakov, and Yakimenko “Aerial Delivery System with High Touchdown Accuracy” was filed with the USPTO on March 22, 2010. The provisional patent application was assigned serial no. 61/316217.
OPERATIONS RESEARCH

OVERVIEW:
The Naval Postgraduate School’s Operations Research (OR) program is a world-class curriculum designed to teach students the science of helping people and organizations make better decisions. Operations Research is necessary in today’s increasingly complex operating environments, in which officers and managers must respond quickly to a vast array of demands, while also weighing the options and consequences of each into their final decisions. Formally, OR is the development and application of mathematical models, statistical analyses, simulations, and analytical reasoning to the understanding and improvement of real-world operations. The military uses OR at the strategic, operational, and tactical levels for such activities as national policy analysis, resource allocation, force composition and modernization, logistics, human resources, battle planning, flight operations scheduling, intelligence, command and control, weapon selection, missile defense, engagement tactics, maintenance and replenishment, and search and rescue.

The OR department’s mission is:

- To educate analysts who are fully capable of conducting independent, analytical studies of military problems, and to provide an educational basis for continued learning and development.
- To develop and maintain a world-class research program in operations research and related areas.
- To provide operations research and general analysis support to the Department of Defense (DoD).

CURRICULA SERVED:
The first eight curricula below are homed in the OR Department. Because of OR’s broad applications, the Department supports the other curricula with courses ranging from optimization to statistics to human systems integration.

- Operations Analysis
- Operational Logistics
- Human Systems Integration
- Master of Systems Analysis
- Systems Engineering Analysis
- Cost Estimating and Analysis
- Systems Analysis Certificate
- Human Systems Integration Certificate
- Modeling, Virtual Environments, and Simulation (MOVES)
- Systems Engineering
- Systems Engineering Management/Product Development
- Undersea Warfare
- Information Systems and Operations
- Information Systems Technology
- Information Warfare
- Joint C4I
- Computer Science
- Naval/Mechanical Engineering
- Electronic Warfare
- Applied Mathematics
- Space-Systems Operations International
- Space-Systems Operations
- Manpower Systems Analysis

DEGREES GRANTED:

- Master of Science in Operations Research
- Master of Science in Applied Science
OPERATIONS RESEARCH

- Master of Systems Analysis
- Master of Science in Human Systems Integration
- Doctor of Philosophy in Operations Research

RESEARCH THRUSTS:

- Probability and Stochastic Processes
- Optimization
- Statistics and Data Analysis
- Human Factors and Systems Integration
- Simulation and War Gaming
- Search, Detection, and Evasion
- Cost Estimation

RESEARCH CHAIRS:

- Chair of Applied Systems Analysis
- Chair of Systems Engineering Analysis
- Chair for Warfare Innovation
- Cost Analysis Chair
- Naval Warfare Integration Group Chair for Strategic Maritime Analysis

RESEARCH FACILITIES:

- Simulation Lab
- Optimization Lab
- Human Systems Integration Laboratory (HSIL)

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Operations Research is provided below:

![Chart showing research funding by source and size of program: $4.4M](chart.png)
OPERATIONS RESEARCH

Robert F. Dell
Chairman & Professor
831-656-2853
dell@nps.edu

Ronald D. Fricker, Jr.
Associate Chairman for Research & Associate Professor
831-656-3048
rdfricker@nps.edu

David Alderson
Assistant Professor
831-656-1814
dlalders@nps.edu

Emily Craparo
Research Assistant Professor
831-656-3094
eemcrapar@nps.edu

Wayne P. Hughes
Professor of Practice
831-656-2484
whughes@nps.edu

Jeffrey Applegate
Senior Lecturer
831-656-7674
jaappleg@nps.edu

Nedialko Dimitrov
Assistant Professor
831-656-3647
ndimitro@nps.edu

Patricia A. Jacobs
Distinguished Professor
831-656-2258
pjacobs@nps.edu

Michael Atkinson
Assistant Professor
831-656-2398
mпаткнs@nps.edu

James N. Eagle
Professor & Chair of Systems Engineering Analysis
831-656-2654
jeagle@nps.edu

Rachel T. Johnson
Assistant Professor
831-656-2577
rtjohnson@nps.edu

Gordon H. Bradley
Professor Emeritus
831-656-2359
gbradley@nps.edu

Lee Ewing
Research Associate Professor
831-656-3040
plewing@nps.edu

David Kelton
Visiting Professor
831-656-3094
wdkelton@nps.edu

Gerald G. Brown
Distinguished Professor
831-656-2140
gbrown@nps.edu

Donald P. Gaver
Distinguished Professor
831-656-2605
dgaver@nps.edu

Quinn Kennedy
Lecturer
831-656-2618
mqkenned@nps.edu

Douglas Burton
CDR, USN
Lecturer & Chair of Applied Systems Analysis
831-656-2284
dbrburton@nps.edu

Thomas E. Halvachs
Senior Lecturer
831-656-2413
halvachs@nps.edu

Jeffrey E. Kline
Senior Lecturer & Program Director, Maritime Defense and Security Research Programs
831-656-7946
jekline@nps.edu

Samuel E. Buttrey
Associate Professor
831-656-3035
buttrey@nps.edu

Thomas A. Hamrick
Lecturer
831-656-2590	
thamrick@nps.edu

Robert A. Koyak
Associate Professor
831-656-2688
rakovak@nps.edu

W. Matthew Carlyle
Associate Professor
831-656-2106
mcarlyle@nps.edu

Gary E. Horne
Research Professor
831-233-4905
gehorne@nps.edu

Moshe Kress
Professor
831-656-2927
mkress@nps.edu
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Email Address</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kyle Y. Lin</td>
<td>Associate Professor</td>
<td><a href="mailto:kylin@nps.edu">kylin@nps.edu</a></td>
<td>831-656-2648</td>
</tr>
<tr>
<td>Robert R. Read</td>
<td>Professor Emeritus</td>
<td><a href="mailto:rread@nps.edu">rread@nps.edu</a></td>
<td>831-656-2382</td>
</tr>
<tr>
<td>Lawrence G. Shattuck</td>
<td>Senior Lecturer</td>
<td><a href="mailto:lgshattu@nps.edu">lgshattu@nps.edu</a></td>
<td>831-656-2473</td>
</tr>
<tr>
<td>Thomas W. Lucas</td>
<td>Professor</td>
<td><a href="mailto:twlucas@nps.edu">twlucas@nps.edu</a></td>
<td>831-656-3039</td>
</tr>
<tr>
<td>Eva Regnier</td>
<td>Associate Professor</td>
<td><a href="mailto:eregnier@nps.edu">eregnier@nps.edu</a></td>
<td>831-656-2912</td>
</tr>
<tr>
<td>Nita Lewis Shattuck</td>
<td>Associate Professor</td>
<td><a href="mailto:nlmiller@nps.edu">nlmiller@nps.edu</a></td>
<td>831-656-2281</td>
</tr>
<tr>
<td>Kevin J. Maher</td>
<td>Lecturer</td>
<td>k <a href="mailto:Maher@nps.edu">Maher@nps.edu</a></td>
<td>831-656-2691</td>
</tr>
<tr>
<td>Johannes O. Roysset</td>
<td>Assistant Professor</td>
<td><a href="mailto:joroyset@nps.edu">joroyset@nps.edu</a></td>
<td>831-656-2578</td>
</tr>
<tr>
<td>Robert Shearer</td>
<td>Assistant Professor</td>
<td><a href="mailto:rsheare@nps.edu">rsheare@nps.edu</a></td>
<td>831-656-3027</td>
</tr>
<tr>
<td>Michael E. McCauley</td>
<td>Research Professor</td>
<td><a href="mailto:memccaul@nps.edu">memccaul@nps.edu</a></td>
<td>831-656-2191</td>
</tr>
<tr>
<td>Javier Salmerón-Medrano</td>
<td>Research Associate Professor</td>
<td><a href="mailto:jsalmero@nps.edu">jsalmero@nps.edu</a></td>
<td>831-656-2779</td>
</tr>
<tr>
<td>Devaushi Singham</td>
<td>Research Assistant Professor</td>
<td><a href="mailto:disingha@nps.edu">disingha@nps.edu</a></td>
<td></td>
</tr>
<tr>
<td>Gregory K. Mislick</td>
<td>Lecturer &amp; Cost Analysis Chair</td>
<td><a href="mailto:gkmislic@nps.edu">gkmislic@nps.edu</a></td>
<td>831-656-3113</td>
</tr>
<tr>
<td>Paul J. Sanchez</td>
<td>Senior Lecturer</td>
<td><a href="mailto:pjsanche@nps.edu">pjsanche@nps.edu</a></td>
<td>831-656-3053</td>
</tr>
<tr>
<td>Christian Smith</td>
<td>Senior Lecturer</td>
<td><a href="mailto:cssmith1@nps.edu">cssmith1@nps.edu</a></td>
<td>831-656-2126</td>
</tr>
<tr>
<td>Scott Nestler</td>
<td>LTC, USA</td>
<td><a href="mailto:stneste@nps.edu">stneste@nps.edu</a></td>
<td>831-656-7700</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td></td>
<td><a href="mailto:ssanchez@nps.edu">ssanchez@nps.edu</a></td>
<td>831-656-2780</td>
</tr>
<tr>
<td>Roberto Szechtman</td>
<td>Associate Professor</td>
<td><a href="mailto:rszechtm@nps.edu">rszechtm@nps.edu</a></td>
<td>831-656-3311</td>
</tr>
<tr>
<td>Daniel A. Nussbaum</td>
<td>Visiting Professor</td>
<td><a href="mailto:dnussbaum@nps.edu">dnussbaum@nps.edu</a></td>
<td>831-656-2387</td>
</tr>
<tr>
<td>CDR, USN</td>
<td>Military Faculty</td>
<td><a href="mailto:dlschiff@nps.edu">dlschiff@nps.edu</a></td>
<td>831-656-2380</td>
</tr>
<tr>
<td>Alan R. Washburn</td>
<td>Research Professor Emeritus</td>
<td><a href="mailto:awashburn@nps.edu">awashburn@nps.edu</a></td>
<td>831-656-3127</td>
</tr>
<tr>
<td>Douglas Otte</td>
<td>CAPT, USN</td>
<td><a href="mailto:deotte@nps.edu">deotte@nps.edu</a></td>
<td>831-656-3890</td>
</tr>
<tr>
<td>John Schmidt</td>
<td>CAPT, USN</td>
<td><a href="mailto:jkschmid@nps.edu">jkschmid@nps.edu</a></td>
<td>831-656-3864</td>
</tr>
<tr>
<td>R. Kevin Wood</td>
<td>Associate Professor</td>
<td><a href="mailto:rwhitaker@nps.edu">rwhitaker@nps.edu</a></td>
<td>831-656-3482</td>
</tr>
<tr>
<td>Steven E. Pilnick</td>
<td>Senior Lecturer</td>
<td><a href="mailto:spilnick@nps.edu">spilnick@nps.edu</a></td>
<td>831-656-2283</td>
</tr>
<tr>
<td>David Schrady</td>
<td>Distinguished Professor Emeritus</td>
<td><a href="mailto:dschrady@nps.edu">dschrady@nps.edu</a></td>
<td>831-656-2801</td>
</tr>
<tr>
<td>Harrison C. Schramm</td>
<td>Lcdr, USN</td>
<td><a href="mailto:hlprice@nps.edu">hlprice@nps.edu</a></td>
<td>831-656-2113</td>
</tr>
<tr>
<td>Chair for Strategic Maritime Analysis</td>
<td></td>
<td>831-656-2358</td>
<td></td>
</tr>
<tr>
<td>Peter Purdue</td>
<td>Professor &amp; Dean of GSOIS</td>
<td><a href="mailto:ppurdue@nps.edu">ppurdue@nps.edu</a></td>
<td>831-656-2663</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
OPERATIONS RESEARCH

REINFORCED INFANTRY BATTALION MOBILE AD-HOC NETWORK (MANET) STUDY TECHNICAL SUPPORT
David L. Alderson, Assistant Professor
Rex Buddenberg, Research Associate (Information Science)
Emily M. Craparo, Assistant Research Professor
Department of Operations Research
Sponsor: Operations Analysis Division (OAD), Marine Corps Combat Development Command (MCCDC)

OBJECTIVE: The proposed work will support the Reinforced Infantry Battalion Mobile Adhoc Network (MANET) Study, which is sponsored by Marine Corps Tactical Systems Support Activity (MCTSSA). This study will determine meaningful, quantifiable methods of measuring MANET architectures to support testing, evaluation, and simulation. This study will also identify and measure the quantifiable advantages of using MANET architectures over traditional architectures. Our role is to add analytic depth and rigor to the Study by providing a literature review, technical support, model verification and validation (V&V), and product feedback to the OAD study team.

NEXT-GENERATION NETWORK SCIENCE
David L. Alderson, Assistant Professor
Emily M. Craparo, Assistant Research Professor
Brian Steckler, Lecturer (Information Science)
Department of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: The objective of this project is to conduct a broad-based, cross-disciplinary research program focused on rigorous, scalable and provably correct analysis of networks and network data. This is a Multiple University Research Initiative (MURI) Award, conducted in collaboration with colleagues at the University of Pennsylvania, California Institute of Technology, and University of California (Santa Barbara and San Diego campuses). This was the third year of a five-year award.

SUMMARY: During the last year, the NPS part of the MURI team has focused on disaster response and management, because disasters tend to expose relationships and tensions that do not exist during everyday life. These situations are at the boundary of network science and embody two of the themes in this MURI: (1) networks with human decision-makers in-the-loop; and (2) networks that have an urgent need to take action, with lots of uncertainty. As the unfortunate circumstances in Haiti, Chile, and the Pacific Rim continue to show, disasters problems have immediate relevance, both domestically and internationally. And there is a desperate need for theory to inform the decision processes that often seem more reactive than proactive. The study of disasters presents a number of interesting challenges and opportunities, including the modeling of dynamic and complex physical phenomena, the interaction of physical science and human behavior, an important intersection with public policy, and new opportunities for data collection, modeling through ongoing field experiments, pre-planned exercises, and real events.

PUBLICATIONS:

PRESENTATIONS:


THESES DIRECTED:


PERFORMANCE ANALYSIS OF GROUND SOLDIER MOBILE AD-HOC NETWORKS

David L. Alderson, Assistant Professor
Emily M. Craparo, Assistant Research Professor
Department of Operations Research
Sponsor: U.S. Army Training and Doctrine Command (TRADOC)
Analysis Center, Monterey (TRAC-MRY)

OBJECTIVE: The proposed research was invited by the sponsor to support an ongoing study that examines the performance of a wireless combat communication system known as the Ground Soldier System (GSS). We propose to study the performance of mobile ad-hoc networks (MANETs)--also called wireless mesh networks (WMNs)--for ground soldier communication. This research directly supports the GSS analysis of alternatives (AoA). Specifically, our goal was to understand how the basis of issue (BOI) for MANET equipment affects the ability of the network to support mission critical communication.

SUMMARY: This study examined performance tradeoffs in the deployment of Enhanced Position Location Reporting System (EPLRS) networks with emphasis on the impact of radio density. This research formulated three different models of network operation and exercised them under various deployment scenarios. The findings indicated that while increasing radio density need not have a significant detrimental impact on network performance, it can pose additional challenges from a network management perspective.

PUBLICATIONS:

PRESENTATIONS:


THESES DIRECTED:


VULNERABILITY ANALYSIS OF ELECTRIC POWER INFRASTRUCTURE SUPPORTING VANDENBERG AFB

David L. Alderson, Assistant Professor
Kevin Wood, Professor
Javier Salmerón, Research Associate Professor
Department of Operations Research
Sponsor: Deputy Assistant Secretary of Defense for Homeland Defense Strategy

OBJECTIVE: We propose to employ sequential play, two-person zero-sum game theory, coupled with standard electric power models, to identify vulnerabilities in the electric power infrastructure in and around Vandenberg Air Force Base. The research will also provide guidance on mitigation measures, and evaluate measure externally proposed by the Department of Defense.

THE HUMAN SOCIAL CULTURAL BEHAVIOR (HSCB) MODELING INITIATIVE AT THE NAVAL POSTGRADUATE SCHOOL

Jeffrey Appleget, Senior Lecturer
Department of Operations Research
Sponsor: OSD-ATL, through ONR

OBJECTIVE: Establish the HSCB program at NPS. The program will eventually contain four coordinated, mutually supporting lines of operation: Education, Assessment, Performance, and Transition. This year (2010) will focus on Education and Performance.

SUMMARY: For FY 10, the NPS HSCB research team was directed to scope their research program from an initial $1.5M proposal to a $500,000 effort. However, FY 10 HSCB programmatic funding cuts reduced the NPS program by half to $250,000. As a result, the scope of research was reduced, and one project was eliminated. However, this program of research was able to make significant modeling progress, conducted a tremendous outreach program across campus, brought in several nationally-known experts in social science modeling for cross-campus seminars, which resulted in the recruitment of several prominent NPS and other researchers for the FY 11 proposal. Four FY 10 research teams conducted significant research for proposed FY 11 HSCB efforts, setting up four HSCB modeling research areas for success for FY 11, (pending resourcing). Additionally, FY 10 NPS research performers created and IW HSCB enrichment week course, and added HSCB-focused material into several classes and curricula.

IRREGULAR WARFARE (IW) DATA VALIDATION PROJECT

Jeffrey Appleget, Senior Lecturer
Department of Operations Research
Sponsor: OSD-CAPE, through TRAC-Monterey

OBJECTIVE: Develop a Data Validation Best Practices Guide (BPG) for Irregular Warfare (IW).
SUMMARY: This research began in April 2010 and concludes in Spring 2011. The four research tasks are:

T1: TRADOC Analysis Center (TRAC) will provide a report that assesses, at a minimum, the validation of IW data, to include an examination of data requirements, data sources, and data availability as well as derivation of data.

T2: TRAC will initiate and complete a case study that assesses, at a minimum, the appropriateness of the CG model for adaptation to an Afghanistan scenario. This will include an assessment of the differences in data requirements and data sources required to adapt the model from an Iraq to an Afghanistan scenario.

T3: Update the VV&A best practices report with lessons learned and refinements based on results from Requirements 3.1 and 3.2.

T4: Provide a white paper that describes the first year of operation of the TRAC data collection cell (forward) in Afghanistan, to include operating procedures, AARs, lessons learned, and data sources.

IRREGULAR WARFARE (IW) METHODS AND TOOLS (MMT) TACTICAL VALIDATION, VERIFICATION AND ACCREDITATION (VV&A) PROJECT

Jeffrey Appleget, Senior Lecturer
Department of Operations Research
Sponsor: OSD-CAPE, through TRAC-Monterey

OBJECTIVE: Develop a Verification, Validation & Accreditation (VV&A) Best Practices Guide (BPG) for Irregular Warfare (IW) Methods, Models, and Tools (MMT) tactical-level representation and apply those best practices to selected existing IW MMT. The Peace Support Operations Model (PSOM) and the Cultural Geography (CG) model will be assessed since those models currently are already hosted at NPS and/or TRAC-Monterey.

SUMMARY: Best Practices Guide went through rigorous external review, amended final draft completed in early spring, completed final draft delivered to sponsor, final document awaiting signature (at TRADOC Analysis Center, research lead).

VALIDATION OF DATA SUPPORTING IRREGULAR WARFARE (IW) METHODS MODELS AND TOOLS (MMT)

Jeffrey Appleget, Senior Lecturer
Department of Operations Research
Sponsor: OSD-CAPE, through TRAC-Monterey

OBJECTIVE: Develop best practices for IW data validation, validation of Agent-Based Models, participate in development and execution of a case study of the Cultural Geography model’s adaptation to Afghanistan, participate in preparation of white paper documenting TRAC-Forward data collection efforts in Afghanistan, and update the IW Validation Best Practices Guide with applicable results.

OPTIMIZATION OF SENSOR ALLOCATION FOR SEARCH AND SURVEILLANCE

Michael Atkinson, Assistant Professor
Moshe Kress, Professor
Johannes O. Royset, Assistant Professor
Department of Operations Research
Sponsor: ONR

OBJECTIVE: Develop an operational and tactical decision aid for employing sensors in an area of interest and fusing the information obtained from these sensors and from other sources.
OPERATIONS RESEARCH

SUMMARY: The decision aid will be used to guide commanders and executive officers to efficiently operate sensors during surveillance missions and to effectively utilize the information obtained from these sensors. The decision aid will also help combat planners in developing concepts of operations (CONOPS) for search and surveillance operations and support analysts in planning acquisition programs for sensors and platforms. We focus on sensors carried by unmanned aerial, ground, and surface vehicles (UXVs), but we also consider information from ground sensors, satellites, manned aircraft, and human intelligence sources. The decision aid will consist of two parts: a probability model for fusing information and an optimization model for operating the sensors. The research effort is currently focused on counter-drug operations at SOUTHCOM (JIATF-S).

PRESENTATIONS:

Presentation to the sponsor, Dr. Don Wagner at NPS, May 2010.


PUBLICATIONS:


LARGE-SCALE OPTIMIZATION

Gordon H. Bradley, Research Professor
Gerald G. Brown, Distinguished Professor
R. Kevin Wood, Professor
Department of Operations Research
Sponsor: Air Force Office of Scientific Research

OBJECTIVE: This annual proposal for continued support of our research in large-scale optimization describes the formulation of defender-attacker-defender models and proposes algorithms for their solution. These models are three-stage Stackelberg games with applications to military-defense problems, critical infrastructure protection, and bio-defense.

SUMMARY: We have described a three-stage Stackelberg game for optimal hardening of critical infrastructure and other applications: (a) The defender of a system uses limited resources to harden certain system components, i.e., to make those components resistant or invulnerable to attack, (b) an attacker observes these defensive preparations and “interdicts” some components, reducing their usefulness to the defender, and (c) the defender, as system operator, operates the interdicted system optimally. Typically, we model system operation as a linear program. The defender’s overarching goal is to minimize the worst possible damage that the attacker can inflict, when measured through the cost of post-interdiction system operation. We have applied this paradigm to bio-defense, have begun applying a variant to anti-submarine warfare (ASW) mission planning, and have studied vulnerable road networks subject to (nonlinear) congestion. In this last case, the defender chooses measures to harden, increase resiliency, add capacity, or otherwise protect bridges and roads, the attacker observes these preparations and mounts his most-damaging attack (in terms of maximally increasing resulting traffic congestion), and finally the vehicular traffic responds as best it can to utilize the surviving infrastructure. Reconstitution times may vary by attacked component, with a suspension bridge taking several years, while a road segment may take merely a month.

PUBLICATIONS:


Wood, K., 2010, Bilevel Network Interdiction Models: Formulations and Solutions, in Wiley Encyclopedia of
LARGE-SCALE OPTIMIZATION
Gerald G. Brown, Distinguished Professor
R. Kevin Wood, Professor
Department of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: To continue development of theory and implementation of optimization-based tools for Navy operational planning.

SUMMARY: In FY11, this research completed initial development and deployment of NMP (Navy Mission Planner), including important embellishments to account for logistics support of such mission plans. We also continue theoretical development of a game-theoretic, anti-submarine warfare model for planning protective screens around a “high-value unit,” typically the aircraft carrier in a carrier battle group. We have also developed and are fielding Replenishment at Sea Planner (RASP), with initial installation completed at 5-th Fleet, Bahrain. RASP is currently in fashion because it minimizes fuel consumption by navy supply ships attending our deployed combatants. We continue to develop and support the Combat Logistics Force (CLF) strategic and operational planning models, and have evaluated current war...
plans for, e.g., 7-th Fleet, for logistic feasibility. We are currently using our missile defense model Joint Defender (JDEF) for EUCOM to reckon how to replace the cancelled defensive interceptor missile fields in Eastern Europe by planning placement of defensive radars and interceptor missiles elsewhere to protect Europe from missile threats from the Middle East. The distinguishing ability we bring to bear here is complete mathematical mastery and ownership of these optimization-based decision-support tools, combined with deep domain expertise in warfare modeling, with reach-back support offered via a single phone call or email at any classification level. Some requests require exigent mathematical developments, and some just seasoned modeling advice.

PUBLICATIONS:


PRESENTATIONS:


Wood, K., 2010, “Maximizing the Resilience of Critical Infrastructure to Terrorist Attack without Guessing,” ORIE Seminar, University of Texas at Austin, Austin, Texas, 29 October.

THESES DIRECTED:


HONORS/AWARDS/PRIZES:

Brown, G., 2010, Military Operations Research society (MORS) 2010 Thomas Award for consistent, sustained technical contributions to improve the analytical underpinnings of the national security operations research profession.

TRANSITIONS:

This sponsor requires timely reports of transitions of our theory to practice, and substantive achievements in practice, and we forward these via emails at appropriate classification levels. Note that all results involving current combat operations in any theater are by default classified SECRET.

MSC SCHEDULE PLANNER MODEL

Gerald G. Brown, Distinguished Professor
Department of Operations Research
Sponsor: Military Sealift Command

OBJECTIVE: Develop, install and support the Replenishment at Sea Planner (RASP), an optimization-based decision support system to aid short-term scheduling of Military Sealift Command supply shuttle ships in a theater of operations. The goal of this scheduling is to reduce shuttle fuel cost while servicing all combatant customer ships.

SUMMARY: In FY11, this research completed initial development and deployment of RASP to 5-th Fleet, Bahrain. In addition, RASP has been used to analyze exigent questions about the impact of withdrawal of certain MSC ships.

CHAIR OF APPLIED SYSTEMS ANALYSIS

CDR Douglas Burton, USN, Military Faculty
Department of Operations Research
Sponsor: Chief of Naval Operations Assessment Division/Capability Analysis Group

OBJECTIVE: The Chair of Applied Systems Analysis was established to act as a liaison point for collaborative efforts between Chief of Naval Operations Assessment Division/Capability Analysis Group, (N81/N00X), and NPS. This cooperative effort provides valuable opportunities for faculty and student professional development at NPS while enhancing N81/N00X's ability to conduct studies, assessments, analyses, and evaluations of plans, program and strategies in support of the Chief of Naval Operations.

SEALIFT CAPABILITY: SIZE, COMPOSITION, AND EMPLOYMENT

W. Matthew Carlyle, Associate Professor
Department of Operations Research
Sponsor: Naval Surface Warfare Center (NSWC) Carderock Division

OBJECTIVE: To extend and improve an optimization-based decision support system for sealift capability assessment to address seabasing, Combat Logistics Force (CLF) fleet restructuring, CLF ship replacement, assessment of new high-speed logistic ship designs, and other analyses.
OPERATIONS RESEARCH

MILITARY APPLICATIONS OF OPTIMIZATION

W. Matthew Carlyle, Associate Professor
Department of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: The objective of this research is to continue to respond to emerging needs in the Navy for operational decision support by developing mathematical models of real decision problems, using cutting-edge optimization algorithms to solve these problems, and designing and delivering prototypical decision support tools to the appropriate commands that are tasked with solving these problems. Past research has included US Navy multi-ship multi-mission planning for large combat operations, unmanned aerial system planning and assignment, US Navy logistics, and many others.

COLLABORATIVE INITIATIVE FOR LAYERED SENSING PROJECT

Timothy H. Chung, Assistant Professor
Department of Operations Research
Sponsor: Johns Hopkins University, Applied Physics Laboratory

OBJECTIVE: This collaborative research investigated the development, evaluation and delivery of complete, operational prototypes of various, optimization-based planning systems for supporting the Maritime Operations Center (MOC) and Maritime Headquarters planning staff in a wide range of maritime operational missions: Strike; Information, Surveillance, and Reconnaissance; Theater Security and Cooperation; Theater Ballistic Missile Defense; Anti-submarine Warfare; Logistics routing; Transit planning; Maritime Interdiction Operations. These planners could be integrated, ultimately, into a larger Command and Control (C2) planning suite to provide local staff with the ability to quickly generate course of actions based on concept of operations, and potential enemy courses of actions for further evaluation.

This partnership with JHU/APL under the Cooperative Research and Development Agreement (CRADA NCRADA-NPS-09-0132) jointly researched and developed a series of optimization-based decision-support tools to aid in operational maritime mission planning. An additional goal was for any developed decision aids to be incorporated into a Service-Oriented Architecture (SOA) that will integrate and display its situational and operational data by applying optimization to discover and recommend a best course of action from which the planner can choose.

SUMMARY: This effort represented initiation of collaborative research and development between the Naval Postgraduate School and the Johns Hopkins University, Applied Physics Laboratory in the area of Layered Sensing. The collaborators generated working documents and courses of action for near-term (FY11) research efforts in support of strategic, operational, and tactical asset planning, tasking, information-gathering, resource allocation and optimization, and data fusion for a wide range of mission scenarios and at diverse spatial, temporal, and operational resolutions.

Dr. Chung travelled to meet JHU/APL collaborators for a site visit in March 2010, engaging in numerous research discussions pertaining to relevant academic scenarios of interest in the layered sensing environment. Both NPS and JHU/APL collaborators worked to outline the scope and objectives of future cooperative research efforts.

PRESENTATIONS:

Johns Hopkins University, Applied Physics Laboratory, Laurel Hills, MD (08 Mar 2010)
Presented for joint research and collaboration at the JEFX10-3 fleet effort

Joint Expeditionary Force Experiment, Norfolk, VA (10 Mar 2010, 13 Apr 2010)
Presented the NPS Situational Awareness for Surveillance and Interdiction Operations (SASIO) decision support system for use at JEFX10-3 live fly
OBJECTIVE: The Naval Postgraduate School (NPS) developed and deployed the Situational Awareness for Surveillance and Interdiction Operations (SASIO) modeling framework in support of the Navy Maritime Operations Center (MOC) during the JEFX10-3 Live Fly Experiment. SASIO leverages probability, stochastic, and optimization models to determine efficient and effective allocation of Intelligence, Surveillance, and Reconnaissance (ISR) assets. The decision support software, called SASIO:Command, was deployed in the MOC at the Mitscher Center to provide recommendations for unmanned aerial vehicle (UAV) search routes to the Intel Cell in support of numerous Navy operational threads.

SUMMARY: SASIO enables the use of integrated analytic models for generating, maintaining, and enhancing situational awareness for numerous operational contexts. These models include a probabilistic representation of likely target locations in the area of operations (AO) as well as a method for integrating new information (e.g., intel injects), a stochastic process model for describing the possible motions of enemy elements in the AO, and also an optimization model for determining the best location(s) to search using limited ISR resources. The operator interface to these SASIO models is through the decision support tool, SASIO:Command, which provides visualization of the current situational awareness map (i.e., probabilities of target presence in different locations), Blue Force status and location information, as well as interactive panels for inputting gathered information and generating optimized search routes. Further, the network-capable SASIO:Command software facilitates machine-to-machine communication for receiving information, e.g., intelligence reports, from multiple data sources and, if needed, transmitting information, e.g., tasking commands, to consumers.

In particular, operational threads in JEFX10-3 utilizing SASIO:Command included the Joint Convoy Protection (JCP), Joint Raid Insertion (JRI), Joint Personnel Recovery (JPR), and Urban Targeting (UT) threads. The need to allocate an available ISR asset, for example, the Buster or T-Raven UAVs, in these threads provided opportunities to demonstrate the benefit of decision support generated by the SASIO modeling framework.

A number of limitations of SASIO were identified through the course of the experimentation. The SASIO modeling framework is designed for surveillance missions; however, in addition to surveillance there is often a need to conduct tactical target tracking. Attempts to use SASIO to provide real-time situational awareness on tracked targets were ineffective. Further, the current SASIO models for target motion require only one type of targets (e.g., dismounts versus mounted threats) present in the AO. The ability to address heterogeneous target motion types would enhance the applicability of the SASIO models to more realistic settings. Also, the validity and quality of information varies with the source of the data, such that addition of user specification of the “trustworthiness” of incoming intelligence would aid in the fidelity of the resulting situational awareness map. Another limitation in the search route optimization is the simplified heuristic (“search the most likely location weighted by distance”) used, which fails to capture additional constraints such as denied flight areas (e.g., locations where surface-to-air threats may be present) or remaining endurance of assets.

Use of SASIO enabled a reduction in the time to develop a search plan, even in the scenarios of limited search complexity encountered in JEFX10-3. This time savings was projected by participants to be more significant as search complexity increased. Use cases for which SASIO was identified as valuable included complex search problems (e.g., large number of targets and/or ISR assets, large search area, complex topography), taking into consideration ISR asset limitations such as remaining endurance and/or dealing with dynamic search problems. Limitations of the current version of SASIO include a need for more search objectives (e.g., minimize time to detect) and more robust target and blue force motion models. As expected, SASIO was found to have more utility in broad area search situations than in close tracking of targets.

From Quicklook memo issued by COMSECONDFLT, 10 May 2010
One of the recommendations made was to “consider putting SASIO to sea for use in confined waters or straits transit.” He agreed in principle with the recommendation and asked us to work with the C2F N7 (Director of Training) and CTF 26 (Amphibious task Force) to consider using SASIO during pre-deployment training work-up cycles where the ARG/MEU and Naval Expeditionary Forces (e.g. Riverine or Naval Construction Battalion) training cycles overlap.

PRESENTATIONS:
Monterey Bay Aquarium Research Institute, Moss Landing, CA (26 Aug 2010)
Presented for collaborations in decision support for marine autonomy

Military Operations Research Society Symposium, Quantico, VA (23 Jun 2010)
Presented as key lecture at special session for unmanned vehicles

Johns Hopkins University, Applied Physics Laboratory, Laurel Hills, MD (08 Mar 2010)
Presented for joint research and collaboration at the JEFX10-3 fleet effort

Joint Expeditionary Force Experiment, Norfolk, VA (10 Mar 2010, 13 Apr 2010)
Presented the NPS Situational Awareness for Surveillance and Interdiction Operations (SASIO) decision support system for use at JEFX10-3 live fly

University of California at Merced, Merced, CA (30 Apr 2010)
Presented at Electrical and Computer Engineering department seminar

THESES DIRECTED:


MCESG ASSIGNMENT TOOL
Emily Craparo, Research Assistant Professor
Department of Operations Research
Sponsor: U. S. Marine Corps Operations Analysis Division (OAD)

OBJECTIVE: The objective of this study is to create an optimization model and tool that streamlines the assignment process of MSG watchstanders based on a set of established assignment criteria (assignment restrictions, detachment needs, etc.). Criteria are to be adjustable to coalesce with the changing requirements of each MCESG assignment period. The MCESG assignments section will be the primary users of the optimization model/tool and will employ its capabilities throughout the year.

SUMMARY: Model parameters and structure were established through site visits and discussions with MCESG personnel. Two optimization models were formulated and implemented in GAMS. The first, a network-based model, provides an MCESG-relevant solution to the classical assignment problem. The second model, an integer linear program-based mode, incorporates detachment-level constraints required by MCESG. An Excel-based tool was created to provide an interface by which a non-specialist user can utilize these models. This work is of a continuing nature. In 2011, the tool was demonstrated via an assignment run in parallel with MCESG’s manual assignment. A
comparative analysis of the results generated by this tool vs the results generated through the manual assignment process has been written and provided to MCESG for feedback. Work remaining to be completed in 2011 includes streamlining of the data entry process, addition of tools for solution analysis and visualization, and replacement of the GAMS solver with a solver that does not require a license.

2009 CHILE-USA NAVAL OPERATIONS RESEARCH WORKSHOP
Robert F. Dell, Professor
Department of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: Deliver a Naval Operations Research workshop to the Chilean Navy.

SUMMARY: A workshop was held for the Chilean Navy on 2-4 December 2009 in Valparaiso, Chile. The workshop was organized by the Office of Naval Research and the Chilean Navy at the request of the Chilean Navy and in consultation with NPS Operations Research (OR) faculty. Workshop speakers included both Chilean and United States researches with most being NPS OR faculty.

USMC F-35 LIGHTNING TRANSITION PLANNER
Robert F. Dell, Professor
Department of Operations Research
Sponsor: Operations Analysis Division, USMC

OBJECTIVE: Develop a prescriptive optimization model to plan pilot and maintainer accessions and transitions to F-35 squadrons.

SUMMARY: The investigators have developed a prescriptive optimization model embedded in an Excel-based graphical user interface to plan monthly USMC pilot and maintainer accessions and transitions to F-35 squadrons over a 13 year planning horizon. As the USMC transitions from AV-8 and F-18 squadrons to F-35 squadrons, the optimization model allows the development of personnel plans to ensure adequate numbers of qualified personnel by experience and rank are available for new F-35 squadrons.

FDA OPTIMIZATION SUPPORT
P. Lee Ewing, Research Associate Professor
Department of Operations Research
Sponsor: Army G-8, Forced Development Directorate, Warfare Analysis Division

OBJECTIVE: The investigator will provide study, analysis, modeling and simulation, and use of analytical tools support to assist the Chief of the Army G-8 Force Development Directorate’s Warfighting Analysis Division (DAPR-FDA) in the fulfillment of the division’s mission. The proposed study focuses on: (1) Providing DAPR-FDA study, analytical, modeling, and technical support to develop optimization models that examine budget year distribution of equipment to maximize the Army’s equipment readiness. (2) Providing study, analytical, modeling, and technical support to DAPR-FDA as they develop in house optimization models which aid the analysis of alternative EPEG POM investment strategies to satisfy multiple objectives, e.g., funding the development and procurement of capabilities in terms of enhancing the Army’s proficiency, sufficiency, and expectancy. (3) Provide support for student’s experience tours, which will enable NPS to continue to refine existing optimization models once developed by the NPS OR faculty and DAPR-FDA staff. (4) Provide continued reach-back support for the Analysis Division staff so they become an integral player in the continued development of the models and resulting analysis.

SUMMARY: Work continued from FY2009 on the Optimal Resource Allocation Model (ORAM) and the Capital Planning Model (CPM). Focus for ORAM research was exploring new uses for the model and training the sponsor’s analysts in its use. Focus for the CPM was on the redevelopment of the objective function. The primary investigator
conducted several engagements with the sponsor’s analysts and management to identify the objectives and associated attributes in the development of the qualitative value model which has become the objective function for the capital budgeting optimization. Analysis results by the sponsor’s analysts have been very well received by senior Army leadership. Continued use is expected to impact Army equipping policy and long-standing decision making processes in the Pentagon. This project has been continued into FY2011 as R6AE7.

PRESENTATIONS:

IATF SOCIAL NETWORK FUNCTIONAL ANALYSIS
P. Lee Ewing, Research Associate Professor
Matt Carlyle, Associate Professor
Dave Alderson, Assistant Professor
Department of Operations Research
Sponsor: Interagency Task Force, United States Special Operations Command

OBJECTIVE: The investigators will research and develop appropriate optimization tools, and use the analytical tools to assist the Chief of the United States Special Operations Command’s Interagency Task Force (USSCOM IATF) in the fulfillment of the division’s mission. The proposed study focuses on: (1) Providing USSCOM IATF optimal interdiction analysis of personnel and equipment moving from one location to another. (2) The study of functional networks and the development of models to efficiently analyze these functional networks. (3) Research social network analysis built upon the functional network development and analysis. (4) Provide support for student’s experience tours and theses, which will enable the NPS Operations Research department (OR) to continue to refine functional detail essential for correct specification of the underlying social networks. (5) Provide continued reach-back support for the IATF staff so they may institutionalize gains made as a result of this project.

SUMMARY: This research concentrated on two areas: 1) development of a dynamic social analysis model to help the sponsor investigate the veracity of forecasting political and social movements after the system receives a shock. 2) development of a social network functional analysis model. The first effort resulted in two thesis’s, with working
models presented to the sponsor. The second effort resulted in a simple social network model with two production functions as a proof of concept. This project ended in FY2010.

THESES DIRECTED:

Garrick, Ronald (June 2010). “Modeling Stakeholder Decision Logic: A Case Study of Lebanese Hezbollah.”

Burciaga, Aaron (June 2010). “A Dynamic Model for Political Stakeholders: Forecasting the Actions and Relationships of Lebanese Hezbollah with Markov Decision Processes.”

SUPPORT TO DTRA INNOVATION OFFICE

Ronald D. Fricker, Jr., Associate Professor
Department of Operations Research
Sponsor: Defense Threat Reduction Agency

OBJECTIVE: Conduct fundamental and applied research into statistical methods and operations research techniques for biosurveillance.

SUMMARY: NPS students conducted fundamental and applied research into statistical methods and operations research techniques that can be used by the Department of Defense (DoD) to improve detection of bioterrorism through the routine surveillance of health-related data.

PUBLICATIONS:

Hagen, K.S., R.D. Fricker, Jr., K. Hanni, S. Barnes, and K. Michie, Assessing the Early Aberration Reporting System’s Ability to Locally Detect the 2009 Influenza Pandemic, in submission.

PRESENTATIONS:


LT Katie Hagen: “Assessing the Effectiveness of the Early Aberration Reporting System (EARS) with Application to Bioterrorism”

LCDR Manuel Ganuza: “Assessing the Effectiveness of Cumulative Sum Poisson- and Normal-based Tests for Detecting Rare Diseases”

LT Jason Dao: “Assessing the Effectiveness of Biosurveillance via Discrete Event Simulation”

LT Randi Korman: “Assessing the ESSENCE Biosurveillance System as Used by the Navy and Marine Corps: User Training, System Employment, and Perceived Value”


THESES DIRECTED:


OPTIMIZING THRESHOLD-BASED SURVEILLANCE SYSTEMS

Ronald D. Fricker, Jr., Associate Professor
Department of Operations Research
Sponsor: U.S. Army Research Office

OBJECTIVE: To develop a mathematical framework for optimally incorporating prior information (intelligence) about an adversary’s intentions into a threshold-based surveillance system aimed at detecting the adversary’s activity.

SUMMARY: This research will develop a mathematical framework for incorporating prior information (intelligence) about an adversary’s intentions into a surveillance system via the use of: (1) threshold-based decision rules and (2) optimized thresholds that maximize the probability of detection subject to a constraint the number of false positive signals. It will generalize the results of Fricker & Banschbach (2010) to situations where data are not normally distributed, data sources are correlated, and, time permitting, where data are autocorrelated.

MODELING ESSENTIAL SERVICES, SECURITY, ECONOMICS AND EMPLOYMENT ASSOCIATED WITH ATTITUDES ABOUT LOCAL GOVERNMENT AND EXTREMIST GROUPS

Ronald D. Fricker, Jr., Associate Professor
Department of Operations Research
Sponsor: U.S. Army Center for Analysis

OBJECTIVE: To develop statistical models from survey data to describe the association between indigenous population opinions about essential services, security, employment and economics, and attitudes towards their government.

SUMMARY: This research will develop models that appropriately describe the association between indigenous population opinions about essential services, security, employment and economics, and attitudes towards their government and external extremist groups. In so doing, it will estimate the parameters for these models using data from actual surveys and document the resulting models for use in information warfare (IW) simulations.
OPERATIONS RESEARCH

DESIGN OF EXPERIMENTS FOR FOLLOW-ON OPERATIONAL TEST OF THE AEGIS MODERNIZATION PROGRAM
Patricia A. Jacobs, Professor
Donald P. Gaver, Professor
Department of Operations Research
Sponsor: Naval Sea systems Command

OBJECTIVE: Support and strengthen the Aegis Modernization (AMOD) program by guiding and assisting in Developmental Tests (DT), Integrated Tests (IT), Initial Operational Test and Evaluation (IOT&E), Follow-On Test and Evaluation (FOT&E) planning. Advise on use of Design of Experiments (DOE) methods to AMOD T&E. Carry out test preview using analytical-mathematical-probabilistic models. Such steps will expedite choice of test design factors (e.g. attacker/raid type, speed, altitude, course, etc.) and quantitative factor levels.

TRAINING AND RESEARCH SUPPORT FOR DIRECTOR, OPERATIONAL TEST AND EVALUATION
Patricia A. Jacobs, Professor
Department of Operations Research
Sponsor: Director, Operational Test and Evaluation

OBJECTIVE: Purpose of the research is to develop training and reference material and new methodology for operational testing use emphasizing modeling and simulation.

SUMMARY: Models to assess reliability growth and Bayesian design of experiments for tests with few observations have been proposed, developed and studied.

USING EFFICIENT DESIGN OF EXPERIMENTS TO EXPLORE THE ARMY’S EQUIPPING ENTERPRISE SYSTEM
Rachel T. Johnson, Assistant Professor
Department of Operations Research
Sponsor: Army G-1

OBJECTIVE: Use experimental design techniques to study the Enlisted Specialty G-1 model.

SUMMARY: The Army G-1 extensively uses models as part of its process of developing, managing, and executing personnel plans, programs, and policies. We used experimental design and analysis techniques to assess sensitivities, identify critical input data, quantifying interactions, and generating distributions of output results from the enlisted specialty model. These efforts provided G-1 with timely insights about model performance and results.

PUBLICATIONS:

PRESENTATIONS:
OPERATIONS RESEARCH

**THESES DIRECTED:**


**MODELING THE IMPACT OF EVENTS ON THE SIMULATED AFGHANISTAN POPULATION AND MODELING THE IMPACT OF EVENTS ON THE SIMULATED HELMAND PROVINCE**

Rachel T. Johnson, Assistant Professor
Department of Operations Research
Sponsor: TRAC - Monterey

**OBJECTIVE:** Apply experimental design methodology to study the relationship between inputs and outputs in the simulated Cultural Geography model of Afghanistan, developed by TRAC – Monterey.

**SUMMARY:** TRAC Monterey was tasked with modeling the impact of events on population specific sub-groups in several provinces in Afghanistan. Three main goals of the project were to (1) provide security for and engage PAK-AF population, (2) marginalize insurgency, and (3) increase government capacity and legitimacy. This research supported those goals by using experimental design and analysis and response surface methodology in order to study the simulated Cultural Geography model.

**PUBLICATIONS:**


**PRESENTATIONS:**


**THESES DIRECTED:**

OBJECTIVE: Develop and evaluate decision aids for use by Navy staffs to plan maritime operations.

SUMMARY: This research will produce, develop, evaluate and deliver complete, operational prototypes of various, optimization-based planning systems for supporting the maritime operations center and maritime headquarters planning staff in maritime operational missions ranging from strike; information, surveillance, and reconnaissance; theater security and cooperation; theater ballistic missile defense; anti-submarine warfare; logistics routing; transit planning; maritime interdiction operations; and others. In 2010 this program further advanced prototypic decision aids related to maritime operational level planning. These included models for naval mission planning (Naval Mission Planner), combat logistics scheduling (Replenishment at Sea Planner), area anti-submarine warfare planning (ASW Planner), and unmanned sensor mission planning (Situational Awareness for Surveillance and Interdiction Operations: SASIO). The SASIO decision aid was selected by Commander, Second Fleet and Navy Warfare Development Command to participate in Joint Expeditionary Force Experiment (JEFX) 10. Its success was evidenced by inclusion in the Navy’s Tactical Publication 3-32.1 for MOC planning. In addition, work was started in coordination with PEO C4I PMA 150 to integrate the Navy Mission Planner in a new operational planning suite of tools.

PUBLICATIONS:


PRESENTATIONS:


TECHNICAL REPORTS:

THESES DIRECTED:


INTEGRATION OF OPERATIONAL-LEVEL OPTIMIZATION DECISION AIDS IN THE NEXT GENERATION

Jeffrey E. Kline, Senior Lecturer
Department of Operations Research
Sponsor: John Hopkins University Applied Physics Laboratory

OBJECTIVE: Develop operational level optimization decision aids for potential use in mission planning for integration into the Next Generation Maritime Operations Center. These decision aids involve a set of operation planners currently in development by NPS faculty and operationally experienced students. The students may travel to JHUAPL to study platform support for maritime irregular warfare and conduct other related short-term studies. Their development involves a phased program to transition each of the best candidate decision aids from a stand-alone model to a complete prototype that will support operational evaluation and be capable of integration into a Maritime Operations Center.

MARITIME INFORMATION SHARING TASKFORCE

Jeffrey E. Kline, Senior Lecturer
Department of Operations Research
Sponsor: Department of Transportation

OBJECTIVE: The Maritime Information Sharing Taskforce (MIST) is an interagency effort to capture best practices in information sharing, create a structure for collaborative problem solving, and convey unique local issues to national policy makers. MIST was stood up in the summer of 2008 as a prototype process to help the federal maritime domain awareness effort incorporate the input of the private sector into the sharing of maritime security information. The MIST team is led by the Maritime Defense and Security Research Program (MDSRP) at the Naval Postgraduate School (NPS) in partnership with several federal agencies: the Maritime Administration (MARAD), the National Maritime Coordination Office (NMCO- formally the Office of Global Maritime Situational Awareness-OGMSA) and Global Maritime and Air Intelligence Integration (GMAII), the U.S. Coast Guard (USCG), Customs and Border Protection (CBP), and Naval Cooperation and Guidance for Shipping (NCAGS) as key partners.

SUMMARY: MIST was stood up in the summer of 2008 as a prototype process to help the federal maritime domain awareness effort incorporate the input of the private sector into the sharing of maritime security information. The MIST team is led by the Maritime Defense and Security Research Program (MDSRP) at the Naval Postgraduate School (NPS) in partnership with several federal agencies: the Maritime Administration (MARAD), the National Maritime Coordination Office (NMCO- formally the Office of Global Maritime Situational Awareness-OGMSA) and Global Maritime and Air Intelligence Integration (GMAII), the U.S. Coast Guard (USCG), Customs and Border
Protection (CBP), and Naval Cooperation and Guidance for Shipping (NCAGS) as key partners. Since its inception, MIST has conducted seminars and workshops in Port of Los Angles, Honolulu, Puget Sound, and Port of Delaware.

**NWDC CHAIR OF WARFARE INNOVATION**  
Jeffrey E. Kline, Senior Lecturer  
Department of Operations Research  
Sponsor: Navy Warfare Development Command

**OBJECTIVE:** Continued support to Navy Warfare Development Command (NWDC) Chair for Warfare Innovation at the Naval Postgraduate School (NPS). Since 14 May 2002 NWDC has leveraged the Chair’s position to invigorate and conduct research and analysis required to develop doctrine, tactics, techniques, procedures, and joint maritime concept of operations. The Chair continues to act as a liaison point for collaborative efforts between NPS research Institutes and Graduate Schools and NWDC. These collaborative efforts continue to provide valuable opportunities for faculty and student professional development at NPS while enhancing NWDC’s mission to foster naval innovation. Specific activities include sponsoring student travel in support of navy warfare research, hosting Innovation Workshop seminars, and sponsoring faculty labor for navy warfare research.

**NAVAL OPERATIONS ANALYSIS TO SUPPORT NORTHRUP GRUMMAN SHIP SYSTEM ANALYSIS**  
Jeffrey E. Kline, Senior Lecturer  
Matt Boensel, Senior Lecturer (Systems Engineering)  
Regina Kaiser, Research Associate  
Department of Operations Research  
Sponsor: Northrop Grumman Ship Systems, Inc

**OBJECTIVE:** The CRADA with Northrop Grumman Ship Systems is established to explore the use of analytical models, systems analysis, and warfare analysis to inform ship design.

**SUMMARY:** NGSB partnered with NPS to devise, build, develop, exercise, and assess a new analytical and modeling construct. NPS faculty expertise in independent defense planning scenario generation, determination of critical performance parameters, and tactical- and mission-level mathematical modeling is considered instrumental to project success. Furthermore, in the course of their NPS curriculum, OA students perform numerous short-term studies to include CONOPS development and concept development & experimentation projects and must complete a research thesis. Many of the joint studies and projects complement both contracted and independent MS&A research and development projects conducted at Northrop Grumman Shipbuilding, and are anticipated to provide innovative and provocative insights into evolving Navy and joint service mission needs, operating concepts, and analysis methodology. NPS supported Northrop Grumman work in CY2010 by creating additional defense guidance-like scenarios, generating tactical situations from those scenarios, modeling them in Naval Simulation System, and creating a tactical air defense model for missile defense. Analysis was conducted to show the value of lasers in air defense and, in a separate study, the contribution of the Future Surface Combatant in ballistic missile defense.
OPERATIONS RESEARCH

TAILORED EFFECTS, METRICS, AND RISK MANAGEMENT IS STRATEGIC PLANNING WORKSHOP FOR OPNAV N00X

Jeffrey E. Kline, Senior Lecturer
Wendy Walsh, Project Manager (MOVES Institute)
Anita Salem, Lecturer (Graduate School of Business and Public Policy)
Lyla Englehorn, DoD Contractor (National Security Institute)

Department of Operations Research

Sponsor: Department of Transportation

OBJECTIVE: Develop and deliver a two-day tailored executive education seminar and workshop for senior staff officers of the United States Navy in OPNAV N00X based on the Executive Learning Officer’s Effects, Metrics, and Risk Management in Strategic Planning workshop delivered by the Operations Research department.

SUMMARY: The Naval Postgraduate School (NPS) located in Monterey, California supports the U.S. Navy, other U.S. military branches, and foreign military services with postgraduate education for selected personnel. Additionally, NPS provides significant research capabilities to the Department of Defense (DoD). The Navy’s Executive Learning officer leverages the NPS Center for Executive Education and the Operations Research department to provide a four-day workshop covering topics of strategic planning, effects based thinking, metrics, and risk management. This is a senior team-oriented workshop where participants attend in groups of three to six and focus on a particular issue related to their organization or enterprise. OPNAV N00X, special assistants to the Chief of Naval Operations and unable to travel to Monterey, requested a focused two-day presentation in Washington D.C. which covered the primary subjects in the workshop and facilitation for advancing their strategic issues. This workshop was conducted in January 2010.

PREDICTION OF REMAINING USEFUL LIFE IN MECHANICAL COMPONENTS

Robert A. Koyak, Associate Professor

Department of Operations Research

Sponsor: Goodrich Corporation

OBJECTIVE: This CRADA was established to assist the doctoral research of CDR David Ruth, which involved applications to predicting remaining useful life in helicopter-related mechanical components. It expires in February 2011.

SUMMARY: There was no activity on this project in CY2010. It was used to provide travel and support to CDR David Ruth in this Ph.D. thesis research, which was completed in September 2009.

STATISTICAL SUPPORT TO THE APACHE BLOCK III TEST PROGRAM

Robert A. Koyak, Associate Professor

Department of Operations Research

Sponsor: U.S. Army Yuma Proving Ground

OBJECTIVE: This project supports research and analysis of data from testing the Apache helicopter fire-control radar at the U.S. Army Yuma Test Center.

SUMMARY: Data from a 1998 tests of the Apache fire-control radar (FCR) was used to develop a statistical methodology for determining radar detection errors using matching algorithms and a set of identified predictor variables. Computer software (S-Plus) was developed to implement the methodology, and delivered to the sponsor.

THESES DIRECTED:

Vaughan, Charles F., “Assessing the Effectiveness of the AH-64D Longbow Apache Helicopter Sensor in the Acquisition
STATISTICAL SUPPORT TO OAD USING THE COMBINED INFORMATION DATA NETWORK EXCHANGE (CIDNE) AFGHANISTAN DATABASE

Robert A. Koyak, Associate Professor
Samuel E. Buttrey, Associate Professor
Lyn R. Whitaker, Associate Professor

Department of Operations Research

Sponsor: U.S. Marine Corps (USMC) Operations Analysis Division (OAD)

OBJECTIVE: This research supports OAD operations in theater through the analysis of IED and casualty event data provided in CIDNE and supplemental data sources.

SUMMARY: Activity on this project in CY2010 focused on development of statistical models used to describe emplacements of IEDs on roads in Afghanistan, and on methods for characterizing Blue Force Traffic on road networks.

PUBLICATIONS:


THESES DIRECTED:


STATISTICAL TRAINING AND SUPPORT TO THE YUMA TEST CENTER

Robert A. Koyak, Associate Professor
Lyn R. Whitaker, Associate Professor

Department of Operations Research

Sponsor: U.S. Army Yuma Proving Ground

OBJECTIVE: This proposal supports training and analytical support for the statistical activities of the U.S. Army Yuma Test Center.

SUMMARY: The U.S. Army Yuma Test Center (YTC) is engaged in testing a wide variety of military weapons and communications systems at the Yuma Proving Ground. These activities result in the generation of data that its personnel analyze in accordance with defined testing protocols. YTC has recognized the need for having its personnel trained in the statistical techniques that are useful in meeting its testing mission. During the summer of 2010, the PIs delivered statistical training on-site at YPG.

PRESENTATIONS:

Koyak, Robert A., Short course on statistical methods presented to the technical staff at the U.S. Army Yuma Proving Ground, 23–25 August 2010, Yuma, AZ.
OBJECTIVE: Model and analyze risk in military supply chains, focusing on the utilization of the newly developed concept of cargo unmanned aerial systems.

SUMMARY: We developed an Excel-based decision aid for optimally deploying and employing Cargo Unmanned Aerial Systems (CUAS) in a theater of operations and assessing the risk associated with such operations. The decision aid provides logistical plans that optimally utilize CUAS and other means of transportation and reduce risk. The model is based on a scenario given by the Operations Analysis Division of the Marine Corps, where a Battalion Landing Team (BLT), comprising three companies is in defense in an austere environment. The BLT needs to be resupplied from the forward arming and refueling point (FARP) using a given set of means of transportation, including CUAS. While carrying out logistical missions, the truck convoys are subject to risks from improvised explosive devises and ambushes, and aerial assets, such as helicopters and CUAS, are subject to interception.

PRESENTATIONS:
Presentation to sponsor, COL Brown, OAD, at NPS, August 2010
Presentation to sponsor, COL Brown, OAD, at NPS, February 2011

THESES DIRECTED:

OBJECTIVE: The proposed work consists of developing a prototype of a tactical decision aid (TDA) for maritime search and surveillance missions during counter-drug operations, with a particular focus on the situation faced by the Joint Inter-Agency Task Force (JIATF) South. Mr. Scali of JIATF South has reviewed a preliminary version of the attached proposal and approved its aim and direction. The proposed TDA will be based on models and algorithms developed in previous ONR-supported research, which will be modified and adjusted to the special situation and needs of JIATF South.
A DYNAMIC MODEL FOR POLITICAL STAKEHOLDERS

Moshe Kress, Professor
Roberto Szechtman, Associate Professor
Mike Atkinson, Assistant Professor
Department of Operations Research
Sponsor: SOCOM

OBJECTIVE: To develop a dynamic model to capture cause-and-effect relations resulting from actions by stakeholders, and analyze the impact of external shocks over a time horizon lasting 3 to 5 years. Shocks include the addition or subtraction of stakeholders and dramatic changes in interests, states, preferences, or the ability to form coalitions. Shocks may occur because of assassinations, coup d’êtsats, etc. The model is applied to Lebanon and focuses on Lebanese Hezbollah.

SUMMARY: We consider a social/economic/political situation comprising several stakeholders.

We examine Lebanese Hezbollah and its interactions with other entities; however this analysis can be applied to other scenarios. The situation evolves over (discrete) time, with the stakeholders taking observable actions at each time step. We formulate a Markov decision process to drive the model dynamics. At each stage every stakeholder is characterized by a state and for each state we associate a set of feasible actions that the stakeholder may take. At the end of each stage, depending on the actions taken by all stakeholders, the state of each stakeholder changes.

KEYWORDS: Markov decision process, Influence diagrams, Lebanese Hezbollah.

PRESENTATIONS:
SOCOM, April 2010. (Brief to sponsor).

THESES DIRECTED:
Garrick, Ronald (Graduated June 2010). “Modeling Stakeholder Decision Logic: A Case Study of Lebanese Hezbollah.”
Burciaga, Aaron (Graduated June 2010). “A Dynamic Model for Political Stakeholders: Forecasting the Actions and Relationships of Lebanese Hizbullah with Markov Decision Processes.”

DYNAMICS OF POPULAR ATTITUDES IN COUNTERINSURGENCY SITUATIONS

Moshe Kress, Professor
Roberto Szechtman, Associate Professor
Mike Atkinson, Assistant Professor
Department of Operations Research
Sponsor: TRADOC/TRAC/TRISA

OBJECTIVE: Develop rational choice models that capture situational awareness and population-behavior effects in counterinsurgency situations.

SUMMARY: We develop a suite of utility-based models that capture the effects of situational awareness, benefits, imposition and coercion in COIN situations. The resulting mathematical models reveal interesting insights regarding the effects of key state variables in an insurgency situation at steady state. In particular, we show cascading and tipping point effects.

PUBLICATIONS:

PRESENTATIONS:


IRREGULAR WARFARE AUTOMATED GAMES

Moshe Kress, Professor
Roberto Szechtman, Associate Professor
Mike Atkinson, Assistant Professor
Department of Operations Research
Sponsor: Center for Army Analysis

OBJECTIVE: To portray the long-term effect of interactions among different groups of people in intra- and inter-social networks, taking into account each group’s idiosyncratic attitude towards the insurgents and the government, and their manifested behavior

SUMMARY: Our research is a first attempt to model population behavior in a COIN environment where two types of social networks, Intra-SN and Inter-SN, are taken into account.

MODELING COUNTERINSURGENCY (COIN) OPERATIONS

Moshe Kress, Professor
Roberto Szechtman, Associate Professor
Mike Atkinson, Assistant Professor
Department of Operations Research
Sponsor: TRADOC/TRAC/TRISA

OBJECTIVE: Develop models that capture the interrelations among key factors in counterinsurgency situations.

SUMMARY: We develop a suite of models that address several facets of COIN operations. The first model attempts to answer the following questions: Under what conditions should government forces attack insurgent strongholds? How should the government allocate its attacking force across different strongholds when the insurgents’ threat to the government’s civilian population must be taken into account? How should the government respond to “smart” insurgents who anticipate the government’s plan of attack and prepare accordingly? How do the results change when collateral civilian casualties resulting from government attacks on insurgent strongholds are taken into account? The second model is a utility-based model that captures the effects of situational awareness, benefits, imposition and coercion in COIN situations. The resulting mathematical model reveals interesting insights regarding the effects of key state variables in an insurgency situation at steady state. In particular, we show cascading and “tipping point”
effects. The third model is a dynamic model that addresses, from a different angle, the issues presented in the second model.

**PUBLICATIONS:**


**PRESENTATIONS:**


TRISA, Ft. Leavenworth, June 2010. (Brief to sponsor)

JPL, ATHENA meeting, Caltech Pasadena, May 2010.

**SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) FOR COUNTER NARCOTICS, COUNTER TERRORISM AND COUNTER PROLIFERATION**

Col Edward J. Lesnowicz, Jr. USMC (ret), Research Associate

Karl Gunzelman, Visiting Professor (National Security Affairs)

Department of Operations Research

Sponsor: Office of Naval Research

**OBJECTIVE:** Provide a service to the Office of Naval Research (ONR) as a “Other Sponsored Activity” to identify small business opportunities in support of OSD CN/CT/CP Directorate, and allocate 1.7 million in SBIR/STTR funding in accordance with ONR guidance.

**SUMMARY:** The Naval Postgraduate School supported and coordinated the submission, selection, and contracting of SBIRs/STTRs applications for the ONR. This support focused on technologies that support the counternarcotics/counterterrorism missions of DoD. It addressed the full spectrum of counternarcotics/counterterrorism related research, development of technology and engineering products. The purpose of this effort was to provide COCOMs with operational, applied services and equipment that would aid in disrupting, deterring and denying the flow of drugs, people, money, and weapons related to illegal trafficking.
A call for proposals was published and several candidate companies were identified and vetted by the selection team. The team provided the ONR SBIR manager’s office:

1. Analysis and recommendations for prioritizing strategic goals of the program, budget planning, resource allocation and budget execution.
2. Analyses and recommendations to ONR SBIR manager upon demand.
3. Responded to all requests for information within 5 working days.
4. Submitted final FY program selections, with budgetary guidance in an Excel Format.

ONR made the final selection of the candidate companies. Upon the ONR decision, the selection team completed the necessary documentation and monitored the activities of the awardees.

**SUPPORT OF US MARINE CORPS TOTAL LIFE CYCLE MAINTENANCE WORKING GROUP (TLCM-WG)**

Col Edward J. Lesnowicz, Jr. USMC (ret), Research Associate  
Dan Nussbaum, Visiting Professor  
Gary Horne, Research Professor  
Greg Mislick, Lecturer  
Mary MacDonald, Research Associate  
Department of Operations Research  
Sponsor: USMC, Total Life Cycle Working Group

**OBJECTIVE:** Provided two research teams in support of research issues identified by the TLCM-WG. The research topics were:

1. LA V Automated Data Collection Assessment.  
   Team 1: Dr Dan Nussbaum, Mr Greg Mislick, Lecturer, and Capt Andy Burrow

2. TLCM-AT Model Assessment, Simulation Development and Analysis.  
   Team 2: Dr Gary Horne and Ms Mary MacDonald, RA

The TLCM-AT team used faculty and available associates to identify the data inputs, processes, and models that are currently in use by the United States Marine Corps, TLCM -AT tool. The ADCI team conducted an assessment of the reliability of automated data collection currently being developed by the Light Armored Vehicle (LAV) program.

**SUMMARY:** LA V Automated Data Collection Assessment: The Marine Corps School of Infantry (SOI) West had collected data for Light Armored Vehicles (LAV) using both manual and automatic methods. The objectives of this research was to determine what, if any, errors are introduced to data collected under an automated data collection system, and what data collection, cleansing and modeling techniques should be used to adjust for these errors. During this research it was discovered that serious data collection flaws existed in the SOI collection plan. Consequently, the research used available data to establish a recommended statistical process for future data collection, and provided the sponsor with recommendations to correct the data collection process.

TLCM-AT Model Assessment, Simulation Development and Analysis: This work focused on identification of any built in assumptions in TLCM-AT, then assessed the impact of these assumptions on commonly used outputs, and provided a practical recommendations on minimizing any major impacts. This research did not identify any assumptions in the code or outputs that had a major impact on the results of various maintenance scenarios and consequently provided the sponsor with a high level of assurance that the model acted appropriately within the scenarios provided.
PUBLICATIONS:

PRESENTATIONS:


THESES DIRECTED:

OPTIMAL SURVEILLANCE PATROL
Kyle Y. Lin, Associate Professor
Michael Atkinson, Assistant Professor
Timothy Chung, Assistant Professor (Systems Engineering)
Department of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: This research proposes to study a class of problems in which a defender dynamically allocates its surveillance assets in anticipation of an attack. The surveillance asset can be an unmanned vehicle, a camera mounted on a blimp, or a patrol officer. The proposed research will develop robust methods to counter the enemy’s strategy in the worst-case scenario.

SUMMARY: This project is planned for 10/1/2010 to 12/31/2011. In the first three months, the research team studied the problem where the defender can assess the probability distribution over potential attack locations. The problem was modeled by a Markov decision process. Although the optimal solution can be solved by computational methods for small problems, the computation becomes practically infeasible for problem sizes that arise in real-world applications. The research team developed a heuristic solution based on Gittins index, and the initial numerical tests showed promising results. In CY2011, the goal is to solve the problem where the enemy will attack the most vulnerable location.

DEVELOPING AND ASSESSING THE MARINE AIR GROUND TASK FORCE TACTICAL WARFARE SIMULATION (MTWS)
Thomas W. Lucas, Associate Professor
Department of Operations Research
Sponsor: MTSD, Training Education Command

OBJECTIVE: Support and coordinate the submission, selection, and contracting of SBIRs/STTRs applications for ONR. This support will focus on technologies that support the counternarcotics/counterterrorism missions of DoD.
OBJECTIVE: Provide direct support to the JIEDDO J9 staff, including a person on-site, by improving the ability to rapidly build or extend models and scenarios, conduct computational experiments (through better design of experiments), and analyze/synthesize the output from multiple experimental tools.

SUMMARY: The SEED Center for Data Farming continued ongoing support to JIEDDO in the counter improvised explosive device (C-IED) fight. An analyst located on-site gave direct staff support in helping JIEDDO with data architecture, metric definition, remote sensing and graphical information systems, modeling and simulation methods, analysis, and visualization to aid specific and ongoing efforts. The SEED Center also organized two workshops in which teams of subject matter experts, modelers, and analysts examined cultural geography models. Direct analytical support included participation in route clearing studies, exploring a social network model of Helmand province, and augmenting field experiments at Camp Roberts and Yuma Proving Grounds with simulation. Methodological advances to support the simulation studies were made by developing and applying algorithms to better handle large numbers of discrete and/or categorical factors in experimental designs and new sequential procedures.

PUBLICATIONS:


PRESENTATIONS:


THESES DIRECTED:


OPERATIONS RESEARCH

ESTABLISHMENT OF EFFICIENT DESIGNS OF EXPERIMENTS IN SUPPORT OF THE US ARMY WARFIGHTING ANALYSIS DIVISION’S (WAD) ANALYSIS OF THE EQUIPPING ENTERPRISE SYSTEM

Thomas W. Lucas, Associate Professor
Susan M. Sanchez, Professor
Department of Operations Research
Sponsor: U.S. Army Warfighting Analysis Division

OBJECTIVE: The Army G-8 has developed the Agile Repast-based Agents for Decision Support (ARADS) model to support the process of ensuring that soldiers have the resources they need to efficiently and safely accomplish their missions. This model has a large number of inputs with potentially intricate interactions. Furthermore, there are sources of uncertainty associated with many of these inputs, e.g., costs, reliability, performance, usage rates, etc. This project will provide using state-of-the-art designs of experiments (DOEs) process to assess the uncertainty and to provide responsive analytical procedures for the Army resourcing decisions. The objectives will include assessing sensitivities, identifying critical input data, determining robust investment strategies, generating distributions on future possibilities, providing analytical augmentation, and providing designs, techniques and training for the G8. The ARADS model -- and the associated data and scenarios will be supported by the Simulation Experiment and Efficient Design (SEED) Center at NPS where the model, scenarios and data will leverage the computational power, DOEs, and analytical staff of the SEED Center.

ENABLING EFFICIENT HIGH-DIMENSIONAL DESIGN OF EXPERIMENTS FOR THE SYSTEM-OF-SYSTEMS SURVIVABILITY SIMULATION (S4)

Thomas W. Lucas, Associate Professor
Susan M. Sanchez, Professor
Department of Operations Research
Sponsor: U.S. Army Research Laboratory (ARL)

OBJECTIVE: The Survivability/Lethality Analysis Directorate (SLAD) of the U.S. Army Research Laboratory (ARL) is charged with analyzing the survivability, lethality, and vulnerability (SLV) of current and future battlefield systems. Increasingly, with network-enabled forces, the SLV of a system depends on the whole system-of-systems and therefore cannot be determined in isolation. Unfortunately, traditional analysis procedures, and the models used to support them, often focus on an individual system and are unable to adequately account for the effects of information flows over a common network. To address this shortcoming, SLAD, in collaboration with the Physical Science Laboratory (PSL) at New Mexico State University (NMSU), is developing the System-of-Systems Survivability Simulation (S4).

IMPROVING THE INTEGRATED TRAINING CENTER MODEL FOR USABILITY TO ENABLE ACCURATE TIME-TO-TRAIN MODELING

Thomas W. Lucas, Associate Professor
Susan M. Sanchez, Professor
Department of Operations Research
Sponsor: USMC Systems Command

OBJECTIVE: Perform a careful review of the Integrated Training Center (ITC) model and recommend enhancements to increase its fidelity. In addition, build a software wrapper around the ITC model to enable it to automatically be run using sophisticated design of experiments.

SUMMARY: Three workshops were held by the SEED Center that included the Joint Strike Fighter (JSF) Program Office, model developers, users (Air Force and Marine aviators setting up training centers), Marine Corps Operational
OPERATIONS RESEARCH

Analysis Division, SEED Center analysts, and outside simulation experts. Through these workshops, and extensive review of the ITC model, it was determined that the model was almost certainly producing optimistic estimates of the time-to-train. To improve the model, recommendations on how to include distributions on maintenance and weather delays were made. In addition, the SEED Center built, tested, and implemented a software wrapper that allows sophisticated experimental designs to be automatically run on a computing cluster. Several quick-turn analyses were performed on potential pilot induction schedules and available resources. Key factors were identified and threshold values determined that identify areas of potential risk.

PRESENTATIONS:


THESES DIRECTED: Two underway in 2011.

HUMAN PERFORMANCE AT SEA 2010
Michael E. McCauley, Research Professor
Department of Operations Research
Sponsor: Naval Surface Warfare Center, Panama City

OBJECTIVE: The objective of this research was to support the Human Factors Team of NSWC Panama City in the development of test plans, protocols, and performance measures to be included in the Littoral Combat Ship (LCS-1 and LCS-2) rough water trials.

SUMMARY: Tests and methods used in similar assessments from the U.S. Navy, the Netherlands, and Canada were reviewed and screened for possible inclusion in the LCS at-sea data collection for the rough water trials. A recommended set of measures and questionnaire survey instruments was submitted.

ONR WORKSHOPS ON HUMAN PERFORMANCE AND ENVIRONMENTAL STRESSORS
Michael E. McCauley, Research Professor
Department of Operations Research
Sponsor: Office of Naval Research, Code 34

OBJECTIVE: The objectives of this project were to participate in a series of meetings at ONR Headquarters and other locations to define a new research thrust for ONR on the topic of “Performance Shaping Functions of Environmental Stressors.”

SUMMARY: These workshops involved iteration and discussion of many potential environmental stressors and the selection of those most likely to induce human performance decrements in naval operations. Prof McCauley presented an overview of the research on environmental stressors with emphasis on ship motion, vibration, and noise. Additional discussions pertained to applying this ONR initiative toward the upcoming rough water trials for the Littoral Combat Ships.

PRESENTATIONS: Internal presentations were given to the Committee, as noted above.
OPERATIONS RESEARCH

PERFORMANCE SHAPING FUNCTIONS OF ENVIRONMENTAL STRESSORS: MOTION
Michael E. McCauley, Research Professor
Department of Operations Research
Sponsor: Office of Naval Research, Code 34

OBJECTIVE: Conduct applied research to support the revision of current human performance models and to update existing measurements and standards associated with the effects of ship motion on human performance and postural stability.

NPS COST ANALYSIS SUPPORT FOR CAPE
Gregory K. Mislick, Lecturer
Department of Operations Research
Sponsor: OSD, Cost Assessment/Program Evaluation (OSD, CAPE)

OBJECTIVE: The objective of this proposal is to support activities related to the investigator’s role as Chair of Cost Analysis during CY2010, Account #s R6ABA and R64BA. The OSD, Cost Assessment/Program Evaluation (CAPE) at the Pentagon is tasked to provide independent cost estimates on all major defense acquisition programs.

SUMMARY: OSD, CAPE requests that the PI secure an NPS student (or two) to conduct thesis research on costing topics of interests to both DoD and OSD, CAPE. This year, the research was conducted by an OA4702 Cost Estimation student, Major Bradley Sams, a student in the Information Systems and Technology Department. He is presently working on a thesis that is researching how software maintenance cost estimation is conducted, and attempting to find ways to better predict that maintenance cost using historical data. He is working with NAVAIR, the Air Force Cost Analysis Agency, and OSD/CAPE on this research. He is scheduled to graduate in September 2011.

The intent of the proposal is to pay for all travel and expenses incurred by the thesis students during their TDY to various cost organizations (R6ABA). Major Sams travelled to Washington, DC, and visited the commands working on this topic. The proposal also allows for the PI to attend the annual DoD Cost Symposium in February sponsored by OSD, CAPE (R64BA). It is a gathering of numerous cost estimators in the country, from DoD, industry, and academia. The four day symposium connect cost estimators and analysts in a highly informative fashion with the goal of increasing the accuracy of weapon acquisition cost estimates, and understanding how to deal with the risks that are inherent in large, state-of-the-art weapon systems purchases. It also offered a useful selection of educational and training opportunities on best practices, and the state-of-the-art in cost estimating. Information gained during this symposium is then added to the course material for the OA4702 Cost Estimation class, keeping it continually relevant and current.

THESES DIRECTED:

OPERATIONS RESEARCH

A SIMULATION-OPTIMIZATION MODEL OF ORGANIZATIONAL CAPACITY FOR THE ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT OFFICE
Scott Nestler, Assistant Professor
Department of Operations Research
Sponsor: US Army Corps of Engineers, Sacramento District Office

OBJECTIVE: Develop a simulation-optimization model of organizational capacity for the Sacramento District office of the Army Corps of Engineers to: (1) provide analytical underpinning to their request for funding as part of the annual President’s Budget (PG) submission, and (2) inform them about how to better shape their organization to suit the actual demand for their services.

BUSINESS CASE ANALYSIS AC/JCTD PROJECT SUPPORT
Daniel A. Nussbaum, Visiting Professor
Department of Operations Research
Sponsor: Office of the Under Secretary of Defense For Advanced Systems and Concepts

OBJECTIVE: This research was a series of studies that developed business case analyses (BCA) for specific Advanced Concept Technical Demonstrations/Joint Concept Technical Demonstrations (ACTD/JCTD).

SUMMARY: This project developed a methodology to provide senior Deputy Under Secretary of Defense for Advanced Systems and Concepts (DUSD (AS&C)) decision makers with improved, consistent, credible, and reliable cost estimates used to evaluate the Advanced Concept Technical Demonstration/Joint Concept Technical Demonstration (ACTD/JCTD) Program. It included an enhanced understanding of the unique characteristics of ACTD/JCTD Program and provided business case analyses for several candidate ACTD/JCTD projects. The study provided a series of rigorous analyses of the costs and benefits associated with the projects and thereby provided the analytic underpinning to the funding decisions for initialization or continuation of candidate projects. Additionally, the work supported transition planning with the joint staff.

PRESENTATIONS:
Nussbaum, D., “Energy Research at Naval Postgraduate School”, NPS Pacific Command Conference, Honolulu, HI, 29 June 2010

THESES DIRECTED:

(D. Nussbaum, F. Hartman, Advisors)

OBJECTIVE: This proposal supports a Business Case Analysis of the cost of developing, transitioning, and sustaining the MAGIC JCTD to an acquisition Program of Record.

SUMMARY: This work determined the continuing financial feasibility and return on investment for technologies associated with the Daily Watch JCTD. The research products are intended to be used in support of future work to expand technical capabilities of those derived from the Daily Watch JCTD. The details of the program are classified.

PRESENTATIONS:
PRESENTATIONS:


Nussbaum, D., “Introduction to Cost Estimating and Analysis”, Defense Management Resources Institute, Naval Postgraduate School, Monterey, CA, 1 September 2010


GRADUATE RESEARCH STUDIES PROGRAM (PHASE II)

Daniel A. Nussbaum, Visiting Professor
Department of Operations Research
Sponsor: Headquarters, USSOCOM

OBJECTIVE: This research continues the process to investigate and analyze various identified USSOCOM programs and process related to:

- Alternative acquisition strategies
- Contingency Operations Modeling and Analysis
- Financial investment opportunities
- Interoperability opportunities with the Services and Allies to fill operations needs, and
- Enhanced personnel training and management of personnel resources.

These efforts will be executed as a series of Graduate Studies Projects jointly conducted by NPS Operations Research Faculty and Graduate Students. This project will establish the framework of prioritized research topics and establish the baseline and format for the program.

SUPPORT TO THE ANALYSIS OF COSTS AND BENEFITS OF THE VULTURE PROGRAM

Daniel A. Nussbaum, Visiting Professor
Department of Operations Research
Sponsor: Defense Advanced Research Projects Agency (DARPA)

OBJECTIVE: The Naval Postgraduate School in cooperation with the Institute for Defense Analysis provided a detailed assessment of the current cost benefit analyses being provided to DARPA for the Vulture Program. This assessment included a Business Case Analysis using standard methodology and techniques utilized by NPS on a previous case relating to Global Observer.

SUMMARY: The Vulture program is being developed by the Defense Advanced Research Projects Agency (DARPA). The end goal of the Vulture program is to develop a high altitude long endurance (HALE) unmanned aerial vehicle (UAV) that is capable of maintaining a 1,000-pound payload on station for five years. The DARPA goals for the Vulture program include, at a minimum, the development and demonstration of advanced reliability technologies for the proposed future Vulture system. It is envisioned that Vulture will provide affordable, persistent coverage over an area of interest for surveillance and communications relay missions.

The study estimated the potential cost savings and identified other benefits associated with the potential operational use of Vulture. This study conducted a business case analysis (BCA) comparing the estimated costs of the Vulture program to those of the Global Hawk and Global Observer systems. Sensitivity analyses were as part of a Master’s Thesis performed on the cost variables, as well as a general risk assessment for Vulture.
OPERATIONS RESEARCH

THESES DIRECTED:


US MARINE CORPS PERFORMANCE PRICING MODEL
Daniel A. Nussbaum, Visiting Professor
Edward Lesnowicz, Research Associate
Department of Operations Research
Sponsor: Headquarters Marine Corps, Installations and Logistics Division

OBJECTIVE: The development of the Performance Pricing Model (PPM) began in the FY 2009 academic year. The initial proof of concept model provided a policy response forecasting capability that focused on the prediction of secondary repairables and (SECREP) and consumable obligations. Based upon this initial success, the US Marine Corps’ Installations and Logistics Directorate provided additional resources to extend the utility and capability of PPM.

SUMMARY: The project employed faculty and student researchers to identify the inputs, processes, and data bases that were in current use by the United States Marine Corps to record the consumables and parts usage in the USMC maintenance program. It explored PPM’s ability to integrate various data bases and policies to better predict the anticipated resourcing requirements in the next budgeting cycle. Additionally the effort began development of a GUI that allowed users of PPM and planners in the budgeting process to more easily utilized the outputs of PPM. This project worked closely with the SEED Center to ensure that PPM data could be readily farmed for the follow on assessment techniques utilized by the SEED center.

PRESENTATIONS:


THESES DIRECTED:


DEVELOPING A RELIABLE LEADING INDICATOR OF MISHAPS
LCDR Paul O’Connor, USN, Assistant Professor
Angela O’Dea, Research Associate Professor (Research Office)
M. Quinn Kennedy, Lecturer
Samuel Buttrey, Associate Professor
Department of Operations Research
Sponsor: Office of the Secretary of Defense

OBJECTIVE: Examine safety survey responses in aviation squadrons.

SUMMARY: This research examined data from surveys administered to naval aviation personnel. An extensive literature review paper that served as the first phase of this efforts was published in Safety Science in 2011. In the second phase, the someone idiosyncratic nature of the data was explored. Factor analysis attempted to organize survey responses by subject. A paper on the efforts of this second phase has been accepted for publication pending revisions.
The third phase of the project compared survey responses to mishaps at the squadron level. Although this work is complete, we have evidence that survey responses can act as a leading indicator of mishaps.

**PUBLICATIONS:**


**NAVY WARFARE DEVELOPMENT COMMAND’S OPERATIONS RESEARCH CHAIR**

**OF WARFARE INNOVATION**

CAPT Douglas Otte, USN, Military Faculty
Jeffrey E. Kline, Senior Lecturer
Carol O’Neal, Research Associate
Regina Kaiser, Research Associate
Department of Operations Research
Sponsor: Navy Warfare Development Command

**OBJECTIVE:** This long standing Chair is based most recently on Memorandum of Agreement between NPS and NWDC designating the Chair’s purpose to “…invigorate and conduct research and analysis required to develop doctrine, tactics, techniques, procedures, and maritime and joint operational concepts” at the Naval Postgraduate School.

**SUMMARY:** The Chair sponsors faculty and student research in a variety of areas. During CY10 this included the CNO Innovation Scenario Based Event “Confronting Irregular Challenges in the Maritime Environment; warfare innovation workshops in maritime irregular warfare, unmanned systems use in communications denied environments and advanced undersea warfare systems; special mini-studies within the Joint Campaign Analysis class; Project Jason, a research series to counter UAVs; development of maritime operational planning aids; and a variety of student travel in support of field experimentation and research trips.

**TRANSFORMABLE-CRAFT (T-CRAFT) PROGRAM TOTAL LIFE CYCLE COST MODELING**

Eugene P. Paulo, Associate Professor (Systems Engineering)
Daniel A. Nussbaum, Visiting Professor
Department of Operations Research
Sponsor: Office of Naval Research, Science and Technology Division

**OBJECTIVE:** Naval Research (ONR), Science and Technology Division, required a credible rough order of magnitude (ROM) life cycle cost estimate (LCCE) for use in the Innovative Naval Prototypes (INP) Seabase Connector Transformable-Craft (T-Craft) Program.

**SUMMARY:** The research of the T-Craft Program developed Life Cycle Cost Estimates on the proposed ships to be deployed as intermediate support base to the Seabase, and then be used as a Seabase connector, transporting wheeled and tracked vehicles, and other cargo, through the surf zone and onto the beach. It included the oversight of separate student theses that addressed a request by decision makers within ONR to provide a credible and reliable rough order of magnitude life cycle cost estimate on the T-CRAFT program over the various project phases of design, acquisition,
operations and support, and disposal. This study also included a series of sensitivity analyses to examine how the baseline rough order of magnitude cost of T-CRAFT is likely to be affected by the vessel’s technical parameters. The study estimated the total cost required to sustain a fleet of T-CRAFT and their related systems over its expected 25-year operational period.

THESES DIRECTED:


FRONT-END OPERATIONS RESEARCH ANALYTICAL MODELS FOR CBP TUNNEL PROBLEM

Steven E. Pilnick, Senior Lecturer
Department of Operations Research
Sponsor: TRAC Monterey

OBJECTIVE: Apply quantitative models and modeling approaches of search and detection theory to the CBP Tunnel operational problem involving sensors and targets in order to evaluate effectiveness and allocate resources.

FACTORS IN JOINT TYPHOON WARNING CENTER WATCHFLOOR

Eva Regnier, Associate Professor
Department of Operations Research
Sponsor: Joint Typhoon Warning Center

OBJECTIVE: To evaluate the task and support environments associated with the Joint Typhoon Warning Center (JTWC) watch floor and provide recommendations with the ultimate goal to improve forecast accuracy.

SUMMARY: In 2010, contracted with Alex Kirlik to visit the JTWC and review their task and support environments. With Dr. Kirlik visited the JTWC for meetings and observations, conducted visit outbrief and follow-on teleconferences and analysis. Report is in preparation and will be delivered by the end of the contract March 30, 2011.

PRINCIPLES OF ENSEMBLE MODELING AND DECISION SUPPORT

Eva Regnier, Associate Professor
Department of Operations Research
Sponsor: Commander, Naval Meteorology and Oceanography Command

OBJECTIVE: To provide instruction and facilitation of “Principles of Ensemble Modeling and Decision Support” training to the current METOC workforce.

SUMMARY: In CY2010, I delivered seminars on meteorology and oceanography (METOC) forecasting for decision support, including introduction to value of information and identifying high-impact decisions in a Navy context, and new connections to the Watchfloor of the Future (WOTF) initiative:

- Nine training sessions in March, to personnel of the Naval Maritime Forecast Center (30), Naval Aviation Forecast Center Norfolk (76), and Strike Group Oceanography Team (28). In addition, the team who was working to develop the Standard Forecasting Process for the WOTF was in town for a prior meeting, and therefore we conducted an interactive discussion with them. We also gave a short brief to three personnel from the Professional Development Center.
• Two sessions to 7 officers, 20 enlisted personnel and 1 civilian of the Naval Meteorology and Oceanography Center at Yokosuka in June.
• Four sessions to 6 officers, 20 enlisted personnel and 5 civilians in the Naval Marine Forecast Center in Pearl Harbor.

BATTLESPACE ON DEMAND (BOND) COMMAND DECISION MAKING:
ENHANCED DECISION MAKING THROUGH MORE EFFECTIVE USE OF METOC
Eva Regnier, Associate Professor
James Hansen, Physical Scientist, NRL-MRY
Department of Operations Research
Sponsor: Office of Naval Research via Naval Research Laboratory

OBJECTIVE: To develop a new approach to modeling meteorology and oceanography (METOC) information and its effects on mission success by using risk-based thresholding.

SUMMARY: In 2010 we built a prototype decision support product that produces a risk-based performance surface, using an ensemble METOC forecast. We worked with a NPS research group working on a related Adaptive Architectures for Command and Control ONR project (David Kleinman, Karl Pfeiffer, Sue Hutchins, William Kemple and Scot Miller), and conducting experiments on the effect of organizational design on team performance in the context of a Maritime Operations Command scenario; in 2011 the experiment will use three experimental conditions that vary the way uncertainty in METOC forecasts is presented to the subjects. I advised two theses related to decision-relevant provision of METOC forecasts and the mission effects of uncertainty in METOC information (Slootmaker and Hall, graduation expected in 2011).

PUBLICATIONS:
Hansen, J. and Regnier, E. Battlespace on Demand (BonD) Command Decision Making:
Enhanced Decision Making through More Effective Use of METOC Data. Naval Research Laboratory Annual Report ONR project N0001410WX20795

PRESENTATIONS:


ADAPTIVE PRECISION ADJUSTMENT FOR EFFICIENT OPTIMIZATION OF COMPLEX SYSTEMS
Johannes O. Royset, Assistant Professor
Department of Operations Research
Sponsor: Air Force Office of Scientific Research

OBJECTIVE: We develop algorithms for solving difficult optimization problems where the objective and/or constraint functions cannot be computed exactly but must be approximated. In particular, we focus on the construction of efficient precision adjustment schemes for controlling the approximations within algorithms.

SUMMARY: The research is directed towards three classes of optimization problems: (i) stochastic programs where functions are defined in terms of expectations, (ii) semi-infinite programs where functions are nonsmooth max-functions, and (iii) optimal control problems where functions are given by the solution of ordinary and partial
differential equations. In 2010, we achieved major advances on problems of class (i), i.e., stochastic programs, and obtained results that show the potential for significant computational savings when the precision of approximations is controlled by a discrete-time optimal control problem. We also obtained new rate of convergence results on part (ii) semi-infinite programs and preliminary results on part (iii) optimal control problems.

**PUBLICATIONS:**

*Journal Papers:*


*Journal Papers (in review):*


*Conference Papers:*


**PRESENTATIONS:**


**THESES AND DISSERTATIONS DIRECTED:**


OPERATIONS RESEARCH

ASYMPTOTIC ANALYSIS OF SAMPLE ALLOCATION IN STOCHASTIC OPTIMIZATION

Johannes O. Royset, Assistant Professor
Roberto Szechtman, Associate Professor
Department of Operations Research
Sponsor: Air Force Office of Scientific Research

OBJECTIVE: In the sample average approximation context, we determine the allocation of the computing budget that leads to the fastest convergence in distribution to an optimal solution.

SUMMARY: Many problems require optimization of a function that can be expressed as the expectation of a function of random variables. In the context of sample average approximation, we study the efficient allocation of the computing budget between two competing demands: generating samples to reduce uncertainty about sample averages, and carrying out iterations of an optimization algorithm. Nonlinear optimization algorithms can typically be characterized by a convergence rate, which affects the resulting allocation. We analyze the case of a single starting point and of multiple starting points, the latter being appropriate for optimization of non-convex functions. We find that for linear and super linear convergent optimization algorithms, little effort is directed to algorithm iteration.

PUBLICATIONS:

OPTIMIZATION OF BRIGADE COMBAT TEAM ASSIGNMENTS

Javier Salmerón, Research Associate Professor
Department of Operations Research
Sponsor: TRADOC - Fort Leavenworth (TRAC-FLVN), KS

OBJECTIVE: To provide research, development, and support of analytical tools to assist the U.S. Army Training and Doctrine Command Analysis Center in the fulfillment of its mission. Specifically, this research focuses on the development of optimization models that examine how to assign brigade combat teams to missions over time in order to maximize the fit of those assignments across the force.

SUMMARY: TRADOC has been investigating the problem of determining the best mix of brigade combat teams (BCTs) for future years. The research has taken into account factors such as the missions BCTs must accomplish, the Army Force Generation (ARFORGEN) cycle, and active and reserve components, among others. An optimization model has been developed and used by TRADOC to inform those decisions.

TECHNICAL REPORTS:

OPTIMALLY LOCATING BETSS-C SURVEILLANCE ASSETS

Javier Salmerón, Research Associate Professor
Kevin Wood, Distinguished Professor
Department of Operations Research
Sponsor: JIEDDO

OBJECTIVE: To develop an optimization model that can be used in optimal location of a given number of Base Expeditionary Targeting and Surveillance Systems-Combined, in order to minimize the expected value of undetected events such as improvised explosive device emplacements.
OPERATIONS RESEARCH

SUMMARY: The research has focused on developing optimization models for optimal placement of cameras and tower-mounted surveillance systems such as BETSS-C (Base Expeditionary Targeting and Surveillance Systems-Combined). These systems have proven themselves useful in detecting improvised explosive devices as they are being emplaced, and in making certain locations less desirable for emplacement. We have created models and solution software that locate a given set of camera towers (also observation towers or aerostats) to optimally cover “points of interest” on the ground. Computational results show that it is possible to obtain near-optimal solutions for problems with up to 30 cameras and 100 points of interest on a laptop computer in less than one minute.

TECHNICAL REPORTS:


MODELING & SIMULATION (M&S) AND DESIGN OF EXPERIMENTS (DOE) APPLICATIONS FOR TEST PLANNING

Susan M. Sanchez, Professor
Thomas W. Lucas, Associate Professor
Department of Operations Research
Sponsor: Naval Air Warfare Systems – Weapons Division

OBJECTIVE: Assist the DoD testing communities as they employ modeling and simulation in the planning and execution of individual platform testing, Systems of Systems evaluation and Joint Test and Experimentation.

SUMMARY: The SEED Center developed a counter-IED use case that modeled aspects of live tests conducted at Yuma Proving Grounds utilizing models of system under test and threat device performance suitable for test planning. A prototype tool to support operational test planning was enhanced to include state-of-the-art experimental designs. The use case demonstrated that combination of modeling & simulation (M&S) and design of experiments (DOE) in test planning can have a synergistic effect on identifying and separating out the key factors or combination of factors that drive mission performance and success. Accumulating evidence that a system performs across its operational envelope through appropriately designed simulations before actual testing can be very cost effective. Identifying and concentrating on the key factors during the live tests can give the operational commanders, program managers and system engineers/designers better insight for operational and engineering decisions.

PUBLICATIONS:


PRESENTATIONS:

OPERATIONS RESEARCH

SEED CENTER SUPPORT TO CULTURAL GEOGRAPHY (CG) AND OPERATION ENDURING FREEDOM (OEF) SCENARIO ANALYSIS
Susan M. Sanchez, Professor
Thomas W. Lucas, Associate Professor
Department of Operations Research
Sponsor: TRAC-Monterey

OBJECTIVE: Provide support to TRAC-Monterey’s efforts to develop a Cultural Geography (CG) model to represent civilian populations in irregular warfare scenarios, by assisting in setting up, running, and analyzing large-scale simulation experiments. Assist in model verification, and document requirements or issues that should be considered in future studies using the CG model.

SUMMARY: This effort focused on designing, conducting, and analyzing experiments to explore model features that had not previously been tested, or had been tested as isolated components rather than as part of the larger model. The scenario in question modeled the civilian population in the Kandahar province in Afghanistan. We developed a class of flexible, experimental designs capable of handling the large number of potential factors, as well as different types of factors (continuous, discrete, and qualitative), that characterize the CG model. Over 30,000 different model runs were made during a one-month period to support PAKAF forces.

PUBLICATIONS:

PRESENTATIONS:


CHAIR FOR STRATEGIC MARITIME ANALYSIS
LCDR Harrison C. Schramm, USN, Chair for Strategic Maritime Analysis
Department of Operations Research
Sponsor: Naval Warfare Integration Group

OBJECTIVE: This annual proposal for continued support of the Chair of Strategic Maritime Analysis.

EFFECTS OF SLEEP ON TRAINING EFFECTIVENESS IN SOLDIERS AT FT LEONARD WOOD, MO
Nita Lewis Shattuck, Associate Professor
Department of Operations Research
Sponsors: Leonard Wood Institute and Army Research Laboratory

OBJECTIVE: Research suggests military recruits experience a high prevalence of fatigue which has important implications for training effectiveness, health, and safety. Prior studies used uncontrolled, descriptive study designs that were limited to correlations between sleep and academic test performance, and many of the recommendations for follow-on research have yet to be addressed. Applied research is warranted to determine the magnitude of effect of sleep scheduling interventions on overall training effectiveness, attrition, health, and safety. This research will implement a controlled sleep scheduling intervention in a military training environment to quantitatively assess the
effects of the intervention on Recruit performance and cost effectiveness.

SUMMARY: This study examined the effect of alterations in the timing of sleep within the circadian cycle on the amount of total nightly sleep and its influence on various indicators of mood and performance of U.S. Army Soldiers attending Basic Combat Training (BCT) at Fort Leonard Wood, Missouri. The quasi-experimental study design compared Soldiers assigned to one of two training companies: a company using the standard BCT sleep regimen (8:30 p.m. to 4:30 a.m.) or a company using a phase-delayed sleep regimen (11:00 p.m. to 7:00 a.m.), the latter being more in line with the biologically driven sleep-wake patterns of adolescents. Demographic and psycho-physiological measures were collected at the start of the study using standard survey instruments and methods. A random sample of approximately 24% of Soldiers wore wrist activity monitors to unobtrusively record sleep quantity and quality. Weekly assessments were made of subjective fatigue and mood throughout BCT. Data on physical fitness, marksmanship, and attrition from BCT were extracted from organizational training records.

The study sample was comprised of 392 Soldiers, 209 in the intervention group and 183 in the comparison group. Based on actigraphic data, it was shown that Soldiers on the modified sleep schedule obtained 33 more minutes of total sleep per night than those on the standard sleep schedule. Soldiers in the intervention group reported less total mood disturbance relative to baseline, but the effect size was modest and diminished over the course of BCT. Improvements in Soldier marksmanship performance over a series of record fires was positively correlated with average nightly sleep during the week preceding the record fires, when basic marksmanship tasks were being learned. By the end of BCT, Soldiers in the comparison group were 2.3 times more likely to have occupationally significant fatigue and were 5.5 times more likely to report poor sleep quality, as assessed using validated survey instruments, than those in the comparison group. There was no effect of the sleep scheduling intervention on physical fitness scores or the relative risk for attrition. Overall, increasing sleep and concomitantly decreasing fatigue had a small but measurable influence on various indicators of Soldier functioning even after controlling for a variety of factors that affect performance.

PUBLICATIONS:


THESES DIRECTED:


Retrieved from The Defense Technical Information Center. (ADA531602)

FATIGUE MODELING USING TOTAL CREW MODEL IN SUPPORT OF THE MISSION MODULE MANNING FOR THE LITTORAL COMBAT SHIP
Nita Lewis Shattuck, Associate Professor
Department of Operations Research
Sponsor: PMS420

OBJECTIVE: This proposal will provide funding for consultation by NPS faculty and staff to the Littoral Combatant Ship (LCS) Mission Module Program Office (PMS 420). The research effort, directed by PMS 420, will be conducted through the Johns Hopkins Applied Physics Laboratory (JHAPL). The overall purpose of the project is to consider the effects of fatigue and ship motion (such as that experienced on the LCS) on crew performance. Faculty at NPS will consult with the JHAPL Research Team in the design and implementation of the study, particularly in the work related to fatigue and sleep deprivation on motion-based platforms. The NPS efforts include participating in data collection
and analysis, participating as integral members of the JHAPL Research Team and assisting in the modification of Total Crew Model.

PSYCHOMOTOR TASK PERFORMANCE OF HUMANS EXPOSED TO MOTION AND FATIGUE
Nita Lewis Shattuck, Associate Professor
Department of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: Conduct applied research to support the revision of current human performance models and to update existing measurements and standards associated with the effects of ship motion on human performance and postural stability.

QUANTITATIVE EVALUATION OF SQUAD AND TEAM LEADER PERFORMANCE WITH AND WITHOUT GSS
Nita Lewis Shattuck, Associate Professor
Department of Operations Research
Sponsor: TRAC-Monterey

OBJECTIVE: The experiment conducted for this project examined the benefit to rifle teams of one of several capabilities of the Nett Warrior system - a near-real time common operational picture that includes friendly position and operational graphics.

SUMMARY: This project conducted and analyzed a laboratory experiment that used the C3Conflict war game to elicit and contrast measures of leader performance across two conditions that simulated alternative Basis of Issue (BOI) for Nett Warrior (NW). C3Conflict is a distributed, computer-based, multiplayer, small unit war game designed to elicit measures of leader performance focusing on command, control, and communication. In the fully NW-enabled condition, the C3Conflict interface simulated the information and communication enabled by NW and made this package available to three soldiers—one in the role of Squad Leader (SL) and two in the role of Team Leader (TL). In contrast, in the partially NW-enabled condition, C3Conflict made that package available only to SL; the interface for the two TL simulated the limitations of line-of-sight vision. Eighteen hypotheses were tested. All predicted that unit performance would be better in the fully NW-enabled condition. Ten were confirmed. No measures showed superiority for the partially NW-enabled condition. These findings were interpreted to reveal that the fully-enabled BOI is the preferable option for two reasons. First, if SLs use the full range of capabilities offered by NW, their workload is likely to decrease. Second, the fully-enabled BOI promotes the autonomy and battlefield awareness of TLs. Fully-enabled TLs are likely to be better prepared to assume command, if necessary.

THE SCIENCE OF TEST: ADVANCED TEST AND EVALUATION IN SUPPORT OF THE DOD TEST AND EVALUATION ENTERPRISE
Rachel T. Silvestrini (Johnson), Assistant Professor
Department of Operations Research
Sponsor: Air Force Institute of Technology

OBJECTIVE: It is widely recognized across science and engineering disciplines that effective testing required effective experimentation strategies. The analytical team must ensure the experimental strategy matches the overall test objectives, maximizes the information obtained, minimizes the resources expended, and provides decision makers with the information needed to make informed, timely decision. Traditionally, scientists equate experimental strategies with “physical testing,” but methods for experimenting on a simulation are equally important. If the simulation is being used to support or influence decisions made in the real world, then improvements made in obtaining the results directly translates to improvements for the real system in question.
OPERATIONS RESEARCH

QUANTITATIVE EVALUATION OF SQUAD AND TEAM LEADER PERFORMANCE WITH AND WITHOUT GSS (QUEST±GSS)

Kip Smith, Senior Lecturer
Department of Operations Research
Sponsor: TRAC Monterey

OBJECTIVE: TRAC Monterey has been assigned responsibility for evaluating the potential benefits of the Ground Soldier System (GSS), emergent wireless technology designed to transmit, receive, and display precise information about the locations of friendly forces on the battlefield in near real time. The goal of this program of research is to support TRAC Monterey’s assessment of alternative options for distributing the GSS to squads.

IRREGULAR WARFARE AUTOMATED WARGAME

Roberto Szechtman, Associate Professor
Department of Operations Research
Sponsor: Center for Army Analysis

OBJECTIVE: The goal is to portray the long-term effect of interactions among different groups of people in intra- and inter- social networks, taking into account each group’s idiosyncratic attitude towards the insurgents and the government, and their manifested behavior. The terms attitude and behavior used here are related, respectively, to the terms private preference and public preference used in Kuran (1989). While it may be hard to shape the attitude of people -- their fundamental beliefs and values that have been shaped over centuries of cultural evolution -- it may be possible to affect their manifested behavior. The objective of the regime is to influence the behavior of the population and gain its support for eliminating the insurgency. Ultimately, with a behavior of the population and gain its support for eliminating the insurgency. Ultimately, with a better understanding of social influences and their possible consequences, it would be possible for the regime to make better allocations of counterinsurgency resources for attaining its objective.

STOCHASTIC OPTIMIZATION SUPPORT

Alan R. Washburn, Distinguished Professor (emeritus)
Department of Operations Research
Sponsor: U. S. Army (TRADOC)

OBJECTIVE: TRADOC (White Sands Missile Range) has developed a multi-objective mathematical optimization as part of the process of advising the Army on cost/effective munitions mixes. The optimization does not deal realistically with weapons that can recover from an initial miss by shooting multiple times, an issue of particular importance for high cost weapons. The objective is to introduce an appropriate shoot-look-shoot model into the optimization.

SUMMARY: In calendar year 2010, the objective was achieved in the form of a spreadsheet named JAGMNL with a command button that calls a GAMS script to perform the desired optimization. Standards for input data were negotiated with AMSAA. Two levels of shoot-look-shoot are represented.
OBJECTIVE: The purpose of this work is to support the TRAC-Monterey project “Exploratory Data Analysis for Operational Environments”. Our goal is to aid a deployed analyst with the equivalent of a one semester statistics source to better support operations. We propose to show, by example with operational data, how a few carefully chosen statistical techniques might aid such an analyst. Of equal importance, we will discuss under what conditions these techniques are use able and when they are not. In the process, we will explore several existing unclassified and classified data bases for their utility and to develop a set of metrics and proxy variables to help in operational assessment. We propose to work closely with TRAC-Monterey. Their expertise will help us understand the operational questions a deployed analyst is likely to encounter, the data he has access to, and which of the types of analysis we propose are likely to be the most useful to him.

DEFENDING INDEPENDENT INFRASTRUCTURE SYSTEMS

R. Kevin Wood, Professor
Department of Operations Research
Sponsor: University of Texas at Austin

OBJECTIVE: Collaborators will develop new theory, models and algorithms for optimal design or retrofit of interdependent infrastructure systems, with the objective of making those systems more resilient to kinetic and other types of Weapons of Mass Destruction (WMD) attacks. “System” refers here to a collection of interdependent infrastructure systems; “defense” implies any actions that reduces the vulnerability of a system, or improves it resilience to attack, e.g., improving security (hardening), adding redundant system components, reducing repair times. “WMD attack” normally means a coordinated attack on a set of system components, using kinetic devices, designed to disrupt system operations.

OPTIMAL INTERDICTION PLANNER

R. Kevin Wood, Professor
Javier Salmerón, Research Associate Professor
Department of Operations Research
Sponsor: JIEDDO

OBJECTIVE: To complete the implementation of our Optimal Interdiction Planner (OIP) to include multiple types of interdiction assets, and continue analysis of data in Afghanistan.

SUMMARY: In 2008 and 2009, we developed the Optimal Interdiction Planner (OIP) for the optimal placement of mobile inspection teams for the purpose of interdicting smuggled IEDs and their components. OIP solves a game-theoretic model for interdiction planning on a transportation network, and has been implemented, with a full graphical user interface, in Excel and VBA. An extension was needed to model multiple types of interdiction assets such as mobile inspection teams, UAVs, and fixed inspection facilities. The new problem was also formulated as a two-person zero-sum game with a surrogate objective that evaluates expected number of detections. That model has been solved with a “direct solution procedure” and a “marginal-probability solution procedure.” On numerous test problems, both procedures correctly compute expected number of detections, but the latter more often finds a solution that simultaneously optimizes interdiction probability. The latter procedure is also much faster and is therefore preferred. LTC Ewing began testing OIP in Afghanistan. That work continues (albeit under different sponsorship) at the time of this report.
THESES DIRECTED:

DEPARTMENT OF
OPERATIONS RESEARCH

2010
Faculty Publications
and Presentations


OPERATIONS RESEARCH


BOOKS


CONTRIBUTIONS TO BOOKS


CONFERENCE PUBLICATIONS & PROCEEDINGS


CONFERENCE PRESENTATIONS


222
VTC, July and August 2010.


Wood, K., “Maximizing the Resilience of Critical Infrastructure to Terrorist Attack without Guessing,” ORIE Seminar, University of Texas at Austin, Austin, Texas, October 2010.


Ewing, P.L. Analytics in Afghanistan; Moving Away from the Anecdotal, Recommendation Paper for GEN S. McChrystal, ISAF Commander, Kabul, Afghanistan, 6 April 2010.


GRADUATE SCHOOL OF ENGINEERING AND APPLIED SCIENCES

SIVAGURU S. SRITHARAN
DEAN
APPLIED MATHEMATICS

OVERVIEW:

The Naval Postgraduate School (NPS) Department of Applied Mathematics is deeply committed to excellence. Our mission is to provide an exceptional mathematical education focused on the unique needs of our students, to engage in relevant research, and to provide quality service to the community. We provide high-quality instruction in all courses, giving emphasis to relevant and modern mathematical techniques in our advanced courses, and we encourage students to develop and utilize skills in analysis, reasoning, creativity, and exposition as they acquire knowledge of mathematics and its applications. We are deeply committed to maintenance of a well-designed curriculum and a supportive environment for our students.

CURRICULA SERVED:

The majority of the departmental effort is devoted to the service courses offered, which support almost every curriculum on campus.

DEGREES GRANTED:

- Master of Science in Applied Mathematics
- Doctor of Philosophy

RESEARCH THRUSTS:

- Applied Analysis
- Discrete Mathematics
- Numerical Analysis/Scientific Computation

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Applied Mathematics is provided below:

Size of Program: $582K
APPLIED MATHEMATICS

Carlos F. Borges
Chairman & Professor
831-656-2124
borges@nps.edu

Pantelimon (Pante) Stanica
Associate Chairman for Research & Professor
831-656-2714
pstanica@nps.edu

David R. Canright
Associate Professor
831-656-2782
dcanright@nps.edu

Christopher L. Frenzen
Associate Professor
831-656-2435
cfrenzen@nps.edu

Beny Neta
Professor
831-656-2235
bneta@nps.edu

Lester E. Carr
Lecturer
831-656-3629
lecarr@nps.edu

Ralucca Gera
Associate Professor
831-656-2206
rgera@nps.edu

Guillermo Owen
Distinguished Professor
831-656-2720
gowen@nps.edu

Margaret Cheney
Visiting Professor
518-276-2646
mcheney@nps.edu

Francis Giraldo
Professor
831-656-2293
fxgiral@nps.edu

Craig W. Rasmussen
Professor
831-656-2763
rasi@nps.edu

Donald A. Danielson
Professor
831-656-2622
dad@nps.edu

William B. Gragg
Professor
831-656-2194
gragg@nps.edu

Clyde Scandrett
Professor
831-656-2027
cscand@nps.edu

Doyle Daughtry
Lecturer
831-656-3478
ddaughtr@nps.edu

Wei Kang
Professor
831-656-3337
wkang@nps.edu

Hong Zhou
Associate Professor
831-656-2600
hzhou@nps.edu

Fariba Fahroo
Professor
831-656-2664
ffahroo@nps.edu

Arthur J. Krener
Distinguished Visiting Professor
831-656-2664
aikrener@nps.edu

Harold M. Fredricksen
Professor
831-656-3249
half@nps.edu

Bard K. Mansager
Senior Lecturer
831-656-2695
bardman@nps.edu
APPLIED MATHEMATICS

HISTORY OF MATHEMATICS AT THE NAVAL POSTGRADUATE SCHOOL
Carlos F. Borges, Professor
Department of Applied Mathematics
Sponsor: Unfunded

OBJECTIVE: To compile a written history of mathematics at the Naval Postgraduate School.

SUMMARY: I compiled a written history of mathematics at the Naval Postgraduate School.

PUBLICATIONS:

DISCRETIZATION VS. ROUNDBING ERROR IN NUMERICAL ODE SOLVERS
Carlos F. Borges, Professor
Department of Applied Mathematics
Sponsor: Unfunded

OBJECTIVE: To analyze how algorithmic structure influences the relationship between discretization and rounding error in the numerical solution of ODEs.

SUMMARY: I have written an expository paper on the influence of algorithmic structure on the relationship between discretization and rounding error. The ideas in the paper are quite general but are applied to the specific example of solving an ODE numerically.

PUBLICATIONS:

EXTRAPOLATION METHODS FOR NUMERICAL ODES
Carlos F. Borges, Professor
Department of Applied Mathematics
Sponsor: Unfunded

OBJECTIVE: Investigation of extrapolation methods to numerically solve ODEs.

SUMMARY: Ongoing work on extrapolation methods for the numerical solution of ODEs with planned applications to solving PDEs.

DEFLECTION METHODS FOR DIVIDE-AND-CONQUER EIGENVALUE SOLVERS
Carlos F. Borges, Professor
Department of Applied Mathematics
Sponsor: Unfunded


SUMMARY: Ongoing work on deflation methods for divide-and-conquer eigenvalue solvers. I have made significant progress in the perturbation analysis for several specific structures and am in the early stages of evaluating a general deflation algorithm.
APPLIED MATHEMATICS

PUBLICATIONS:


ALGEBRAIC ATTACKS ON AES

David R. Canright, Associate Professor
Department of Applied Mathematics
Sponsor: Unfunded

OBJECTIVE: To examine cryptographic attacks on the Advanced Encryption Standard algorithm based on solving algebraic equations that describe the algorithm. Of particular interest is a new approach called Multiple Right-Hand Side equations (MRHS). This work is ongoing.

SUMMARY: Algebraic attacks on cryptographic algorithms have previously been explored, so far without any resulting attack being more efficient than brute force key search. Much of this work involves multivariable polynomial equations over the binary Galois Field, GF(2), for the individual bits in intermediate results of encryption rounds. (Over a finite field, any nonlinear function can be expressed as a polynomial function.) Methods employed for solving these equations include Extended Linearization (XL) and Extended Sparse Linearization (XSL). Another recent approach explores attacking AES using equations over the larger field GF(256), in which most of the operations of AES are defined. Typical methods involve Gröbner basis methods.

Late in 2007 I came across new work by a team in Bergen, Norway. They had developed a novel approach, which they called Multiple Right-Hand Side equations. This is not the same as a linear system with multiple right-hand sides representing different data vectors for which the system should be solved. Rather, here the multiple right-hand sides represent the set of all valid outputs of the system. Any nonlinear equation over a finite field can be expressed in this way by simply listing the possible outputs. They described methods for solving systems of such MRHS equations, and, for a “toy” version of AES, were able to break the key, as had been done by others using Gröbner basis tools; but the MRHS approach was roughly six orders of magnitude faster!

In 2008 I had a MS student (ECE Dept.), Panteliemon Mantzouris. The Norwegian team was kind enough to provide some of their code (though, curiously, could not provide a complete working version), and I used that to develop an interactive implementation of MRHS. I also wrote software to generate the MRHS equation systems for small variants of AES. This allowed my student to explore the different techniques (agreeing, gluing, linear extraction, guessing) used for MRHS systems. One surprise he discovered is that for some small AES variants, a given plaintext/ciphertext pair may have more than one valid key! His thesis was not completed before he left Naval Postgraduate School for duty in the Hellenic Navy, and it was finally finished in September 2009.

In Fall 2008, Pantelimon Stănîcă and I submitted a research proposal to AFOSR, seeking support to work on MRHS equations. We still have not heard a decision, though as recently as January 2011 the person processing the proposal assured me it was not yet dead.

Late in 2008, one of our Ph.D. students, CPT Natalie Vanatta, agreed to work with me on the MRHS topic. She began work in January 2009. One particularly promising topic is extending the “agreeing” technique, where pairs of MRHS equations are compared to eliminate inconsistent right-hand sides, to agreeing n-tuples of equations, using graph theory. Currently MAJ Vanatta is teaching at West Point, while continuing research on this topic as time allows; we talk weekly about her progress.
OBJECTIVE: To develop an implementation of the Advanced Encryption Standard (AES) that minimizes the number of operations needed, as a basis for a fast bit-sliced AES and for ASICs applications of AES.

SUMMARY: My previous work on AES resulted in a compact S-Box 20% smaller than the previous best. These results have been used by others in bit-sliced AES implementations, where fewer operations mean faster speed. However, my previous work only considered the most computationally intensive step of AES: the S-box (ByteSubstitution).

This current work optimized the whole algorithm, based on the idea of maintaining a different representation (another basis for the Galois field of bytes) throughout whole rounds, rather than just for the S-box. By considering different choices of basis, and combining the affine transformation of the S-box with linear transformations of the MixColumns step, and with my collaborator’s superior matrix optimization software, we reduced the operations required by another 9% (and 13% for decryption).

In 2010, my colleague Dag Arne Osvik presented a conference paper about this and related work (see below). We are continuing to work on applying this work to develop a fast bit-sliced AES. Preliminary results suggest we will set a speed record for software AES, if we can deal with some technical hurdles. Also, I am exploring another approach for the Galois representation that may further reduce the needed operations, hence increase the speed.

PUBLICATIONS:


OBJECTIVE: Apply astrodynamics theory to problems of interest to the military.

SUMMARY: In 2010 Prof. Danielson continued to update his earlier work in orbital dynamics, and attended the Astrodynamics Symposium held in Monterey on May 17-19.

OBJECTIVE: We utilized a new metric in graphs to find possible synonymous words.

SUMMARY: The goal of Natural Language Processing (NLP) is to design and build a computer system that will
analyze, understand, and generate natural human-languages. Within this area, as a member of Craig Martell’s team (Computer Science, NPS) I was part of the following projects:

- The Link Graphs of the Complete Graph (with Pranav Anand, Henry Escuadro, Craig Martell). Submitted and rejected, will resubmit with modifications
- On The Complexity of the Triangular Line Graphs (by Pranav Anand, Henry Escuadro, Ralucca Gera, Stephen Hartke, Dereck Stolee) – submitted

This research project, funded by Program Executive Officer, Integrated Warfare Systems sought ways to improve the capability of SHARE (Software Hardware Asset Reuse Enterprise) repository searching. Most current search technology is based on a popularity metric (e.g., PageRank or ExpertRank), but not on the semantic content of the document. Part of the proposed project produced a prototype search-engine designed to search over the “meaning” of requirements documents, provide a road-map for future work to build a robust requirements-document search engine, and provide prototype tools to the requirements-document author that limit ambiguity and specify the requirements in a semi-formal, searchable representation. For this work we considered link graphs, introduced in graph theory as triangular line graphs, which identify ambiguous words in text, such as polysemous words (see the first two articles above). The third project above considered the computational complexity of the decision problem: is a given graph a triangular graph or not? In one of the submitted for publication projects we were able to prove the NP-completeness of triangular line graphs.

PRESENTATIONS:

“Link Graphs-- A Tool for Word Sense Disambiguation “, Joint Mathematics Meetings in San Francisco, Jan 13-16th

“Triangular Line Graphs: Tools for Word Ambiguity Detection in Automated Search” SIAM conference on Discrete Mathematics, Austin, TX, June 14-17

“Triangular Line Graph: A Tool for Word Sense Disambiguation,” 8th French Combinatorial Conference, Orsay, France, June-July

PUBLICATIONS:


The Link Graphs of the Complete Graph (with Pranav Anand, Henry Escuadro, Craig Martell). Submitted and rejected, will resubmit with modifications(submitted 2010)


3-CIRCUIT CENTER AND PERIPHERY IN GRAPHS
Ralucca Gera, Assistant Professor
Department of Applied Mathematics
(with Linda Eroh, Steven J. Winters)
Sponsor: not funded

OBJECTIVE: We introduce a new metric in graphs as a generalization of the standard distance.

SUMMARY: The Traveling Salesman Problem (TSP) is still one of the most researched topics in computational mathematics, and we introduce a variant of it, namely the study of the closed k-walks in graphs. We search for a shortest closed route visiting k cities in a non complete graph without weights. This motivates the following definition. Given a set of k distinct vertices in a simple graph G, the closed k-stop-distance of set S, d(S), is defined to the
minimum sum of the distances between the k vertices, among all permutations from S onto S. That is the same as saying that d(S) is the length of the shortest closed walk through the k vertices. A related concept was introduced as Steiner distance, sd(S), where sd(S) is the number of edges in a minimum connected subgraph containing all of the vertices of S. We note some relationships between Steiner distance and closed k-stop distance and study the problem when k=3.

**PRESENTATIONS:**

“Choosing a central location for multiple deliveries,” 41st Southeastern International Conference on Combinatorics, Graph Theory, and Computing, FL, March 3-7th

**PUBLICATIONS:**

Grady Bullington, Linda Eroh, Ralucca Gera and Steve Winters. “Closed k-stop distance in graphs.” Discussiones Mathematicae Graph Theory #686 (accepted 2010)


**FUNCTIGRAPHS**

**Ralucca Gera, Assistant Professor**

**Department of Applied Mathematics**

(with Andrew Chen, Daniela Ferrero, Linda Eroh, Cong Kang, Craig Larson, Eunjeong Yi)

**Sponsor:** Unfunded

**OBJECTIVE:** We studied the domination parameter on a new class of graphs that generalize the permutation graphs studied by Chartrand and Harary.

**SUMMARY:** Let G1 and G2 be copies of a graph G, and let f: V(G1) to V(G2) be a function. Then a C(G, f)=(V , E) is a generalization of a permutation graph, where the vertex set is the union of V(G1) and V(G2), and the edge set is given by the union of E(G1), E(G2) and all the edges given by the permutation from G1 to G2. In this project we study the domination number of functigraphs.

**PRESENTATIONS:**

“Functigraphs: A generalization of Permutation graphs,” MathFest 2010, Pittsburgh, Pennsylvania, August 6-8

**PUBLICATIONS:**

Andrew Chen, Daniela Ferrero, Ralucca Gera and Eunjeong Yi. Functigraphs: an extension of permutation graphs, Math Bohem (accepted 2010)


APPLIED MATHEMATICS

COMPUTATIONAL MATHEMATICS FOR STORM SURGE MODELING
Francis X. Giraldo, Professor
Department of Applied Mathematics
Sponsor: Office of Naval Research

OBJECTIVE: To extend tsunami propagation modeling to storm surge modeling under severe conditions such as hurricanes. The PI will compare two numerical codes, the GeoClaw, which is being developed at the University of Washington, and a discontinuous Galerkin approach, being developed at the Naval Postgraduate School.

EFFICIENT TIME-INTEGRATORS FOR LOCAL HIGH-ORDER METHODS
Francis X. Giraldo, Professor
Department of Applied Mathematics
Sponsor: Air Force Office of Scientific Research (Computational Mathematics)

OBJECTIVE: To construct computational methods for the Navier-Stokes or Euler equations, researchers typically construct spatial discretization and time-integrators separately and then couple them; this is called the method of lines. The problem with this approach is that the time-integrator is not designed to make optimal use of the spatial discretization method. In this work, we build time-integrators specifically tailored to high-order local spatial discretization methods such as spectral element and discontinuous Galerkin methods for wave propagation problems. This includes explicit, semi-implicit, and fully-implicit time-integrators.

PRESENTATIONS:

PUBLICATIONS:


THESES DIRECTED:
Collaborating with Wilkinson Postdoctoral Fellow Dr. Emil Constantinescu under this project.
APPLIED MATHEMATICS

THE MATHEMATICS OF STORM SURGE MODELING
Francis X. Giraldo, Professor
Department of Applied Mathematics
Sponsor: Office of Naval Research (Computational Mathematics)

OBJECTIVE: The U.S. Navy has models that it uses to predict how storms will affect coastal regions (e.g., Chesapeake Bay and the U.S. Naval Academy). However, the models currently used for these purposes are not as accurate as they ought to be because they are based on computational algorithms designed in the early 1970s; fortunately, many advances have been made in both computing and the design of new algorithms. In this project, we (in collaboration with Professor Randall J. LeVeque at the University of Washington) have designed a new class of tsunami and storm-surge models that are: 1) fully conservative, 2) high-order accurate, 3) able to use adaptive unstructured grids, and 4) highly efficient on massively parallel computers.

PRESENTATIONS:
Development of a Coastal Inundation Model using Triangular Discontinuous Galerkin Methods, 2nd Author with S. Gopalakrishnan -- Modeling and Computation of Shallow-Water Coastal Flows, University of Maryland, College Park MD (September 2010).

PUBLICATIONS:

THESES DIRECTED:
NRC Posdoctoral Dr. Shivasubramanian Gopalakrishnan is being supervised under this project.

MULTI-SCALE NONHYDROSTATIC ATMOSPHERIC MODELS
Francis X. Giraldo, Professor
Department of Applied Mathematics
Sponsor: Office of Naval Research (Battlespace Environments)

OBJECTIVE: The U.S. Navy would like to replace their existing global and mesoscale atmospheric models with new software that can scale up to tens of thousands of processors of a massively parallel computer. To this end, we propose to develop spectral element and discontinuous Galerkin methods that are high-order accurate, conserve all variables, permit the use of unstructured adaptive grids, and scale linearly on distributed-memory computers. Furthermore, we have constructed one unified model that can handle the mesoscale (limited area or regional) problem as well as the global problem.
PRESENTATIONS:


PUBLICATIONS:


THESES DIRECTED:

U.S. Army Major Joe Lindquist completed his PhD dissertation on constructing high-order (using spectral element methods) non-reflecting boundary conditions with high-order time-integration for acoustic problems.

NRC Posdoctoral James Kelly is being supervised under this project.

Simone Marras (via Barcelona Supercomputing Center) is being directed on his PhD on the construction of variational multi-scale stabilization methods for the Euler equations.

NEXT-GENERATION GLOBAL AND MESOSCALE ATMOSPHERIC MODELS
Francis X. Giraldo, Professor
Department of Applied Mathematics
Sponsor: Office of Naval Research

OBJECTIVE: This project aims at developing two new weather prediction models for the U.S. Navy.
APPLIED MATHEMATICS

OBSERVABILITY IN DATA ASSIMILATION AND OPTIMAL SENSOR CONFIGURATION
Wei Kang, Professor
Department of Applied Mathematics
Sponsor: NRL

OBJECTIVE: To develop mathematical concepts and numerical algorithms for the evaluation and optimal design of sensor configuration in data assimilations.

SUMMARY: The objective of this project is to develop mathematical concepts and numerical algorithms for the evaluation and optimal design of sensor configuration in data assimilations. The technical objectives include: (1) applying concepts of observability to the problem of data assimilation and numerically test the concepts using a mid-size model; (2) developing computational algorithms that are scalable to large size problems; (3) developing problem formulation and computational algorithms for maximizing the observability of forecast models by finding optimal sensor locations.

PRESENTATIONS:
Semi-plenary speaker, IFAC NOLCOS, September 1-3, 2010, Bologna, Italy.

PUBLICATIONS:

OPTIMAL MOTION PLANNING IN OBSTACLE-RICH ENVIRONMENT
Wei Kang, Professor
Department of Applied Mathematics
Sponsor: TDSI - Singapore

OBJECTIVE: To develop a mathematical formulation, numerical algorithms, and optimal trajectories for the optimal trajectory planning of helicopter UAVs.

SUMMARY: The goal is to develop and test algorithms of optimal trajectory planning for Helicopter UAVs in obstacle-rich environment using computational optimal control. Solving a nonlinear optimal control problem with complex constraints is commonly considered very difficult and extremely time-consuming. However, after several decades of rapid advances in computational technology and improvement in optimization algorithms, that paradigm is changing and recent research, leading by researchers from Naval Postgraduate School (NPS), is showing the applicability of optimal control techniques in real-time guidance and control. Whereas optimization methods traditionally created a solution in minutes to hours, solutions can now be found within seconds or less, and the improvements in computational speed increase their ability to handle system uncertainties and optimality requirements simultaneously. Now the improvements in optimal control methods and computational speed present a strong argument for their application in online real-time optimal motion planning.

PRESENTATIONS:
Computational Optimal Control using Pseudospectral Methods, Seminar of Temasek Laboratories & Centre for Intelligent Control and IEEE Singapore Control Systems Chapter
OBJECTIVE: The objective of the research is to develop practical methods to solve highly nonlinear optimal control problems, and to prove the efficiency of the method by proving the feasibility and convergence. The fundamental concept in the approach is based on the Pseudospectral approximation theory of numerical computation, and nonlinear programming for complicated optimization problems.

SUMMARY: For some important families of nonlinear systems, the feasibility and convergence of the Pseudospectral optimal control method are proved. In addition, the covector mapping theorem, an important result that bridges the optimal state in a control system with the necessary conditions of optimal control, is proved for general nonlinear systems. In 2007 and 2008, we proved several new theorems on convergence with significantly simplified and reduced the assumptions relative to the theorems proved in 2006. In addition, we generalized the convergence results to problems with discontinuous optimal control.

PUBLICATIONS:

NUMERICAL SOLUTION OF THE FIRST ORDER PARTIAL DIFFERENTIAL EQUATIONS OF NONLINEAR CONTROL
Arthur J. Krener, Distinguished Visiting Professor
Department of Applied Mathematics
Funding Agency: AFOSR

OBJECTIVE: To develop numerical methods for solving some of the PDEs of nonlinear control.

SUMMARY: This year we are developing methods to find patchy solutions to the Hamilton Jacobi Bellman (HJB) Partial Differential Equations (PDE) that arise in nonlinear optimal control. In future years we will extend the method to other PDEs that arise in nonlinear control. Our approach combines the power series method of Al’brecht with the patchy technique of Ancona and Bressan using the techniques of Cauchy-Kovalevskaya and the fast sweeping and fast marching methods. At present the method is not applicable to all nonlinear optimal control problems, just those where the linear quadratic regulator (LQR) consisting of the linear part of the dynamics and the quadratic part of the Lagrangian admits a stabilizing solution. Further down the road we envision extending the patchy technique to other optimal control problems.

PRESENTATIONS:
U. of New Mexico, June 25, 2010
AFOSR Review, August 11, 2010, Ballston, VA
NOLCOS, September 3, 2010, Bologna, Italy
Ecole de Mines, Sept. 27, 2010, Paris, France
SupElec, Sept. 28, 2010, Gif, France
Royal Society, London, Sept. 30, 2010
UCSD, Oct. 4, 2010
CDC, Dec. 17, Atlanta
UCD, Jan. 25, 2010
APPLIED MATHEMATICS

PUBLICATIONS:


PRINCIPAL TANGENT SYSTEM REDUCTION

Arthur J. Krener, Distinguished Visiting Professor
Department of Applied Mathematics
Funding Agency: NSF

OBJECTIVE: To develop numerical methods for reducing the size of models of control systems

SUMMARY: High dimensional models of complex systems are common tools in science and engineering. Frequently these models are too complex to analyze or to design controllers for them. Reduced order models are needed. The goal of this project is to develop computational methods for reduction of complex models that are described not analytically but numerically, i.e., by computer code. The intellectual merit of our proposed activity is that model reduction will no longer need to be carried out with analytic methods or constructed in an ad hoc manner for each individual application, but rather directly from the computational model defining the complex system. The broader impact of this project is that it will provide enabling tools for researchers from a wide spectrum of areas to extract key information about and design controllers for complex nonlinear systems that, in their original format, cannot be handled in real-time by current and near future computational power. These enabling techniques will be developed and refined by test cases in flow control in collaboration with Dr. Andrzej Banaszuk of United Technologies Research Center (UTRC).

PUBLICATIONS:


WORKSHOP ON COMPUTATIONAL ISSUES IN NONLINEAR CONTROL

Arthur J. Krener, Distinguished Visiting Professor
Department of Applied Mathematics
Funding Agency: AFOSR

OBJECTIVE: We are proposing to organize the Workshop on Computational Issues in Nonlinear Control. The topics to be addressed include HJ and HJB equations; numerical calculation of optimal trajectories; and numerical calculation of invariant manifolds. The goal of this workshop is to bring together three different communities of researcher to exchange ideas and stimulate future research in this area.

A STUDY OF NON-REFLECTING BOUNDARY CONDITIONS

Beny Neta, Professor
Department of Applied Mathematics
Funding Agency: NPS

OBJECTIVE: The implementation of high-order nonreflecting boundary conditions. One model we used is the linearized Klein-Gordon equation. This equation is solved by the spectral elements method in space and high order Runge-Kutta in time.
PUBLICATIONS:


THESES DIRECTED:

Major Joseph M. Lindquist, USA defended his PhD dissertation.

HIGH ORDER NONLINEAR SOLVERS FOR SIMPLE AND MULTIPLE ROOTS
Beny Neta, Professor
Department of Applied Mathematics
Sponsor: NPS

OBJECTIVE: One of the most important problems in numerical analysis is the solution of nonlinear equations \( F(x) = 0 \). To solve these equations one can use iterative methods. There are many schemes for obtaining simple roots of nonlinear equations. Our work is to extend such methods to the case of roots with multiplicity greater than one, but also to find more efficient schemes for simple roots. This work was done jointly with Professor C. Chun, Sungkyunkwan University, Republic of Korea and Professor Miodrag Petkovic, University of Nis, Serbia.

PUBLICATIONS:


LARGE TIME BEHAVIOR OF SOLUTIONS AND FINITE DIFFERENCE SCHEME TO A NONLINEAR INTEGRO-DIFFERENTIAL SYSTEM
Beny Neta, Professor
Department of Applied Mathematics
Sponsor: NPS

OBJECTIVE: The large-time behavior of solutions and finite difference approximations of the nonlinear integro-differential equation and system of such equations associated with the penetration of a magnetic field into a substance are studied. Asymptotic properties of solutions for the initial-boundary value problem with homogeneous Dirichlet boundary conditions are considered. The rates of convergence are given too. The convergence of the semidiscrete and the finite difference schemes are also proved. This work is a joint project with Professors Temur Jangveladze and Zurab Kiguradze of Ivane Javakhishvili Tbilisi State University and Ilia Chavchavadze State University, Tbilisi, Georgia.

PUBLICATIONS:


Some items are available on my home page at http://faculty.nps.edu/bneta/

MATHEMATICAL MODELS OF SEARCH
Guillermo Owen, Professor
Department of Applied Mathematics
Sponsor: Department of Defense Analysis

OBJECTIVE: Professors McCormick and Owen have developed game-theoretic models for search.

GAME-THEORETIC APPROACHES TO TERRORIST INSURGENT NETWORKS
Guillermo Owen, Professor
Department of Applied Mathematics
Sponsor: Department of Defense Analysis

OBJECTIVE: Owen and Professor Gordon McCormick of DA are co-Principal Investigators.

THEORY OF GAMES AND APPLICATIONS
Guillermo Owen, Professor
Department of Applied Mathematics
Sponsor: Department of Defense Analysis

OBJECTIVE: This is an unsponsored project, on which Professor Owen has worked with mathematicians at the University of Caen, France, at the Complutense University in Madrid, Spain, at the Autonomous University of Madrid, Spain, at the Polytechnic University of Catalonia, Terrassa, Spain, and at the Universities of Tilburg and of Amsterdam, Netherlands.

PUBLICATIONS:
Owen, G., Algaba, E. “Representation of Message conduits as Players.”

Owen, G., Manuel, C. and Gonzalez, E. “Behavior of the Kernel under Transfers in Composition of Games.”
APPLIED MATHEMATICS

SET COLORINGS IN GRAPHS
Craig W. Rasmussen, Associate Professor
Department of Applied Mathematics
Sponsor: NPS Workload Reduction Funds

OBJECTIVE: We examine a new graph parameter called the set chromatic number. The initial goal is to find bounds and/or exact values of the set chromatic number of a graph in terms of familiar graph parameters.

SUMMARY: This work was initiated in 2008 with Gary Chartrand and Ping Zhang (both at Western Michigan University) and Futaba Okamoto (University of Wisconsin at LaCrosse). The work continued in 2009, with Raluca Gera (NPS) joining the effort. A set coloring in a nontrivial connected graph \( G = (V,E) \) is defined as follows: the map \( c \), from \( V \) to the natural numbers, is a vertex coloring in which adjacent vertices might receive the same color. For a vertex \( v \) in \( V \), the neighborhood color set \( NC(v) \) is the set of colors assigned to the neighbors of \( v \). The coloring is called a set coloring if \( NC(u) \) disagrees with \( NC(v) \) for every edge \( e = \{u,v\} \) in \( E \). The minimum number of colors required of such a coloring is called the set chromatic number, denoted \( \chi_s(G) \). The initial work was focused on determining the set chromatic numbers of some well known classes of graphs and on finding bounds on the set chromatic number of an arbitrary graph \( G \) in terms of more familiar graph parameters. From this initial effort, we proceeded to investigate the set chromatic numbers of joins of the join \( G+H \) of two graphs \( G \) and \( H \). Sharp lower and upper bounds were established for \( \chi_s(G+H) \) in terms of \( \chi_s(G), \chi_s(H), \) and the clique numbers \( \omega(G) \) and \( \omega(H) \). Recent work has focused on the complexity of computing the set chromatic number, on the set chromatic numbers of certain classes of perfect graphs, and on Nordhaus-Gaddum-type inequalities for the set chromatic number. Two journal articles appeared in 2009 (reported on 2009 research summary), and one more was in galleys by the end of 2010.

PUBLICATIONS:


AMS SUBJECT CLASSIFICATION: 05C15, 05C17.

COLORINGS OF THREE FACTORS OF A COMPLETE GRAPH
Craig W. Rasmussen, Associate Professor
Department of Applied Mathematics
Sponsor: NPS Workload Reduction Funds

OBJECTIVE: Extend the Nordhaus-Gaddum results on chromatic numbers of sums and products of a graph and its complement to sums and products of three factors of a complete graph.

SUMMARY: This was new work done in 2009 with Futaba Okamoto (UW-Lacrosse), peripheral to our work with Gera and Zhang on set colorings; one paper accepted in 2009 went to press in 2009 but did not appear in the authors’ mailboxes until 2010 and so was not listed in the 2009 research summary. The work concerned an extension of the Nordhaus-Gaddum theorem that gave lower and upper bounds on the chromatic numbers of sums and products of a graph and its complement to sums and products of three factors, characterizing integer triples realizable as chromatic numbers of three factors of a complete graph. It is unclear at this point how we can fully generalize the Nordhaus-Gaddum results, and the project has been set aside for the time being.

PUBLICATIONS:

Realizing Lattice Points in 3-Space as the Chromatic Numbers of Three Factors of a Complete Graph, Congressus Numerantium 198 (2009), pp. 31-37.

AMS SUBJECT CLASSIFICATION: 05C15, 05C70.
INVESTIGATION OF ACOUSTIC CLOAKING

Clyde Scandrett, Professor

Department of Applied Mathematics

Sponsor: Naval Undersea Warfare Center – Newport Division

OBJECTIVE: In collaboration with NUWC researchers, assess the feasibility of acoustic cloaking. Initial work will bear on what is theoretically possible while other researchers at NUWC will focus on a class of meta-materials capable of realizing the analytical potentials. This year’s effort centered about the issue of broadband applicability of a layered acoustic cloak.

SUMMARY: Acoustic cloaks comprised of piecewise constant layers of pentamode materials (fluids possessing anisotropy in bulk moduli) were investigated. The objective was to perform a constrained optimization of the material properties of the layered system that would minimize the total scattered energy from a cloaked sphere. It was hypothesized that as the number of layers increased, optimal parameters would match values found from applying transformational acoustics. In a broad sense, this was found to be true, but given the discrete nature of practical cloaks and limitations on what range material anisotropies can take, it is a bit more ambiguous. In any event, a methodology for optimizing material parameters within cloaking layers was developed loosely based on a homotopy method that optimizes over an initial frequency, and expands the band over which the optimization occurs to create as broad of a band as possible. Results were submitted for publication to Wave Motion.

PRESENTATIONS:

Presented a paper at the National Acoustical Society in Baltimore in April.

PUBLICATIONS:


THESES DIRECTED:

Currently working the foreign national physics student Ana Vieira in acoustic cloaking of a fluid loaded thin spherical shell.

MODELING OF SEMICONDUCTOR MINORITY-CARRIER DIFFUSION

Clyde Scandrett, Professor

Nancy Haegel, Professor (Department of Physics)

Chris Frenzen, Associate Professor Applied Mathematics

Sponsor: unfunded

OBJECTIVE: To collaborate with experimentalists using an optical microscope coupled with a scanning electron microscope, producing images that can be modeled numerically to determine diffusion lengths of minority carriers within a semiconductor. Also did modeling of the time dependent problem for determination of minority carrier lifetimes in “thick” semiconductors.

SUMMARY: Point source and line source experimental results have been obtained and modeled in the determination of diffusion lengths for a variety of semiconductors. Excellent fits between experimental and mathematically modeled results have been obtained, but efforts to data fit using a non-linear least squares method seems to be very problem dependent, so for a given data fit, general techniques are still being explored.
**APPLIED MATHEMATICS**

**PUBLICATIONS:**


**THESES DIRECTED:**

Co-advising Major Kevin Blaine who is a dual degree student in Math and Physics with an expected graduation date of June 2011.

**NINTH INTERNATIONAL SYMPOSIUM ON TECHNOLOGY & THE MINE PROBLEM**

Clyde Scandrett, Professor  
Department of Applied Mathematics  
Sponsor: Office of Naval Research

**OBJECTIVE:** Hosted the “Ninth International Symposium on Technology and the mine Problem”, held at the Naval Postgraduate School May 17-21, 2010.

**SUMMARY:** Funding from ONR supported the planning and execution of a technical symposium on Mines. The purpose of the symposium is to continue the examination of the potentials of emergent technologies to enhance the capabilities of the U.S. and its Allies in mining, mine countermeasures, and humanitarian demining that includes area remediation. The themes of the upcoming symposium are technologies for Mine Warfare, Expeditionary Warfare, with an emphasis on the use of unmanned systems. As with the eight preceding symposia, this symposium is a joint undertaking of several U.S. Government Agencies.

**PUBLICATIONS:**

Proceeding of the talks was produced and distributed to participants, navy labs, ONR, and libraries.

**TENTH INTERNATIONAL SYMPOSIUM ON TECHNOLOGY & THE MINE PROBLEM**

Clyde Scandrett, Professor  
Department of Applied Mathematics  
Sponsor: Office of Naval Research

**OBJECTIVE:** The funds will help support the planning and execution of a technical symposium on Mines. The purpose of the symposium is to continue the examination of the potentials of emergent technologies to enhance the capabilities of the U.S. and its Allies in mining, mine countermeasures, and humanitarian demining that includes area remediation. These symposia have been nationally and internationally acclaimed and have been well recognized by the policy and executive levels in the Department of Defense and in the Military Departments. Each symposium has been attended by 300-450 individuals who have been drawn from the DOD operating forces, industry, academia, the international community, and by senior DOD, Navy, Army, and Marine Corps officials. As with the nine preceding symposia, this symposium is a joint undertaking of several U.S. Government Agencies. The planned dates for the Tenth Symposium are May 21-24, 2012.
APPLIED MATHEMATICS

CRYPTOGRAPHIC BOOLEAN FUNCTIONS – MATHEMATICAL ISSUES
Pantelimon Stanica, Professor
Department of Applied Mathematics
Sponsor: Unfunded

OBJECTIVE: To investigate other transforms on the set of cryptographic Boolean functions.

SUMMARY: Boolean functions received a lot of attention in the field of coding theory, sequences and cryptology. The most important method of analyzing the Boolean functions is by exploiting a certain kind of discrete Fourier transform, which is known, as Walsh-Hadamard transform. The maximum nonlinearity of a Boolean function is achieved when the maximum absolute value in the Walsh spectrum is minimized. For even n, such functions are well known as bent functions and the magnitudes of all the values in Walsh spectrum are the same. From the perspective of coding theory, these functions attain the covering radius of first order Reed-Muller code. Towards a nega-periodic analogue of the bent criteria, one can use nega-Hadamard transform and investigate Boolean functions with nega flat spectrum.

PRESENTATIONS:
A quick walk through cryptography, Romanian Diaspora Conference, IMAR (Institute of Mathematics of Romanian Academy), Bucharest, Romania, September 2010.

PUBLICATIONS:

THESES DIRECTED:
• Spyros Pollatos (Ph.D., MA);
• Thor Martinsen (Ph.D., MA)
• Jong Chung (Ph.D. MA)
• Eric McCay (Master’s, ECE & MA)
• Chris Johnson (Master’s, ECE);
• Carole Etherington (Master’s, ECE)
• Timothy O’Doud (Master’s, ECE)

CRYPTOGRAPHIC BOOLEAN FUNCTIONS – COMPUTATIONAL ISSUES
Pantelimon Stanica, Professor
J.T. Butler, Professor (Department of Electrical and Computer Engineering)
Department of Applied Mathematics
Sponsor: Unfunded

OBJECTIVE: To build and characterize an Atlas of cryptographic Boolean functions.

SUMMARY: The present project had (has), as its main objective, the study of bent and other relevant Boolean functions properties and their cryptographic relevance. Bent functions have the advantage that their (Hamming) distance from the set of all affine functions is the largest one can achieve. As a result, bent functions (or slight modifications of them) are the least susceptible of all functions to various types of linear attacks. We used the features of the high-end reconfigurable computer SRC-6 (which has two conventional processors, 10 FPGAs (Xilinx Virtex II Field Programmable Gate Arrays), and 32 GB of global common memory) to generate the sought-after bent functions and intersections of this class with other cryptographically relevant subclasses of Boolean functions.
INVESTIGATIONS ON NUMBER THEORETICAL FUNCTIONS
Pantelimon Stanica, Professor
Department of Applied Mathematics
Sponsor: Unfunded

OBJECTIVE: Investigate various properties of binary sequences, prime factorizations in these products and properties of arithmetical functions in number theory.

SUMMARY: This is a continuation of various projects having as end result a better understanding of binary and p-ary sequences and their number theoretical properties. Methods from Number Theory and Linear Algebra (like matrix factorizations) are used.

PRESENTATIONS:
Nonoverlap property of the Thue—Morse sequence, International Conference on Fibonacci Numbers and Applications, July 2010, Mexico.


PUBLICATIONS:

FUNDAMENTAL PROBLEMS IN DEVELOPING LASER-PROTECTION MATERIALS
Hong Zhou, Associate Professor
Department of Applied Mathematics
Sponsor: Naval Research Office

OBJECTIVE: High-energy laser weapons are very powerful and lethal. The beam from a laser weapon deposits energy to disable or destroy an opponent target. In order to protect the object surface from damages, it is desirable to develop materials which do not absorb the photons from laser beams. The proposed project aims to develop this type of materials with light weight and high performance.
APPLIED MATHEMATICS

SUMMARY: We would like to start with liquid crystalline polymers as potential materials and focus on basic physical problems. Our recent work includes (1) providing analytical solution to the temperature rise induced by a rotating or dithering laser beam on a semi-infinite domain and obtaining the relationship between the maximum temperature rise and the speed of rotation or dithering; (2) finding numerical solutions to the temperature rise induced by a rotating or dithering laser beam on a finite body; (3) seeking numerical solutions to the wave propagation on an anisotropic liquid crystal medium.

PUBLICATIONS:

H. Zhou, “Temperature rise induced by a rotating or dithering laser beam”, submitted.


MATHEMATICAL MODELING, ANALYSIS AND SCIENTIFIC COMPUTATIONS OF COMPLEX FLUIDS

Hong Zhou, Associate Professor
Department of Applied Mathematics
Sponsor: AFOSR

OBJECTIVE: The proposed project aims 1) to develop robust and efficient numerical methods and codes to solve the kinetic equations and mesoscopic tensor equations for rodlike polymers in the presence of flows and external fields; 2) to characterize solution behavior of the Smoluchowski equation of general potentials; 3) to study the effect of flow coupling and the effect of weak compressibility on complex fluids.
DEPARTMENT OF
APPLIED MATHEMATICS

2010
Faculty Publications
and Presentations


C. Rasmussen. “Realizing Lattice Points in 3-Space as the Chromatic Numbers of Three Factors of a Complete Graph”, *Congressus Numerantium* 198 (2009), pp. 31-37.


**CONFERENCE PUBLICATIONS & PROCEEDINGS**


APPLIED MATHEMATICS


CONFERENCE PRESENTATIONS


R. Gera. “Choosing a central location for multiple deliveries,” 41st Southeastern International Conference on Combinatorics, Graph Theory, and Computing, FL, March 3-7th


APPLIED MATHEMATICS

presented at Autonomous University of Madrid, Spain, May 22 2010.

Krener, A. J. U. of New Mexico, June 25, 2010
Krener, A. J. AFOSR Review, August 11, 2010, Ballston, VA
Krener, A. J. NOLCOS, September 3, 2010, Bologna, Italy
Krener, A. J. Ecole de Mines, Sept. 27, 2010, Paris, France
Krener, A. J. SupElec, Sept. 28, 2010, Gif, France
Krener, A. J. UCSD, Oct. 4, 2010
Krener, A. J. CDC, Dec. 17, Atlanta
Krener, A. J. UCD, Jan. 25, 2010


G. Owen: “Non-emptiness of the Core in Not-Quite Non-Atomic Games” presented at Polytechnic University of Catalonia, Terrassa, Spain, 4 June 2010.


TECHNICAL REPORTS


RESEARCH REPORTS

Owen, G., Algaba, E. “Representation of Message conduits as Players.”

Owen, G., Manuel, C. and Gonzalez, E. “Behavior of the Kernel under Transfers in Composition of Games.”

PATENTS

Phillips III, C.W., Scandrett, C., Lloyd, J. A Fullerene-Based Hydrogen-Storage System, Navy Case #20080002
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

R. CLARK ROBERTSON
CHAIRMAN
ELECTRICAL AND COMPUTER ENGINEERING

OVERVIEW:

The Department of Electrical and Computer Engineering (ECE) has a broad research program, reflecting the variety of skills and interests of the faculty. ECE faculty research projects are supported by systems commands, warfare centers, the services, basic-research agencies, other universities, and industry. These research projects are grouped into ten major areas of emphasis that support the curricula served by the department and Department of Defense plans. Unique to the ECE Department and the Naval Postgraduate School (NPS) is the ability of faculty and students to perform military-relevant classified research at all levels. The department’s research program ensures that our graduate students will have a creative and meaningful thesis experience, our curricula and courses will remain at the cutting edge, we can recruit and retain quality faculty, and we can provide our sponsors with cutting-edge solutions to their problems.

CURRICULA SERVED:

• Electronic Systems Engineering
• Information Warfare
• Electronic Warfare
• Space-Systems Operations
• Space-Systems Engineering
• Undersea Warfare
• Joint C4I Systems
• Information Technology Management
• Systems Engineering

DEGREES GRANTED:

• Master of Science in Electrical Engineering
• Master of Science in Engineering Science
• Master of Engineering (Electrical Engineering)
• Electrical Engineer
• Doctor of Philosophy

RESEARCH THRUST AREAS:

• Communications and Signal Processing
• Electric Power and Control
• Network Engineering
• Sensor Systems Engineering
• Computers and Microelectronics

LABORATORIES:

• Nano-Electronics Laboratory
• Circuits, Signals, and Digital Systems Laboratory
• Academic Computing Laboratory
• Microwave and Antenna Laboratory
• Optical Electronics Laboratory
• Radar and Electronic-Warfare Systems Laboratory
• Controls and Robotics Laboratory
• Power Systems Laboratory
• Digital Signal Processing Laboratory
• Computer Communications and Networking Laboratory
• Secure Computing Laboratory
• Communications Research Laboratory
ELECTRICAL AND COMPUTER ENGINEERING

• Signal Enhancement Laboratory

RESEARCH CENTERS:

• Center for Cyber Warfare
• Center for Joint Services Electronic Warfare
• Center for Reconnaissance Research
• Center for Signal Processing
• Center for Radiation Hardened Electronics
• Communications Research Center

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Electrical and Computer Engineering is provided below:
ELECTRICAL AND COMPUTER ENGINEERING

R. Clark Robertson  
Chairman & Professor  
831-656-2081  
crobertson@gmail.com

Robert W. Ashton  
Associate Professor  
831-656-2928  
ashton@nps.edu

David C. Jenn  
Professor  
831-656-2254  
jenn@nps.edu

Phillip E. Pace  
Professor & Director Center for  
Joint Services Electronic Warfare  
831-656-3286  
pepace@nps.edu

Peter R. Ateshian  
Visiting Lecturer  
831-656-2255  
prateshi@nps.edu

Alexander L. Julian  
Assistant Professor  
831-656-2101  
avilin@nps.edu

Ric Romero  
Assistant Professor  
831-656-3288  
rromero@nps.edu

Jon T. Butler  
Professor  
831-656-3299  
butler@nps.edu

Jeffrey B. Knorr  
Professor Emeritus  
831-656-2815  
jknorr@nps.edu

Alan A. Ross  
Professor of Practice  
831-656-3769  
aross@nps.edu

Roberto Cristi  
Professor  
831-656-2223  
cristi@nps.edu

Herschel H. Loomis  
Professor  
831-656-3214  
loomis@nps.edu

James Scrofani  
Associate Professor  
Weilian Su  
Associate Professor  
831-656-3217  
weilian@nps.edu

Monique P. Fargues  
Professor  
831-656-2859  
fargues@nps.edu

John C. McEachen  
Professor  
831-656-3652  
mceachen@nps.edu

Frederick W. Terman  
Senior Lecturer  
831-656-2178  
terman@nps.edu

Douglas J. Fouts  
Professor & Associate Dean of Research  
831-656-2852  
fouts@nps.edu

James Bret Michael  
Professor  
831-656-2655  
bmichael@nps.edu

Preetha Thulasiraman  
Assistant Professor  
831-656-3456  
phulas@nps.edu

Vicente Garcia  
Professor of Practice  
831-656-7766  
vcgarcia@nps.edu

Sherif N. Michael  
Professor  
831-656-2252  
michael@nps.edu

Murali Tummala  
Professor  
831-656-2645  
mungala@nps.edu

Rachel E. Goshorn  
Assistant Professor & C4I Chair  
831-656-3835  
goshorn@nps.edu

Michael A. Morgan  
Professor  
831-656-2677  
morgan@nps.edu

Wilbur R. Vincent  
Research Associate Professor  
831-656-2753  
wrvincent@nps.edu

Tri T. Ha  
Professor  
831-656-2788  
ha@nps.edu

David Neely  
Associate Chair & Military Research Associate  
831-656-2233  
dsneely@nps.edu

Todd Weatherford  
Associate Professor  
831-656-3044  
trweather@nps.edu

Robert G. Hutchins  
Associate Professor  
831-656-3289  
hutchins@nps.edu

Giovanna Oriti  
Research Assistant Professor  
831-656-2637  
goriti@nps.edu
ELECTRICAL AND COMPUTER ENGINEERING

Douglas Weismann
Lecturer
831-656-1815
dmweisma@nps.edu

Xiaoping Yun
Professor
831-656-2629
yun@nps.edu

Lawrence J. Ziomek
Professor
831-656-3206
ziomek@nps.edu
OBJECTIVE: The goal of this research is to develop a functionally integrated architecture and design simulation environment to implement automated methods for exploring different electrical distribution system tradeoffs in a total ship context in order to find optimum ship designs in terms of operational effectiveness metrics.

SUMMARY: The proposed design environment will provide methods for performing interoperability analysis of system components and provide design metrics such as ship electrical system operational effectiveness mapped to overall ship system effectiveness in the areas of survivability, vulnerability, and warfighting. The simulation design environment provides methods for evaluation the performance of both the physical layout of the power system components and the dynamic response characteristic, yielding the resulting affect on the survivability of the overall ship system in a warfighting context. Ship power requirements will vary greatly depending upon the top speed, hull form, weight disbursement, survivability, and weapons — therefore different combinations of generation and distribution equipment will be tested for different hull architectures and weapon configurations. These new capabilities will compress the technology development cycle, support rapid technology insertion for the joint service acquisition re-capitalization, and de-risk full-scale hardware testing by providing the ability to evaluate the entire system performance prior to testing. System designers will be better equipped when formulating measures of ship vulnerability, survivability, and mission effectiveness. The system’s integration of the various hardware and software components will provide the capability to validate performance, define and reduce risk, develop operational capabilities and support near real time manufacturing capabilities.

OBJECTIVE: Provide expert electromagnetic aircraft launch system (EMALS) prime power interface subsystem (PPIS) and power conversion subsystem (PCS) power electronics technical consultation. This includes device, controller and algorithm design calculation review as well as interfaces, test plans and procedure review of solid-state power electronic based power conversion devices supporting EMALS design, production and testing.

SUMMARY: The principle investigator will provide non-recurring engineering and program support services to the Naval Surface Warfare Center, Carderock Division, Philadelphia Site (NSWCCD-SSES) in support of the NAVSEA 05 Electromagnetic Aircraft Launching System (EMALS) Program.

OBJECTIVE: To produce efficient designs for logic circuits that realize numeric functions, such as \( f(x) = \sin(x) \). The design is easily adapted to a range of commonly used functions, including trigonometric functions, \( 2x \), \( \log x \), entropy function, sigmoid function, and Gaussian function. An important characteristic is that composite functions can be easily implemented. For example, the composite log \( \log(\sin(\sqrt{x})) \) is as easily realized as any single function.

SUMMARY: This year’s contributions include further development of our work in floating point representation. In
addition, we published a paper in the Journal of Computational and Applied Mathematics that showed a formal process by which one can estimate the number of segments in a piecewise approximation of a given function that depends on the function (its second derivative), the region of approximation, and the desired approximation error. The significance of this is that we are now able to accurately estimate the complexity of the circuits that realize this approximation. Before, we had to attempt the circuit design to determine if it was feasible. We actually did this research several years earlier, but the journal publication describing this work only appeared this year. We continued our work on realizing functions on two variables.

PUBLICATIONS:


BENT FUNCTIONS FOR CRYPTOGRAPHY
Jon T. Butler, Professor
Pantelimon Stanica, Professor (Department of Applied Mathematics)
Department of Electrical and Computer Engineering
Sponsor: Unfunded

OBJECTIVE: To apply the reconfigurable computer as a research tool for Boolean functions for cryptography. For example, we have focused on bent functions because they are the most nonlinear of all Boolean functions and are resilient to linear attacks. With a reconfigurable computer, we can adapt the architecture to the problem and thus achieve significant speed ups.

SUMMARY: We made three significant advances this year, as represented by three Masters thesis. First, we showed the feasibility of the circular pipeline in sieving for bent functions. For example, we achieved a 55 times speedup in this process using only 2.3 times the FPGA resources. Second, we showed how to implement the fast Walsh transform in an FPGA to derive the nonlinearity of the a Boolean function, and we made progress on an efficient heuristic for finding functions with high nonlinearity (e.g. bent functions). Third, we showed that the sieve approach for finding bent functions could also be used to find functions with high correlation immunity. Like bentness, correlation immunity, is an important cryptographic characteristic.

PRESENTATIONS:


PUBLICATIONS:

J. L. Shafer, S. W, Schneider, J. T. Butler, and P. Stanica, "Enumeration of bent Boolean functions by reconfigurable
ROBUST ADAPTIVE CONTROL WITH EXTERNAL DISTURBANCES AND UNMODELED DYNAMICS
Brij N. Agrawal, Professor (Department of Mechanical and Aerospace Engineering)
Roberto Cristi, Professor
Department of Electrical and Computer Engineering
Sponsor: NRO, 14675 Lee Road, Chantilly, VA 20150-1715

OBJECTIVE: The objective of this research program is to develop and evaluate robust adaptive control techniques for accurate pointing and tracking of spacecraft with flexible appendages, external disturbances and unmodeled dynamics. This works is a continuing effort to the design of an adaptive controller which compensates for model uncertainties and flexible modes in dynamic systems. Typical applications are systems with flexible appendages deployed in space.

PUBLICATIONS (In Progress):

ECE DISTANCE LEARNING PROGRAM
Roberto Cristi, Professor
Clark Robertson, Professors
Department of Electrical and Computer Engineering
Sponsors: various sponsors (Statistical Account)

OBJECTIVE: The ECE Department has been offering a number of Distance Learning programs specially in Electronic Warfare (EW), Power Systems and Digital Signal Processing.

During CY2010 we had two cohorts from NAWC (PtMugu and Chinalake) for the MEng(EE) and one cohort from NSWC (from Crane, Indiana) for the MSEE.
ELECTRICAL AND COMPUTER ENGINEERING

INVESTIGATIONS INTO WAVELET OFDM RECEIVER PERFORMANCES
Monique P. Fargues, Professor
Department of Electrical and Computer Engineering
Sponsor: Unfunded

OBJECTIVE: This project proposes to investigate Wavelet OFDM schemes. First, we conducted a review of the literature in that area. Next we propose to investigate how crucial the exact knowledge to the wavelet information is in resulting demodulation performances.

SUMMARY: Background literature review of the technical area has been conducted and initial modulator/demodulator implemented.

FUTURE AIRBORNE CAPABILITIES ENVIRONMENT (FACE)
Douglas J. Fouts, Professor
Department of Electrical and Computer Engineering
Sponsor: Naval Air Systems Command/PMA-209 (Air Combat Electronics)

OBJECTIVE: To develop a common specification for all future embedded computing systems on Naval aircraft and UAVs.

SUMMARY: The principal investigator is a member of a team of researchers that includes technical personnel from the Georgia Institute of Technology, the Georgia Institute of Technology Research Institute, Vanderbilt University, the Naval Air Systems Command, and two different defense contractors, to develop a common specification for all future embedded computing systems on Naval aircraft and UAVs. This includes both real-time computing systems and non real-time computing systems. The specification, once completed and adopted, will also be retroactively applied to existing aircraft when embedded computing systems undergo major upgrades.

At this point in time, the team is concentrating on the software specification, especially the software interface specifications, including but not limited to board support packages, input/output drivers, operating systems, middleware interfaces, application interfaces, application development languages, application development environments, etc. The principal investigator is concentrating on the interface specification between the operating system and the applications, as well as the use of Java, real-time Java, and hard real-time Java.

INTEGRATED CIRCUIT DESIGN AND LIBRARY CELL DEVELOPMENT
Douglas J. Fouts, Professor
Department of Electrical and Computer Engineering
Sponsor: NELO

OBJECTIVE: This research is classified.

GED SPECIAL PROJECT RESEARCH
Vincente Garcia, Professor of Practice
Department of Electrical and Computer Engineering
Sponsor: OSAF

OBJECTIVE: This research is classified.
OBJECTIVE: C4I Chair efforts, to synchronize NPS and PEO C4I S&T efforts.

SUMMARY: The objective of the C4I Chair is to synchronize NPS and PEO C4I S&T efforts. PEO C4I requested that I be their C4I Chair at NPS. Before the MOA went through (JAN 2010), PEO C4I funded me to begin the C4I Chair duties. The work carried out over the summer of FY09 (and cont. in Fall 2009) is in response to a request from PEO C4I to prepare for assisting PEO C4I in FY10 as C4I Chair at the Naval Postgraduate School. In FY10, assisting PEO C4I required: interfacing with PEO C4I on gathering potential theses, capstone projects, faculty research topics and circulating with the Naval Postgraduate School, Departments, Institutes, Academic Groups and Research Centers. Workshops in the fall and spring quarter will be hosted at NPS to assist in circulating these topics, and a website will be hosted at NPS to also circulate these topics. In order to prepare for FY10 position of assisting PEO C4I, several visits to PEO C4I were carried out over the summer, along with attending a demonstration (requested by PEO C4I). The visits to PEO C4I over the summer encompassed, working closely with APEO for Science and Technology (S&T) and meeting with PEO C4I, Program Managers, Technical Directors, S&T, etc to gather topics and discuss NPS research and curricula. The PEO C4I supported work covered trips to PEO C4I (about one per month this summer) and one visit to the Empire Challenge demonstration in China Lake, labor for the trips were covered as well as a few weeks of labor to carry out additional preparations. Additional preparations were: work with ITACS Business Solutions Group to develop concepts for a Website for hosting the C4I Chair information (accessible by NPS and PEO C4I, with various levels of access), worked with NPS to socialize C4I Chair and PEO C4I, interacted with NPS (Dean of Research) on getting up to speed and tracking with current research and curricula, developed a plan for matrix mapping between NPS and PEO C4I, and worked with PEO C4I on gathering research topics (theses, capstone projects, faculty/labs research, etc). September 2009, C4I Chair was announced to NPS at a briefing, where PEO C4I Technical Director briefed NPS on PEO C4I’s Masterplan, which is the basis of mapping between NPS and PEO C4I. I have been carrying out the C4I Chair duties and the MOA was signed by PEO C4I and NPS JAN 2010, and summarized well in the NPS public article at: http://www.nps.edu/About/News/NPS-Stands-Up-New-C4I-Chair-.html (with a snapshot in figure below). Worked across all schools, institutes, departments to socialize C4I efforts and potential collaboration with PEO C4I.

Per the MOA, the C4I Chair reports to the Dean of Research and works across campus (schools, institutes, academic groups, faculty, students) to synchronize C4I efforts between NPS and PEO C4I. Socialized PEO C4I efforts, research needs, with respect to the C4I portfolios of PEO C4I, to NPS Four Schools (GSEAS, GSOIS, GSPPP, SIGS), four Institutes (MEYER, NSI, MOVES, Cebrowski), Department Chairman, Faculty, Students. Socializing, and querying school, department, institute, faculty, etc areas and how they feel they map to the C4I portfolios (with respect to basic research, applied research, modeling, test and evaluation capabilities, etc.). Developed and offered C4I Workshop, with faculty and students across campus (all schools and institutes) participating with PEO C4I. The C4I Workshop brought together the Naval Postgraduate School and PEO C4I to coordinate research opportunities for NPS faculty, students, institutes and academic groups/labs. The Naval Postgraduate School presented its C4I capabilities, mapped to PEO C4I’s portfolio areas (see below and attached C4I Workshop Agenda), as listed: A. Communications – SATCOM/Non-SATCOM Wireless/Tactical Data Links; B. Networks – Wide Area Networks/ Local Area Networks/ Network Management; C. Common Computing Environment/Common Services – Hardware (CANES)/Software (Core Services/Tactical Edge); D. Application Services - Business Apps/ISR/Battle Space Awareness/Command & Control; E. Cross Cutting Services - Cyber Warfare/Information Assurance/Encryption/Information Ops. A senior faculty member represented each portfolio area and presented NPS’ C4I capabilities in research and education per roadmap area. PEO C4I presented its programs of record and potential research areas for NPS. The workshop provided about a 100 C4I research topics. This was the first ever C4I Workshop that brought GSOIS, GSEAS, SIGS, GSPP and all four institutes together in a common goal of synching over C4I portfolio areas. During the planning phases of the C4I Workshop, interest across the DoD/DHS for attending and speaking and funding NPS was shown (PEO C4I wanted the first workshop to be scoped down). This is planned for the future. Working with PEO C4I S&T office
for mapping NPS capabilities to PEO C4I research topics (from C4I Workshop, June 2010); mapped to C4I Portfolio areas and S&T Gaps. Working to see if PEO C4I has additional research topics, and funding, in the cyber area and international C4I. NPS has students and faculty in this area interested in PEO C4I research topics. There is interest through C4I to use NPS for a “tie-together”, with PEO C4I’s leadership and guidance, to help connect C4I across all of these organizations. Given the overlap (of C4I sponsor interests) a Vision of NPS could be: NPS as a neutral ground, with PEO C4I’s leadership, for roadmap to help map basic research to fielded and maintaining (e.g. through “colors of money” 6.1, 6.2, 6.3, 6.4, 6.5,… ) for C4I systems (impacting the DoD/DHS in a unified manner through C4I). This could be a way to get a common denominator across Navy and DoD through C4I. Note: Admiral Mullen wants Team SPAWAR synched with NPS (Ref: Rachel Brief, JAN 2005). Invited brief, meeting with, Admiral Leighter (Deputy Commander of 10th Fleet) for the purpose of C4I Chair efforts, and how 10th fleet cyber research problems may overlap with PEO C4I research topics, at NPS, working with NPS Intel Chair and NPS C4I Chair. Working with PEO C4I S&T office for establishing a POC per PEO C4I presented research topic (from the C4I Workshop); in addition, working to see if funding is available for students: ideally $5K (two trips to PEO C4I), $10K (two trips to PEO C4I and equipment), $20-25K ($10K for students and $10K-$15K for student advisor). Working with S&T office, plan PMW focus groups with NPS, as a follow-on to C4I Workshop (June 2010). For more workshop details see below and referenced article (figure below) and C4I Workshop Agenda (about 100 thesis topics were presented that are being circulated with students).

C4I WORKSHOP AT THE NAVAL POSTGRADUATE SCHOOL

C4I Workshop Overview: The C4I Workshop will bring together the Naval Postgraduate School and PEO C4I to coordinate research opportunities for NPS faculty, students, institutes and academic groups/labs. The Naval Postgraduate School will present its C4I capabilities, mapped to PEO C4I’s Roadmap, as listed below. PEO C4I will present its programs of record and potential research areas for NPS.

C4I Workshop Objective: The workshop is an opportunity for PEO C4I and NPS to explore potential collaborations that can support PEO C4I needs via faculty and student theses, analysis, studies, research, and T&E.

PRESENTATIONS: Several presentations were made under this research.

THESES DIRECTED:

LCDR Dan Haase, MSSE 580 Network-Centric Systems Engineering Track (Graduates Spring CY10), Research Area: Network-Centricity in Consolidated Afloat Network Enterprise Services (CANES)

Under my role as C4I Chair, several other NPS students’ thesis topics have come from this research.

NPS SUPPORT FOR CY2010-2012 RAPID PRO VIRT (RPV)

Rachel E. Goshorn, Assistant Professor
Department of Electrical and Computer Engineering
Sponsor: PMM123, MCSC

OBJECTIVE: The Marines need ever-improving systems to find, fix and target enemies. They have adopted a rapid prototyping approach with 5 key elements: (1) an architecture for composing capabilities; (2) a set of evolving components; (3) an environment for testing and employing candidate systems; (4) a fitness function that assesses how well the candidates perform in the environment and that guides feedback; and (5) a feedback function that assures investment flows into successful components and promising new candidates. The fitness function must shape successive systems to utilize highvalue information and reduce low-productivity activities that produce or consume low-value bits. This is what our VIRT techniques address: how to assure that significant bits flow to and affect decision-makers while they have time and processing resources to exploit them. VIRT is a key aspect of the fitness function that will make the evolutionary approach converge on superior systems. This proposal aims to support MCSC Intell to implement these key elements and attain a best of breed solution to the intelligence problem that continuously evolves and improves.
ELECTRICAL AND COMPUTER ENGINEERING

WIRELESSLY NETWORKED OPPORTUNISTIC ARRAYS

David C. Jenn, Professor
Department of Electrical and Computer Engineering
Sponsor: NUS (CRADA)

OBJECTIVE: An opportunistic array is an integrated platform wide digital phased array, where elements are placed at available open areas over the entire length of the platform. This phase of the research continued the development of the hardware and techniques to implement the concept. Detailed simulations and hardware studies were performed, resulting in a demonstration design for a 2.4 GHz array.

SUMMARY: The recent research focused on designing and building a demonstration array at 2.4 GHz, taking advantage of low cost components available at this frequency. The demonstration array has most of the functionality of the full scale system, although the performance is scaled back to save cost. The major purpose of demonstration array is to examine timing and synchronization issues, and to develop controller and signal processing software. Also, a coherent cancellation circuit was added to improve the phase synchronization accuracy.

PUBLICATIONS:


THESES DIRECTED:


DIGITAL TRACKING ARRAY

David C. Jenn, Professor
Department of Electrical and Computer Engineering
Sponsor: Unfunded

OBJECTIVE: The objective of this program is to design, build and demonstrate a ground based digital phased array to automatically track video signals from a UAV.

SUMMARY: In previous research, NPS demonstrated the basic operation of a base station digital phased array that can be used to automatically track and receive video signals from a UAV. The antenna beam is formed digitally and tracks an incoming UAV signal using a monopulse technique. A prototype array has been built using COTS hardware at 2.4 GHz. The array operation was verified in the NPS anechoic chamber. The most recent work concentrated on improving the acquisition and tracking software. The robustness of the FM demodulation software and NTSC video decoder was improved. The improvements will result in a system with longer operating range, wider bandwidth, and provide a compact package that can be field tested at Camp Roberts.

PUBLICATIONS:

ELECTRICAL AND COMPUTER ENGINEERING

THESES DIRECTED:


ELECTRIC SHIP THESIS TOPIC DEVELOPMENT
Alexander L. Julian, Assistant Professor
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research

OBJECTIVE: Jesse Black is pursuing a PhD in electrical engineering at NPS. This funding was provided by ONR to support my efforts advising him and guiding him toward a thesis topic.

NON LINEAR MODEL OF A TWELVE PHASE TRANSFORMER FEEDING A 24 PULSE DIODE RECTIFIER
Alexander L. Julian, Assistant Professor
Department of Electrical and Computer Engineering
Sponsor: NCRADA-NPS-10–0143, DRS Technologies Corp.

OBJECTIVE: The goal of this CRADA is to modify the transformer model developed with DRS under the CRADA, NCRADA-NPS-07-0097 to include the non-linear effect of core saturation in the transformer model and adapt it to another application. Dynamic simulations will be developed to accurately predict the transformer performance.

PULSED POWER SUPPLY (PPS) DESIGN AND ANALYSIS FOR THE RAILGUN
Alexander L. Julian, Assistant Professor
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research

OBJECTIVE: Naval Postgraduate School (NPS) will support the Navy Railgun Program by providing basic/applied research in the area of pulsed power systems (PPS). From a component level thyristors and snubbers will be electrically characterized. From a broader system level NPS will develop a concept for a mobile gun charging system, Perform a trade study for a rotating machine PPS, and perform failure mode and effects analysis.

ANALYSIS AND MODELING OF RECEIVERS FOR 4G-LIKE SIGNALS
Frank E. Kragh, Associate Professor
Donna Miller, Research Associate
Department of Electrical and Computer Engineering
Sponsor: Navy Information Operations Command Suitland, Maryland

OBJECTIVE: This work explores methods for receiving MIMO OFDM and MIMO OFDMA signals for the case when the channel state information at the transmitter is not a correct representation of the channel state information at the receiver, as might be the case when the receiver is not the intended receiver. The work also explores methods for access to an adversary’s networks using RF means.

SUMMARY: This work was begun in November 2010. I have visited the sponsor, reviewed research ideas, and
adjusted them to align better with the sponsor’s desires. Literature review has been conducted. This research continues into CY2011.

**THESES DIRECTED:** One in progress.

**NSA/IDG COMMUNICATIONS RESEARCH LAB AND THESIS RESEARCH SUPPORT**

Frank E. Kragh, Associate Professor  
Donna Miller, Research Associate  
Department of Electrical and Computer Engineering  
Sponsor: National Security Agency

**OBJECTIVE:** As 3G evolves and 4G technologies deploy, we must be ready to exploit adversaries’ use of these devices. We can do this by exploring and developing techniques for detecting, collecting, deinterleaving, geolocating, and demodulating 3G and 4G signals to exploit the message content and the identities and locations of sender and receiver(s), and integrating the resulting intelligence with other intelligence. Advanced interference mitigation and joint demodulation techniques are needed for robust demodulation.

**SUMMARY:** Analysis was done in the potential for demodulation of OFDM signals by an unintended receiver. This research included analysis of bit error ratio (BER) at the unintended receiver for various combinations of received signal power and receiver configuration. Of special importance was the number of receive antennas. The number of receive antennas was found to strongly affect the BER, even when the total received energy per bit was kept constant. This research continues into CY2011.

**PERFORMANCE ANALYSIS OF RECEIVERS IN COMMUNICATIONS SYSTEMS WHICH EMPLOY MULTIPLE INPUT MULTIPLE OUTPUT (MIMO), SPACE TIME CODING (STC), AND ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM) TECHNIQUES**

Frank E. Kragh, Associate Professor  
Donna Miller, Research Associate  
Department of Electrical and Computer Engineering  
Sponsor: Laboratory for Telecommunications Sciences

**OBJECTIVE:** This work explores the performance of disadvantaged receivers in communications systems that utilize Multiple Input Multiple Output (MIMO), Space-Time Codes (STCs), and Orthogonal Frequency Division Multiplexing (OFDM). In some MIMO systems, the receiver uses a reliable feedback channel to convey channel state information (CSI) to the transmitter. The transmitter, in turn, can use this information to adjust its transmissions to optimize reception at the location of the receiver. This work analyzes performance when this mechanism is flawed or there are multiple receivers, some not at the location for which the transmission has been optimized.

**SUMMARY:** To increase understanding, many MIMO systems of increasing complexity were analyzed and simulated to determine the bit error ratio (BER) performance under various channel conditions. The systems to be analyzed included narrowband MIMO systems without STCs, OFDM MIMO systems with STCs, Narrowband MIMO systems with STCs, OFDM MIMO systems with STCs, Narrowband MIMO systems with STCs and knowledge of CSI at the transmitter, and OFDM MIMO systems with STCs and knowledge of CSI at the transmitter.

Notice that the analysis of the final system is the primary objective of this research. Simulations were computer simulations of channel effects, noise, and receiver algorithms using MATLAB. This research continues into CY2011.
THESES DIRECTED:


A COMPREHENSIVE REVIEW ON INTEGRATION OF CELLULAR TECHNOLOGY WITH U.S. MILITARY COMMUNICATION NETWORKS

Frank E. Kragh, Associate Professor
Geoffrey G. Xie, Professor (Department of Computer Science)
Donna Miller, Research Associate
Department of Electrical and Computer Engineering
Sponsor: Joint Program Executive Office Joint Tactical Radio System (JPEO JTRS)

OBJECTIVE: The research is motivated from the current lack of communication capabilities observed by Marines while in a tactical/field environment. The objective is to analyze military communications need and smart phone technologies to determine the applicability and limitations of this technology for military tactical use. Furthermore, the research examines ways to leverage aspects of the commercial technology while avoiding other aspects to provide the proper combination of utility and security demanded of military use.

SUMMARY: Research produced recommendations regarding utilization of different smart phone and mobile phone technologies in different military environments, including garrison, forward operating base, infantry missions, etc. These recommendations included a recommendation to combine commercial hardware and protocol technologies with military grade encryption and physical layer technologies to achieve a high degree of military utility with lower costs due to the leveraging of commercial capabilities and practices. Research in RF detectability of both commercial mobile phone signals and tactical radio signals revealed that at high throughputs (greater than 10kbps), they were comparable. This work continues into CY2010, with emphasis on comparison of JTRS radios and others for robustness in multipath channels.

THESES DIRECTED:


CONFIGURABLE FAULT-TOLERANT PROCESSORS (CFTP) FOR RELIABLE SPACE-BASED COMPUTING

Herschel H. Loomis, Jr., Professor
Alan Ross, Professor of the Practice
Department of Electrical and Computer Engineering
Sponsor: Secretary of the Air Force

OBJECTIVE: To build Single Event Upset (SEU) tolerant techniques for applying Field Programmable Gate Array (FPGA) technology to space-borne computing. In particular, we wish to investigate the ability of the newly discovered Reduced Precision Redundancy (RPR) technique to detect and acceptably correct SEUs in data and configuration memories in arithmetic processes in Software Defined Radios (SDRs) and other suitable algorithms on space-borne FPGAs and dedicated processors.

To test and evaluate the RPR algorithms developed by us and our students for the detection and correction of data and configuration errors using the CFTP test computers developed during our previous research. Triple Modular Redundancy will be used where necessary for non-arithmetic algorithms such as state-machine controllers.

SUMMARY: In August of 2010, we performed radiation test experiments with the Configurable Fault Tolerant Processor (CFTP) using the 63Mev Proton beam at the Crocker Nuclear Laboratory at UC Davis. The current focus
of the CFTP research effort is reduced precision redundancy (RPR) fault protection, and we planned to test an RPR multiplier, an RPR accumulator, and a TMR multiplier algorithm during the test. Unfortunately, we were unable to exercise the RPR multiplier in the beam, but we did generate data with the other two experiments.

We had been asked to look at whether RPR could apply to end-of-life power reduction efforts in an application that has been implemented as a TMR design. As a first test case, we implemented a version of a pixel accumulator as an RPR design, and tested it in simulation and in an FPGA in the 63 Mev proton beam at UC Davis.

The target system does multiple sampling of pixels, and sums them in an accumulator. The pixel values are 12 bits, and the accumulator is a 20 bit value. In the TMR implementation the accumulator values are triplicated, so 60 bits are saved in each iteration. The goal of an RPR implementation is to decrease the number of bits to be saved. For example, we chose to use 5 bits for each of the upper and lower bounds, which means we could store 30 bits instead of 60. The challenge is to decide how to define the five bits of the estimates. In our previous adder and multiplier designs, we have scaled our inputs so that they are fixed point fractions. In those cases the reduced precision versions are simply the most significant bits. Pixels are integers, so if we apply the same technique to an accumulator design, the start of every accumulation will have estimates of zero, because the sum of the first few pixels won’t reach the RPR precision. If we set the limits at the low end, they will quickly overflow. The solution is to use a floating point representation of the accumulated sum as the estimate. When we generate a floating point version of a number, we calculate an exponent and a mantissa. In order to save storage, the IEEE floating point standard assumes a normalized mantissa, and hides the most significant bit (it is always one in a normalized number.) Thus, the exponent is also an estimate of the entire number and actually represents a lower bound. In order to protect our accumulated sum, we will record the bit position of the most significant one in the sum, and save that as a lower bound, add one to it, and save that as the upper bound. With 20 bits in the sum, we use 5 bits to represent the bounds. With an assumption that we only care about the most significant 16 bits of the sum, we could reduce the number of bits in each bound to 4.

We designed a circuit to implement this concept, instantiated it in our CFTP test board, and on the 3rd and 4th of August, we ran this experiment in the proton facility at UC Davis. On the 3rd, we ran for about 8.5 minutes, for a total dose of about 50 rads, and the selectmap readback on the chip reported a total of 14 upsets, with only the last one causing a processing error. On the 4th, the run duration was 19 minutes, 112 rads, and 45 upsets, again with only one causing data errors to be reported. In both cases, only one of the eight test circuits on the test chip was affected. Examination of the results demonstrated what we had suspected. The RPR scheme is probably not suited to protect an accumulator when the most probable error will be a “stuck-at” fault. Since it is most likely that an SEU will upset a configuration bit, and once it does that bit will remain upset until the chip is re-configured, the RPR protection will stick at a particular value. While RPR will detect an error of this type, the protection is probably insufficient.

The second circuit that we tested was a TMR multiplier, and the result was as expected – TMR protected the circuitry, but used a large portion of the chip area.

The third circuit that we attempted to test was an RPR multiplier, but we were unable to complete the instantiation in time for the radiation testing.

As presented in the publication and thesis listed below, our student, LTJG Athanasios Gavros, was able to demonstrate a radix-4 FFT which included RPR protection. This circuit is on our list for a future test.

PUBLICATIONS:

LTJG Athanasios Gavros, Hellenic Navy, Prof. Herschel H. Loomis, Jr., Prof. Alan A. Ross, “Reduced Precision Redundancy in a Radix-4 FFT Implementation on a Field Programmable Gate Array,” Accepted by 2011 IEEE Aerospace Conference, Big Sky, Montana, March 2011

THESES DIRECTED:

Gavros, Athanasios, “Use of the Reduced Precision Redundancy (RPR) Method in a Radix-4 FFT Implementation,” MS in Electrical Engineering, September 2010 (C)
ELECTRICAL AND COMPUTER ENGINEERING

EVALUATE FAULT TOLERANCE OF THE OPERA MULTIPROCESSOR
Herschel H. Loomis, Jr., Professor
Alan Ross, Professor of Practice
Department of Electrical and Computer Engineering
Sponsor: SAF/FMBIB-AFOY

OBJECTIVE: To study the fault tolerance of On-board Processing Expandible Reconfigurable Architecture (OPERA).

LOW POWER FAULT-TOLERANCE FOR RELIABLE SPACE-BASED COMPUTING
Herschel H. Loomis, Jr., Professor
Alan Ross, Professor of Practice
Department of Electrical and Computer Engineering
Sponsor: Sandia National Laboratories

OBJECTIVE: To examine the Sandia developed TMR designs and determine where RPR might be applied to decrease the size and complexity of the designs and whether such reduced size might result in reduced power consumption.

MARITIME DOMAIN AWARENESS SYSTEM DEMONSTRATION
Herschel H. Loomis, Jr., Professor
Alan Ross, Professor of the Practice
RADM Thomas Betterton, (Ret) Visiting Professor (Space Systems Academic Group)
Department of Electrical and Computer Engineering
Sponsors: Naval Postgraduate School, Maritime Protection Research Group

OBJECTIVE: It is our belief that:
1. The essential requirement for successful Maritime Domain Protection is complete Maritime Domain Awareness.
2. Maritime Domain Awareness must include the global tracking of all shipping.
3. Tracking of shipping must involve the fusion of data from multiple sensors, at multiple levels of security.
4. The Sensors and the technology in large measure exist today to permit the United States to carry out global tracking of all shipping in excess of 300 tons.
5. By having complete information on the tracks of ships throughout the world, one can:
   a. Find the track history of any ship of interest
   b. Detect anomalous behavior of particular ships.
   c. Know what ships require special collection efforts to be deployed to detect threats to U.S. and allied interests.
6. The above operations can and must be carried out largely automatically, with only rare human intervention.

These beliefs are based on significant experience by the investigators in the fields of Space-based reconnaissance and important research by our students.

Our concept involves the fusion of classified data from national Signals Intelligence (SIGINT) and Image Intelligence (IMINT) sources, unclassified contact information from AIS collectors and radar satellites, unclassified open source information from shipping companies, port authorities, vessel tracking systems, such as in use by the U.S. Coast Guard, and classified human intelligence (HUMINT) sources.

Additionally, in an effort to promote further awareness and knowledge-sharing of not only MDA-related products, but all research (theses, technical reports, conference proceedings, etc.) at NPS, we have developed (through sponsor-ship of USSTRATCOM GISC) a Classified Research Database on both the SIPRnet and JWICS systems. The database on both systems provides a summary of all releasable research (abstracts) and a method for dissemination of NPS's
ELECTRICAL AND COMPUTER ENGINEERING

classified (and unclassified) products. We have partnered with the Defense Technical Information Service (DTIC) for the user validation and document distribution portion. Users need only apply for a DTIC account from the NPS website to access the full-text documents associated with the records (when present). The URLs to the NPS websites are:

SIPRnet: http://web.nps.navy.smil/thesisdatasearch

JWICS: http://www.nps.pacom.ic.gov (no period between www and nps)

ACHIEVEMENTS FY2010

1. We have met regularly to discuss the National MDA effort and architecture.
2. We have planned and hosted a Maritime Domain Awareness session at the Classified Advanced Technology Update (CATU) held at NPS in June 2010.
3. As part of the MDA research effort, we investigate new and existing sources of ship location and tracking data. Most recently we have followed the development of the Maritime Automated Super-Track Enhanced Reporting (MASTER) system and received training on the use of the system while it was still in a beta phase. MASTER is an analytic tool with automated track-stitching algorithms, additional data feeds, and user-defined alerting and track-analysis tools. Most importantly, MASTER has evolved to an operational capability, operated by ONI, called Sealink Advanced Analysis (S2A).
4. We have identified the Track as a fundamental concept of information on ship movement. Up until now, ship tracks have been reported as the aggregation of individual contact positions containing time, position, confidence ellipse, with perhaps identification and other information. We propose that the individual contact information be removed and the track be reported as periodic best-estimated position with confidence. Identification and other ship information can be attached to the track. Using this model, one can better obscure sources and methods, leading to a reduced classification of the track.
5. We have supported a thesis study by an Operations Research student on the impact of the proliferation of modern LPI radars on our ability to achieve MDA.

THESES DIRECTED:

Culnen, James J., “Assessing the effects of Low Probability of Intercept (LPI) Radar on the ability of the United States Intelligence Community (IC) to maintain Maritime Domain Awareness (MDA),” MS Operations Research, September 2010 (C)

PROJECT GUSTY ORIOLE (U)
Herschel H. Loomis, Jr., Professor
Alan Ross, Professor of the Practice
RADM Thomas C. Betterton, (Ret) Visiting Professor (Space Systems Academic Group)
Department of Electrical and Computer Engineering
Sponsor: Secretary of the Air Force

OBJECTIVE: This project is concerned with the application of fault-tolerant techniques to reconfigurable space-based digital processors, with computer algorithms to specific military space projects, the development of specialized computer architectures for military Space applications, and the infusion of the research into the Space Systems Curricula.

SUMMARY: During 2010 the following contributions have been made:

1. The development of a fault-tolerant Software-Defined Radio (SDR) for eventual incorporation on an existing DoD spacecraft-deployed FPGA. [1]
2. Support of the LPI communications committee and LPI research.
3. Development of Geolocation algorithms and techniques. We have identified a geolocation algorithm for implementation on the NRO-funded MAESTRO Rad-hard multi-core chip.
4. Supported the inclusion of relevant research into Space Systems Courses, SS3001 and SS4051. [2]
ELECTRICAL AND COMPUTER ENGINEERING

PUBLICATIONS:

LTJG Athanasios Gavros, Hellenic Navy, Prof. Herschel H. Loomis, Jr., Prof. Alan A. Ross, “Reduced Precision Redundancy in a Radix-4 FFT Implementation on a Field Programmable Gate Array,” Accepted by 2011 IEEE Aerospace Conference, Big Sky, Montana, March 2011

Report of the SS4051 Capstone Architecture Class, NPS Technical Report NPS-SP-10-001, July 2010

THESES DIRECTED:

Culnen, James J., “Assessing the effects of Low Probability of Intercept (LPI) Radar on the ability of the United States Intelligence Community (IC) to maintain Maritime Domain Awareness (MDA),” MS Operations Research, September 2010 (C)

Gavros, Athanasios, “Use of the Reduced Precision Redundancy (RPR) Method in a Radix-4 FFT Implementation,” MS in Electrical Engineering, September 2010 (C)

Graewert, Eric and Smith, Troy, “Feasibility of Using a Tactical Precision Geo-Location System in a GPS-Denied Environment,” MS in Information Warfare Systems Engineering, September 2010 (C) (Joint Thesis)

Jarvis, “Geolocation of LTE Subscriber Stations Based on the Timing Advance Ranging Parameter,” MS in Electrical Engineering, September 2010 (C)

KEYWORDS: Space Vehicles, Fault-tolerant Computing, FPGA application, Emitter Location

BOB EVALUATION AND ANALYSIS
John C. McEachen, Professor
Department of Electrical and Computer Engineering
Sponsor: SAF

OBJECTIVE: This research includes testing of malicious software and various cyber defense products. Broadband onboard bus (BOB) is a new technology proposal under consideration by the U.S. Air Force. This work relates to large scale testing, evaluation and analysis of BOB in a variety of scenarios. Certain aspects of this research may be classified.

SUMMARY: This research involves the large-scale testing, evaluation and analysis of BOB technology. Specifically, this effort evaluates BOB security aspects and compares the findings to other bus technologies. As part of the testing, an appropriate test infrastructure is being designed and developed. The test infrastructure consists of more than a hundred personal computers and will require a custom imaging system that will allow the researchers to install a variety of operating systems and configurations on each PC simultaneously. Testing also includes development of custom software tools and scripts to facilitate and automate testing. Various technologies are being explored in development of these tools, including PXE booting, perl scripts, and windows scripts, and Linux shell scripts. Parts of the test and evaluation process involve integration into and observation of several mainstream security systems such as video surveillance systems, airport scanners, metal detection systems and other personnel scanners.

THESES DIRECTED:

Brumm, Benjamin, Scalable management of BOB imaging systems, MSEE Thesis (in progress).
OBJECTIVE: Long Term Evolution (LTE) and WiMax are the two emerging and competing technologies for the next generation of mobile phones. Both technologies use Orthogonal Frequency Division Multiple Access (OFDMA). Both the 3GPP LTE and IEEE WiMax standards are vague about signal parameters to allow providers as much flexibility as possible in deploying their cellular networks. Specifically, both do not specify a specific carrier frequency or bandwidth. Further, both use multiple subcarrier counts, cyclic prefix values and varied subcarrier designations. The collecting these signals without any prior knowledge is difficult at best. Additionally, OFDMA signals in general are designed to allocate both time and frequency units to multiple users. This presents a problem in terms of determining the user allocation boundaries and allocation maps in addition to being able to determine the underlying OFDM waveform. Fortunately, all OFDMA signals incorporate cyclostationary features in their underlying waveform. These features can be exploited to reveal substantial amounts of information about the waveform. The objective of this new research is to develop novel signal identification, classification and differentiation techniques for 4G mobile signals based characteristics associated with their waveforms. Initial work in this area indicates that these techniques can be used without knowledge of the bandwidth, subcarrier counts or subcarrier designations. Validation will be conducted through simulation of 4G mobile intercept under a variety of conditions.

GEOLOCATION OF WIMAX/4G MOBILE DEVICES

OBJECTIVE: WiMAX is an emerging technology for metropolitan-area, high data rate access. It is considered the leading contender for 4G mobile phone adoption. The objective of this research is to develop precision geolocation techniques based on control messages used by WiMAX basestations and subscribers.

SUMMARY: The timing adjust measurements from an IEEE 802.16-2009, mobile WiMax system are used to geolocate a mobile subscriber. From Time of Arrival (TOA) and Time Difference of Arrival (TDOA) calculations, two key observations are made. First, geolocation error occurs when calculating in a two-dimensional plane. Second, TDOA calculations can eliminate the initial bias of a measured timing adjust and thereby allow geolocation calculations with less knowledge of the system. Through simulation, the three-dimensional TOA and TDOA methods are shown to outperform the corresponding two-dimensional methods. Experimentation with an Alcatel-Lucent 802.16e-2005 OFDMA based system validates the accuracy of the three-dimensional geolocation method with an average geolocation error of 23 meters compared to 87 meters for the two-dimensional approach.

PRESENTATIONS:

McEachen, J., “How much do you have to worry about your wireless mobile device?, Homeland Security Conference, Monterey, 1 Sep 2010.


PUBLICATIONS:

D. E. Barber and J. McEachen, “Geolocation of WiMAX Subscriber Stations Based on the Timing Adjust Ranging
OBJECTIVE: Long Term Evolution is an emerging 4th Generation digital cellular technology for metropolitan-area, high data rate access. Based on technology similar to that of WiMAX, it is being widely deployed in many North American and European markets. The objective of this research is to develop precision geolocation techniques based on control messages used by LTE basestations and subscribers.

SUMMARY: The possibility of geolocating a Long Term Evolution (LTE) subscriber station based on the timing advance ranging parameter within the network signal internals is investigated in this effort. The basic approach to geolocation based on radial distances from multiple base stations is outlined. Specifics of the timing parameters used during LTE network entry are examined as they relate to calculating these distances. Computer simulation is used to demonstrate expected geolocation accuracy in multiple base station networks when estimating likely locations of subscriber stations on a two-dimensional coordinate mapping system. Computer simulation is further refined to demonstrate expected geolocation accuracy in multiple base station networks when estimating likely locations of subscriber stations on a three-dimensional coordinate mapping scheme. The possibility of fixes with ten times greater accuracy than in previous results in literature are shown by applying timing advance techniques to Global System for Mobile communications networks when using a two-dimensional coordinate mapping scheme. Accuracy capable of being within 50 centimeters when using a three-dimensional coordinate mapping scheme, comparable to the accuracy in Global Positioning System technologies, are also shown.

PRESENTATIONS:

THESES DIRECTED:

Henderson, Jason, User/target tracking in 4G networks based on time adjust and cell identification Data, MSEE Thesis (in progress).

NOVEL 3-D GEOLOCATION OF 4G MOBILE DEVICES

John C. McEachen, Professor
Murali Tummala, Professor
Department of Electrical and Computer Engineering
Sponsor: NRO

OBJECTIVE: Mobile broadband adoption is occurring on a global scale faster than adoption of any other technology in history, including the adoption of mobile phone. Long Term Evolution (LTE) and WiMax are two emerging and competing technologies for the next generation of mobile phones. Specifically, WiMax was recently backed by a $3.28 investment by a consortium of Intel, Google, Sprint and others. Nationwide WiMax networks are already deployed and in use in countries like Pakistan, Iran, and Columbia. On the other hand, the ten largest mobile phone operators in the world have committed to LTE when commercial handsets become available. The objective of this continuing research is to develop precision geolocation techniques based on control messages used by 4G basestations and subscribers. This will be done through analysis of traditional geolocation techniques and modification of the computational constraints to incorporate the WiMax control information. This approach leverages prior knowledge of mobile phone geolocation with new knowledge of the 4G signals. Validation will be conducted through actual field testing at Yuma Proving Ground and simulation of 4G mobile intercept under a variety of conditions.

WIRELESS NETWORKING AND COMMUNICATIONS RESEARCH

John C. McEachen, Professor
Murali Tummala, Professor
Department of Electrical and Computer Engineering
Sponsor: National Security Agency

OBJECTIVE: This proposal describes research into modern digital radio networks. Specifically, the effort intends to improve upon power consumption in specific radio implementations. Several aspects of this proposal are classified.

SUMMARY: Delay Tolerant Networking facilitates communication in challenging environments where high degrees of latency, disconnection and disruption prevent the implementation of standard networking protocols. In mobile sensor networks the complications of mobility, terrain and power limitations often lend themselves to delay tolerant applications. In this effort, a performance evaluation for a delay tolerant wireless ad-hoc network composed of the RAPTORGALAXY nodes was conducted. RAPTORGALAXY, which natively supports mesh networking, utilizes the LOSTHAT application to provide delay tolerant functionality for file storage, routing and communication. Evaluation of the LOSTHAT algorithm was conducted utilizing the MeshTest wireless testbed, which is capable of simulating node movement through the use of programmable attenuators and provides repeatable scenarios to assess the performance of adhoc networks. For this research, procedures were developed to allow remote access to all testbed, node and data logging functions from the Naval Postgraduate School. Analysis of the baseline algorithm resulted in the implementation of a random backoff technique to reduce the excessive number of interrupted file transmissions. The RAPTORGALAXY delay tolerant network performed well in realistic scenarios and future research involving file size and the Rank Based Routing algorithm should yield improvements in the LOSTHAT application.

A novel method for identifying and selecting high performing channels in a multi-channel wireless network through the application of a state based model to data channels has been developed. The proposed scheme can increase throughput and reduce delay; however, a significant challenge is node coordination. Several node coordination schemes exist, one of which uses a dedicated control channel and N data channels. In a dedicated control channel scheme, data channels are selected based upon channel agreement between nodes, such as random selection of channels which can lead to suboptimal network performance when one or more data channels are disadvantaged. We are currently exploring a method of state based channel selection to overcome the inefficiency of random selection. We develop a mathematical performance model of this state based selection scheme and compare results to random selection. Simulations are being conducted to demonstrate improvements in transmission errors by state based selection over random selection.
PRESENTATIONS:


PUBLICATIONS:


THESES DIRECTED:


JOINT THREAT WARNING SYSTEM (JTWS) THREAT SIGNALS PROJECTION AND RESEARCH

John C. McEachen, Professor
Murali Tummala, Professor
Weilian Su, Assistant Professor

Department of Electrical and Computer Engineering
Sponsor: US Special Operations Command

OBJECTIVE: This research describes Research, Development, Testing, and Evaluation (RDT&E) actions, to support the Joint Threat Warning System (JTWS) Program. This will include investigating integration of smart dust technology into the JTWS Component Architecture Framework (JCAF), investigations into integrating computer network operations into lightweight SOF SIGINT ground and UAV systems, and classified signals analysis.
SUMMARY: This research has the following primary areas of focus:

- Investigate efforts with Smart Dust programs for integration into the JTWS Component Architecture Framework (JCAF).
- Integrate techniques in computer network operations into JCAF.
- Assessment of future technologies and threats for defining SOF SIGINT requirements.
- Leverage algorithms of the Communications Research Laboratory for analysis of signals of interest to SOCOM.

This effort expanded the charter of the SOF Multimission Advanced Research and Technology (SMART) forum to allow research relevant to SOF Multimission SIGINT operations to be presented in a common forum. This effort also examined smart dust technologies, such as WOLFPACK, and the procedure to bring them into conformance with JCAF. Specifically, an interface was developed for prioritizing and forwarding sensor information. The Communication Research Laboratory investigated signals processing techniques of interest to SOCOM and provided recommendations as to avenues for follow-on pursuit. Methods for distributed beamforming and direction finding for application to JTWS systems such as the GSK and TT have been investigated. Further investigations into efficient medium access methods for wireless sensor and Smart Dust programs and their integration into JTWS were conducted. Also, techniques for fusion of sensor data in JTWS have been studied.

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

PRESENTATIONS:


McEachen, J., “ECE Cyber Research,” presented to Commander of USMC Training and Education Command, USMC Director of Intelligence, Marine Corps Warfighting Lab, and Director of the USMC Center for Advanced Operational Culture Learning, Monterey, 3 May 2010.


PUBLICATIONS:


THESES DIRECTED:


JTWS FY09 THREAT SIGNALS PROJECTION AND RESEARCH
John C. McEachen, Professor
Weilian Su, Assistant Professor
Murali Tummala, Professor
Department of Electrical and Computer Engineering
Sponsor: US Special Ops Command

OBJECTIVE: The objective of this project is to support the Joint Threat Warning System (JTWS) program.

SUMMARY: Researches conducted under this project include developing new distributed direction finding and geolocation algorithms, integrating techniques in computer network operations into SOF operational systems and investigating efforts with wireless sensor and SMART Dust programs for integration into SOF operational systems.

JTWS FY10 THREAT SIGNALS PROJECTION AND RESEARCH
John C. McEachen, Professor
Weilian Su, Associate Professor
Murali Tummala, Professor
Department of Electrical and Computer Engineering
Sponsor: US Special Ops Command

OBJECTIVE: The objective of this project is to support the Joint Threat Warning System (JTWS) program.
ELECTRICAL AND COMPUTER ENGINEERING

SUMMARY: Researches conducted under this project include assessing future technologies and threats for defining SOF SIGINT, providing new distributed direction finding and geolocation algorithms and investigating efforts with wireless sensor and SMART Dust programs for integration into SOF operational systems.

EXTENDING THE ENDURANCE AND CAPABILITIES OF THE RAVEN UAV USING ADVANCED FLEXIBLE SOLAR CELLS
Sherif N. Michael, Professor
Space Systems Academic Group / Department of Electrical and Computer Engineering
Sponsor: NAWCWD, China Lake CA

OBJECTIVE: In this research the potential advantages of modifying current military Unmanned Aerial Vehicles (UAV) with available thin-film photovoltaic (PV) cells, and light-weight high-density batteries in order to increase their endurance, and/or capabilities will be investigated.

SUMMARY: The focus of this research is to design, develop and build a prototype extended endurance UAV with enhanced capabilities that would be suitable for a wide range of military and special missions. This will be accomplished by researching and selecting the most appropriate air vehicle that would meet all the requirements of this goal. Research tasks will include investigating current state-of-the-art commercial-off-the-shelf (COTS) flexible and rigid solar cells and power converters that combine ruggedness, high efficiency and weight conservation, and can be re-engineered and optimized for use in military UAV applications, with special emphasis on the Raven UAVs.

PUBLICATIONS:

THESES DIRECTED:


MODELING, DESIGN AND OPTIMIZATION OF MULTI-JUNCTION SOLAR CELLS USING SILVACO VIRTUAL WAFER FABRICATION SOFTWARE
Sherif N. Michael, Professor
Space Systems Academic Group / Department of Electrical and Computer Engineering
Sponsor: NRO

OBJECTIVE: To develop advanced models of Multi-junction Solar cells, using Silvaco Software, along with developing a radiation model for these cells. Radiation Effects on advanced cell Models are also investigated and compared with experimental results conducted using the NPS LINAC.

SUMMARY: A new method for developing a realistic model of any type of solar cell using the SILVACO/ ATLAS Virtual Wafer Fabrication Software, is proposed. Taking into account the high cost of research and experimentation involved with the development of advanced cells, we propose here this novel methodology. In our opinion, the introduction of this modeling technique to the Photovoltaic community will prove to be of great importance in aiding the design and developing of advanced solar cells. A multi-junction InGaP/GaAs solar cell was successfully modeled and was fully simulated. The major stages of the process are explained and the simulation results were compared to published experimental data. The flexibility of the proposed methodology is demonstrated and example results
Throughout the whole process are presented. Further research for the development of more accurate model that can be used for the design and optimization of advanced multi-junction cells is also investigated.

PUBLICATIONS:


THESES DIRECTED:


RADIATION TOLERANT ASIC & VLSI DEVICES FOR SPACE BASED SYSTEMS

Sherif N. Michael, Professor
Department of Electrical and Computer Engineering
Sponsor: Secretary of Air Force

OBJECTIVE: To design radiation tolerant mixed mode VLSI & ASIC circuits for space applications. To fabricate these design after extensive simulation using regular silicon process as a first step. To study the Space radiation effects on these state-of-the-art designs using the NPS LINAC as a radiation source. Upon verification of the experimental results, the layout will be submitted for future fabrication using SOI process.

SUMMARY: In this research, a general purpose digitally programmable VLSI network for space-based system is proposed. The design is based on a technique that was developed earlier by Michael and has shown excellent radiation sensitivity performance. The mixed mode signal circuit, using BiCMOS Techniques is currently under development. Previously fabricated VLSI ASIC chips will also be irradiated using the NPS LINAC for testing its performance under radiation environment. Past experimental results using this technique has shown great improvements in the circuit’s radiation performance. Research in incorporating these design using SOI fabrication techniques will be also considered.

THESES DIRECTED:


INVERSE AC PROPAGATION MODEL

Michael A. Morgan, Distinguished Professor
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research

OBJECTIVE: This research develops and validates advanced computer algorithms for identifying onboard sources of AC electric and magnetic ship signatures using measured sensor data having nominal frequency content up to 3000 Hz.

SUMMARY: During this third year of a three-year funded effort the formulation and continued testing of near-field low-frequency imaging was conducted using back-propagation of spheroidal harmonic expansions. A procedure
was created for using noisy data measured on a planar grid of sensors to estimate the spatial field distribution on a spheroidal surface enclosing the vessel under test. An optimal procedure based on regularized singular value decomposition was developed for inverting the resultant over-determined but ill-posed system of equations.

The PI participated in a full-scale experimental effort at the Navy’s South Florida Test Range to acquire measured signatures from submerged magnetic and electric sensors for the Coast Guard ship OSS BOLD. Over 300 GB of 6 KHz time-sampled data was generated. A unique method based on synchronous detection was developed for extracting coherent single frequency phasor fields from measured time-domain sensor data. Extracted sensor signatures were back-propagated onto a spheroidal surface and compared to known source locations and frequencies aboard the vessel. Results indicate the potential for viable mapping of field sources in naval vessels based on real-world measurements from magnetic and electric sensor arrays.

PRESENTATIONS:


TECHNICAL REPORTS:

M. A. Morgan, “Inverse AC Propagation Model,” ONR Quad-Chart Report, 11 Jan 2010
M. A. Morgan, “Inverse AC Propagation Model,” ONR Division Report, 18 May 2010, 4 pages

SOURCE IDENTIFICATION AND SHIELDING

Michael A. Morgan, Distinguished Professor
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research

OBJECTIVE: The primary objective is development and validation of a new series of inverse algorithms for identifying onboard sources of electric and magnetic ship signatures using measured sensor data. A secondary objective is investigation of enhanced passive shielding using layers of dissimilar materials and through use of new exotic materials, such as meta-materials. A third objective is investigation into leveraging of ONR funded efforts in advanced EM computational modeling to provide accurate assessment of the strengths and frequencies of unwanted signature sources having know locations in the model.

PULSED POWER SUPPLY (PPS) DESIGN AND ANALYSIS FOR THE RAILGUN

Giovanna Oriti, Research Assistant Professor, Co-PI
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research

OBJECTIVE: To investigate several issues related to the power supply including high voltage capacitor charging, lithium ion battery modeling, failure modes and effects analysis and module electrical stress characterization.

SUMMARY: The high voltage capacitor charger has been characterized by modeling and analysis and by summarizing the vendor’s proposals. Two physics based models, which include the lithium ion battery pack powering the charger, were developed to accomplish small scale and large scale simulations and analysis. The modeling work supports the design of the charger without the need for large, expensive laboratory prototypes. Examples of the model analytical capabilities include topology modifications versus component stress, power converter size versus speed of charge,
control strategy versus switching devices stress and stability analysis. Experimental validation of the modeling effort was performed on a laboratory prototype.

The battery management system was also studied as part of a thesis project.

PUBLICATIONS:


THESES DIRECTED:


NCRADA-NPS-08-0114, TASK ONE: SHIPBOARD ELECTRIC SYSTEM MODELING
Giovanna Oriti, Research Assistant Professor
Department of Electrical and Computer Engineering
Sponsor: Northrop Grumman Systems Corporation, Electronic Systems Sector

OBJECTIVE: “Modeling and analysis of hybrid electric drive (HED) shipboard power systems”.

SUMMARY: Assess the system impacts via the use of Matlab/Simulink models and simulations for various hybrid electric drive (HED) shipboard power systems and exercise these models to assess the impact of varying power system architectures as related to load characteristics operational modes overall ship performance and fault mitigation. Particular attention was paid to the doubly fed induction machine drive topology.

PUBLICATIONS: Report.

CUEING RECEIVER FOR FASTER EA RESPONSE
Phillip E. Pace, Professor
Department of Electrical and Computer Engineering
Sponsor: Office of Naval Research, Arlington, VA

OBJECTIVE: This is a continuing effort to investigate new receiver architectures including a photonic sigma-delta modulators for digitizing the signal directly at the antenna using oversampling.

SUMMARY: A photonic sigma-delta modulator that utilizes a mode-locked laser, wideband amplitude modulators, detectors, and high speed comparator processors is being constructed. Also being integrated is a ring resonator (being built by UCSB) to serve as the accumulator that will be embedded in a feedback loop around the comparator processor. Other photonic solutions were also investigated.

PATENTS:


PUBLICATIONS:


OBJECTIVE: The objective of this proposal is to design and simulate a novel high-resolution RF SQUID ADC that uses only three single-JJ SQUID rings to significantly extend the flux detection range. A unique resonant detection method based on the robust symmetrical number system (RSNS) will be used to provide a high resolution representation of the input magnetic flux. The architecture to be investigated breaks down the flux detection operation into \( N = 3 \) parallel sub-operations (moduli) that are of smaller computational complexity. Consequently, each sub-operation only requires a precision in accordance with that modulus and a much higher RF voltage resolution is achieved after the \( N \) different moduli are used and the results of these low precision sub-operations are recombined. In addition, the dynamic range of the RF SQUID ADC is greatly extended.

N433 THREAT MISSILE SIMULATOR VALIDATION WORKING GROUP
Phillip E. Pace, Professor
Department of Electrical and Computer Engineering
Sponsor: Naval Research Laboratory, Washington DC

OBJECTIVE: The objective of this proposal is to provide technical leadership to the Navy Surface Anti-Ship Cruise Missile Threat Simulator Validation Working Group. Three types of simulations are currently being validated by the SVWG for use in test and evaluation. These include (a) radio frequency missile hardware simulators, (b) infrared missile hardware simulators and (c) computer models of missile seekers and related electronics. In addition, the OPNAV reorganization will be addressed.

NAVY SURFACE ANTI-SHIP CAPABLE MISSILE THREAT SIMULATOR VALIDATION WORKING GROUP
Phillip E. Pace, Professor
Department of Electrical and Computer Engineering
Sponsor: Naval Research Laboratory, Washington DC

OBJECTIVE: The objective of this work is to provide technical leadership (as Chairman) to the OPNAV N433 Surface Anti-Ship Capable Missile Threat Simulator Validation Working Group (SVWG). Three types of simulations are currently being chartered for validation by the SVWG for use in test and evaluation. These include (a) radio frequency missile hardware simulators, (b) infrared missile hardware simulators and (c) computer models of missile seekers and related electronics.

SUMMARY: The duties for the SVWG chairman include coordinating with the Navy’s Simulator Validation Coordinator, the NRL ENEWS Program Manager and other Navy commands (e.g., Commander Operational Test and Evaluation Force) to prioritize the simulator validations for N433 approval. Additional responsibilities include coordinating with the Office of Naval Intelligence for threat data review and convening the SVWG as an independent and unbiased reviewer for all of the validation reports. A SIPRNet website is also maintained to provide a central location for all reports, plans and threat briefs.
OBJECTIVE: This effort is to investigate the current submarine EW capabilities and to suggest a new roadmap for future upgrades that are needed.

SUMMARY: As a member of this working group, I am on both the technical panel and the operational panel to look at the various EW solutions that are needed for today’s threats.

ULTRAWIDEBAND ANTENNA ANALYSIS
Andrew Parker, Research Associate
Department of Electrical and Computer Engineering
Sponsor: ONR

OBJECTIVE: Model, simulate, procure, and test ultrawideband antennas in support of the Radio Reconnaissance Equipment Program (RREP).

SUMMARY: ONR/USMC RREP provides for the ultrawideband intercept of adversary communications on the battlefield in hostile zones such as Iraq and Afghanistan. Frequency demands, size, weight, aspect constraints, and jamming resistance necessitate extensive modeling, simulation analysis, fabrication, and field tests to meet program requirements.

ENABLING FORCENET WITH WIRELESS AD HOC NETWORKS
Lt. Brian E. Phillips, Electrical and Computer Engineering Student
Department of Electrical and Computer Engineering
Sponsor: Space and Naval Warfare Systems Center-Pacific

OBJECTIVE: To research and develop Wireless Ad Hoc Networking schemes to increase their capability when deployed in support of the warfighter, thus enabling FORCEnet.

ANALYZE AND PRIORITIZE LEFT-HAND-SIDE-OF-KILL-CHAIN EW/IO CAPABILITIES
Ralph C. Robertson, Professor
Department Electrical and Computer Engineering
Sponsor: SPAWAR (PMW-160)

OBJECTIVE: The objective of this research project was to do research to: a) provide and explicit rationale for prioritizing “left-hand-side-of-kill-chain” EW/IO (Shipboard IW Exploit and CCOP) investments by clearly aligning them to the missions they enable and b) understand which capabilities would offer the most bang for the buck, based on likely mission demands from the evolving threat environment. Research was to build directly on work products and knowledge developed in the fist demonstration and the earlier DDR&E efforts piloted by N2/N6F34. (Note: This project was only partially funded, $250,000 of the $2.5 million requested, and the sponsor canceled the project in August 2010.)

SUMMARY: The Electrical and Computer Engineering Department Center for Cyber Warfare (CCW) research for this project initially consisted of reviews of available documentation on SIPRnet and JWICs of Shipboard EW/IO exploit systems and capabilities, with particular emphasis on Graywing/Medusa/ICADS. They also developed a Framework for a Cyber Roadmap and CONOP which highlighted exploitation technologies and non-kinetic cyber
options that would have applicability to ICADS and Medusa/Graywing. Additional CCW research that was relevant to this project included examinations into exploitation of WIMAX and LTE signals at the physical layer, research on photonic non-cooperative intercept receivers for applications in electronic support, and, research on the characteristics of the DF-21.

Although our research was still in its early stages, we examined a new Space-Based EW/Cyber Warfare approach which we believed will be critical to providing enhanced capabilities for future SEWIP block upgrades and a worthwhile investment strategy for the Navy.

THESES DIRECTED:


OTHER:

Knorr, J., Will, P. Framework for a Cyber Roadmap, Naval Postgraduate School, June 28, 2010

CYBER RESEARCH TO SUPPORT GED MISSION AREAS

Ralph C. Robertson, Professor
Vicente Garcia, Professor of Practice
Department Electrical and Computer Engineering

Sponsor: Office of the Secretary of the Air Force

OBJECTIVE: The overall objective of this project was to conduct cyber research relevant to the Ground Enterprise Directorate (GED) mission areas and to provide meaningful thesis research topics to graduate students. The sponsor provided the specific research topics.

SUMMARY: The sponsor specifically requested that NPS conduct research on WiMAX networks and have Wayne State University (WSU) conduct research into blind acoustic target extraction. NPS served as the program manager of the project and awarded WSU’s Distinguished Professor, Dr. Sean Wu, a grant to conduct research on the acoustic topic.

Wayne State University examined the effectiveness and robustness of an innovative, hybrid acoustic technology for localization of sound source(s) in real time without any prior knowledge of the location of the sound sources. They built a prototype sensor system that contained one microphone together with other hardware for data acquisition and performed live demos of blind sound source localizations and blind acoustic feature (human voices) extractions using the prototype systems. At the end of the performance period for this research, they provided NPS and the sponsor a detailed technical report and a dvd demonstration of their findings and analyses.

For the WiMAX topic, NPS conducted comprehensive research on WiMAX communications protocols at the physical layer and studied adaptive space-time codes (AST). AST can be perceived as code hopping and can be implemented down to the OFDM symbol level (fast code hopping) or to the packet level (slow code hopping). Therefore, NPS conducted research on both real and complex AST codes and systems implemented with 2 or 4 transmit antennas, resulting in several student theses reports. The techniques that were investigated are applicable to any digital signal that uses multiple transmitter antennas which are presently being used in Cyber and EW systems. Follow-on classified research will lead to the proper classification of signals, such as WiMAX/LTE, and techniques to identify the desired parameters needed for developing new Cyber processes for infiltration into foreign systems, as well as, providing U.S. DoD personnel methods to develop protection from enemy access.

WSU PUBLICATIONS:

INVESTIGATION OF EMERGING COMMUNICATIONS TECHNOLOGIES

Ralph C. Robertson, Professor
Department of Electrical and Computer Engineering
Sponsor: National Security Agency

OBJECTIVE: The objective of this project was to investigate detection and signal processing techniques for newly emerging waveforms such as the wavelet modem. Additionally, appropriate laboratory test equipment was acquired in order to digitize and analyze these newly emerging signals.

SUMMARY: Conventional modems often adopt orthogonal frequency-division multiplexing (OFDM) standards such as IEEE 802.11g, IEEE 802.11n, and IEEE 802.16e. A newly developed waveform utilizes wavelet-division multiplexing instead of OFDM. This new technology requires study to determine detection techniques and optimal waveform signal processing. A broadband signal analyzer and recorder was acquired and was to be used to digitize and analyze the wavelet modem waveform. The results of the analysis were to be used to develop new techniques to detect and optimally process this new waveform. It has been asserted that the wavelet modem generates a featureless waveform; however, it was determined that the waveform is not featureless, and these features can be used to exploit the waveform. This intended multi-year project was not funded beyond the first year due to the delay incurred at NPS in purchasing the required equipment. As a result, the project remains uncompleted and is currently inactive.

PM AND TRAVEL SUPPORT FOR SHIPBOARD IW EFFORTS

Ralph C. Robertson, Professor
Department Electrical and Computer Engineering
Sponsor: SPAWAR (PMW-120)

OBJECTIVE: The objective of this project is to conduct research and travel in support of PMW-120 Shipboard IW efforts.
RESEARCH AND TRAVEL IN SUPPORT OF PMW-160 SHIPBOARD IW EFFORTS

Ralph C. Robertson, Professor
Department Electrical and Computer Engineering
Sponsor: SPAWAR (PMW-160)

OBJECTIVE: The objective of this research project was to conduct research and travel in support of PMW-120 Shipboard IW efforts. (Note: This project was canceled by the sponsor prior to the end of the performance period.)

SUMMARY: The funding received from SPAWAR PMW-160 was used primarily for faculty and staff labor associated with 6.1 (Basic) and 6.2 (Applied) level research activities and associated travel. Travel to the STRATCOM Cyber Conference and several meetings at SPAWAR Systems Center and other DoD sites were required for data collection on the current state of IW shipboard systems. NPS explored the integration of non-kinetic solutions to affect “left-hand-side of the kill-chain” to counter adversary C4ISR and C2 assets utilizing Cyberspace Domain capabilities, such as Computer Network Operations (CNO). In that realm, NPS Center for Cyber Warfare (CCW) faculty and students conducted research in three key areas that they believed would take the Navy shipboard IW capabilities to the next level; exploitation of 4th Generation wireless communications protocols (4G or NGW), EW receivers, and DF21 defeat strategies. CCW’s long-term objective was to analyze the results from these three key areas of study and to collaborate with transition agencies to provide enhanced capabilities for future SEWIP blocks (and other systems such as MEDUSA and GRAYWING), as well as to support integration of other non-kinetic capabilities into Fleet Operations.

Although our research was still in its early stages, we examined a new Space-Based EW/Cyber Warfare approach which we believed will be critical to providing enhanced capabilities for future SEWIP block upgrades. That approach, we believed, would also support other systems under development such as MEDUSA and GRAYWING, and would enable the Fleet to introduce new EW and Cyber capabilities to defeat the C4ISR and C2 systems associated with adversary threats. The complete research summary was classified.

THESES DIRECTED:


OTHER:

Knorr, J., Will, P. Framework for a Cyber Roadmap, Naval Postgraduate School, June 28, 2010

SURFACE EW DEVELOPMENTS, RESEARCH/LAB SUPPORT

Ralph C. Robertson, Professor
Department Electrical and Computer Engineering
Sponsor: Naval Sea Systems Command

OBJECTIVE: Research capabilities to enhance surface EW defenses.

MOVING COGNITIVE RADAR PLATFORM AND APPLICATIONS

Ric Romero, Assistant Professor
Department of Electrical and Computer Engineering
Sponsor: Research Initiation Program, NPS, Monterey, CA

OBJECTIVE: The objective of this work is to extend research on Cognitive Radar to practical applications. Realistic target and interference modeling will be investigated for use with the ground surveillance application of the static CR platform. Additionally, the static CR is to be transitioned to a moving platform. This includes the incorporation of Space-Time Adaptive Processing (STAP) into the CR’s receiver processing.
ELECTRICAL AND COMPUTER ENGINEERING

SUMMARY: The research has just recently been funded by NPS’s Research Initiation Program (RIP) in December, 2010. Preliminary investigation into incorporation of STAP modeling and techniques is promising. Workstation and server needs are awaiting quotes and funding resolution.

ENGINEERING OF SMALL SATELLITES FOR SPACE-BASED EXPERIMENTS
Alan A. Ross, Professor of Practice
Department of Electrical and Computer Engineering
Sponsor: SAF/FMBIB-AFOY

OBJECTIVE: To further investigate the previous year’s small satellite designs and prepare for future year prototype.

MEMS ACOUSTIC SENSOR
CAPT John Roth, Electrical and Computer Engineering Student
Gamani Karunasiri, Professor (Physics Department)
Douglas Fouts, Professor
Department of Electrical and Computer Engineering
Sponsor: Space and Naval Warfare Systems Center-San Diego

OBJECTIVE: To design, fabricate, package, and test a micro-electromechanical directional microphone.

SURFACE WARFARE DEVELOPMENTS RESEARCH AND LAB SUPPORT
Weilian Su, Assistant Professor
Department of Electrical and Computer Engineering
Sponsor: NAVSEA CAPT Doug Small

OBJECTIVE: The objective of this project is to investigate new network extraction technique.

SUMMARY: Researches conducted under this project include analysis of web and network vulnerability data.

ELECTRONIC COMPONENT FAILURE PREDICTION
Todd Weatherford, Associate Professor,
Department of Electrical and Computer Engineering
Sponsors: NRO AS&T

OBJECTIVE: To develop the capability to predict the degradation of electronic components by device simulation.

SUMMARY: Work in 2010 included examining electromigration and investigating various techniques to predict component failure.

THESES DIRECTED:

Seigenthaler – Modeling Degradation of GaN HEMTs
OBJECTIVE: To investigate the degradation and failure of insulated gate bipolar transistors under various switching conditions, via device / circuit modeling and measurements.

SUMMARY: Work in 2010 included developing simulations to understand electrical and thermal properties of IGBTs in power circuits.

THESES DIRECTED:
G. Vineyard
R. Lebel

SUPPORT FOR THE NPS LINEAR ACCELERATOR (LINAC)
Todd Weatherford, Associate Professor,
Andrew Parker, Research Associate
Department of Electrical and Computer Engineering
Sponsors: Various

OBJECTIVE: To operate the NPS Flash X-ray facilities.

SUMMARY: In 2010 the Center for Radiation Hardened Electronics has not been supporting NPS research due to command restrictions on operating radiation sources.

SUPPORT FOR THE NPS FLASH X-RAY
Todd Weatherford, Associate Professor
Andrew Parker, Research Associate
Department of Electrical and Computer Engineering
Sponsors: Various

OBJECTIVE: To operate the Flash X-Ray facility in support of instruction and DoD research initiatives.

SUMMARY: In 2010 the Center for Radiation Hardened Electronics was idle due to the failure of the base wide radiation safety inspection by RASO. This year was spent retraining, medically recertifying, and preparing new Normal and Emergency Operating Instructions for the Flash X-Ray. Extensive work was conducted in correcting existing schematic diagrams and proposing modifications and alterations to both circuits and procedures to meet the current RASO interpretation of RAD-10 with respect to Flash X-Ray operations. To date, testing to support NPS research relating to rad-hard electronics for space and strategic systems awaits RASO clearance. The center also awaits supporting NPS classes related to microelectronics reliability for space systems. Outside researchers
LOW COST, PORTABLE, MULTI-USER, IMMERSIVE VIRTUAL ENVIRONMENT SYSTEMS FOR EDUCATION AND TRAINING IN WORLDS OF UNLIMITED SIZE

Xiaoping Yun, Professor
Department of Electrical and Computer Engineering
Sponsor: NSF

OBJECTIVE: The objective is to develop a portable virtual environment system for education and training applications.

SUMMARY: In recent years virtual reality has become an invaluable tool for research, development, training, healthcare, commerce, communication, and education, as well as a medium for entertainment. Fully immersive systems – those that allow users to explore a simulated environment by naturally walking, turning, and looking – are particularly useful because they provide increased realism through multisensory stimulation. Yet in general, the use of current virtual environment systems has required users to travel to specialized facilities in which an expensive infrastructure has been pre-installed. Often these facilities allow only one user at a time, and users usually move through virtual worlds by means of an artificial interface device or a movement metaphor. Most virtual environment facilities are centralized, specialized, and expensive, and have thus been relatively unavailable to a great majority of the population. This collaborative project between Naval Postgraduate School and Miami University aims to develop an innovative immersive virtual environment system that is low cost and completely portable. The main effort of the NPS team in the first year of this four-year project is the design, fabrication, and testing of an ultrasonic ranging system that is to be worn by a user for the purpose of detecting obstacles.

SHIPBOARD CALIBRATION ENHANCEMENTS
Xiaoping Yun, Professor
Department of Electrical and Computer Engineering
Sponsor: NSWC-Corona

OBJECTIVE: The objective is to investigate approaches to enhance shipboard calibration procedures.

SUMMARY: An approach for enhancing shipboard calibration and reducing the SISCAL manpower requirement is developed. On newer ships, system consoles are placed at various locations to display information about machinery conditions (temperature, pressure, rpm, etc). An IP-based KVM device and a battery-powered local wireless LAN with repeaters are utilized to provide a calibration technician with the capability of roaming with a laptop to view live console information and interact with console applications. This is all achieved without installing any applications on or making any modifications to the consoles. As a result of this approach, the number of required calibration personnel is reduced from two to one. Preliminary testing results onboard two LPDs validated the proposed approach.
DEPARTMENT OF
ELECTRICAL AND
COMPUTER ENGINEERING

2010
Faculty Publications
and Presentations


### BOOKS


### CONTRIBUTIONS TO BOOKS


N. Goodman, J. Bae, and R. Romero, “Waveform Design for Target Class Discrimination with Closed-Loop Radar,”
ELECTRICAL AND COMPUTER ENGINEERING


CONFERENCE PUBLICATIONS & PROCEEDINGS


B. Newell and S. Michael, “A The Evaluation of HOMER as a Marine Corps Expeditionary Energy Pre-Deployment


J. L. Shafer, S. W. Schneider, J. T. Butler, and P. Stanica, “Enumeration of bent Boolean functions by reconfigurable computer”, The 18th Annual International IEEE Symposium on Field-Programmable Custom Computing Machines, Charlotte, NC, May 2-4, 2010, pp. 265-272. 132 papers were submitted. Only 41 were accepted (31%). Our paper was among only 23 (17%) that were accepted as a full paper (8 pages).


PATENTS


DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

KNOX T. MILLSAPS
CHAIRMAN
MECHANICAL AND AEROSPACE ENGINEERING

OVERVIEW:
The Department of Mechanical and Aerospace Engineering (MAE) provides a strong academic program that spans the engineering disciplines of thermal-fluid sciences, structural mechanics, dynamic systems, guidance and control, materials science and engineering, propulsion, and systems engineering, including total ship systems engineering, spacecraft, and missile design. These disciplines are blended together with a strong emphasis on naval engineering applications required by surface vessels, submarines, and spacecraft. Furthermore, the department provides advanced education in classified topics in astronautical engineering. Programs leading to the degree of Master of Science in Mechanical Engineering or Master of Science in Astronautical Engineering are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). A specific curriculum must be consistent with the general minimum requirements for the degree as determined by the academic council. Any program leading to a degree must be approved by the department chair at least two quarters before completion. In general, approved programs will require more than the stated minimum degree requirements in order to conform to the needs and objectives of the United States Navy and satisfy the applicable subspecialty-code requirements.

RESEARCH MISSION:
To increase the combat effectiveness of U.S. and allied armed forces and to enhance the security of the United States through research in areas related to mechanical engineering, spanning the field from basic phenomena to engineering design, development, operation, maintenance, and disposal of components and systems for naval platforms.

CURRICULA SERVED:
The MAE Department serves the Naval and Mechanical Engineering curriculum (570), the Mechanical and Reactors-Engineering curriculum (571), the Mechanical Engineering program for deployed nuclear-trained officers curriculum (572), and the Space-Systems Engineering curriculum (591). These curricula support the Navy’s need for individuals with advanced technical education in mechanical and astronautical engineering and related fields. The 570 curriculum provides the educational component for the engineering duty-officer program, and the research program in the department is designed to support the requirement for officers to have the ability to identify, formulate, and solve technical and engineering problems in areas related to mechanical engineering. The Space-Systems Engineering program provides officers with a comprehensive, scientific, and technical knowledge of national security, military, and naval space-systems.

DEGREES GRANTED:
- Master of Science in Mechanical Engineering
- Master of Science in Astronautical Engineering
- Master of Science in Engineering Science (Mechanical Engineering)
- Master of Science in Engineering Science (Astronautical Engineering)
- Mechanical Engineer
- Astronautical Engineer
- Doctor of Philosophy in Mechanical Engineering
- Doctor of Philosophy in Astronautical Engineering

RESEARCH THRUSTS:
- Fluid Dynamics, Heat Transfer, and Turbomachinery
- Combustion, Energy Systems, Alternate and Synthetic Fuels
- Pulse Detonation Engines, Rotordynamics, Fluid-Structure Interactions
- Dynamic Systems, Controls, and Robotics
- Autonomous Systems, Unmanned Systems, Guidance and Control, and Space Robotics
- Solid Mechanics, Vibrations, Structures
- Computational Mechanics, and Ship Shock, Design, and Optimization
- Materials Science and Engineering
MECHANICAL AND AEROSPACE ENGINEERING

- Friction Stir Processing and Welding
- Space-Systems, Adaptive Optics, Astrodynamics Optimization
- Total Ship Systems Engineering

FACULTY EXPERTISE:

- Fluid Dynamics, Heat Transfer, and Turbomachinery:
  Professor Knox Millsaps, Associate Professor Chris Brophy, Professor Garth Hobson
- Dynamic Systems, Controls, and Robotics:
  Distinguished Professor Brij Agrawal, Professor Morris Driels, Professor Isaac Kaminer, Associate Professor Fotis Papoulias, Assistant Professor Marcello Romano, Professor I. Michael Ross, Professor Oleg Yakimenko
- Solid Mechanics, Vibration, and Shock:
  Professor Young W. Kwon, Associate Professor Joshua Gordis
- Materials Science and Engineering:
  Professor Terry McNelley, Professor Indranath Dutta
- Space-Systems:
  Distinguished Professor Brij Agrawal, Professor Isaac Kaminer, Assistant Professor Marcello Romano, Professor I. Michael Ross
- Total Ship Systems Engineering:
  Associate Professor Fotis Papoulias

RESEARCH FACILITIES:

The mechanical engineering laboratories are designed as complements to the educational mission and research interests of the department. In addition to extensive facilities for the support of student and faculty research, a variety of general use equipment is available. This includes equipment and facilities for the investigation of problems in engineering mechanics; a completely equipped materials science laboratory, including advanced scanning electron microscopes, an Auger microprobe, a transmission electron microscope, and X-ray diffractometers; an oscillating water tunnel, a unique underwater towing tank and a low-turbulence water channel; a vibration analysis laboratory; a fluid power controls laboratory; a robotics and real-time control laboratory; facilities for experimentation with low-velocity air flows; equipment for instruction in thermal transport phenomena; a laser Doppler velocimeter; nuclear-radiation detection equipment; and an interactive CAD/CAE computer-graphics laboratory. Experimentation is further enhanced by a broad selection of analog and digital data acquisition and processing equipment and instrumentation.
The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Mechanical and Aerospace Engineering is provided below:

Size of Program: $6.6M
MECHANICAL AND AEROSPACE ENGINEERING

Knox T. Millsaps
Chairman, Professor &
DoD Executive Agent for SMART Scholarship-for-Service Program
831-656-3382
millsaps@nps.edu

Garth V. Hobson
Associate Chairman & Professor
831-656-2888
gvhobson@nps.edu

Christopher A. Adams
Lecturer
831-656-3400
caadams@nps.edu

Jarema M. Didoszak
Research Assistant Professor
831-656-2604
jmdidosz@nps.edu

Kevin D. Jones
Research Associate Professor
831-656-7711
jones@nps.edu

Brij N. Agrawal
Distinguished Professor
831-656-3338
agrawal@nps.edu

Vladimir N. Dobrokhotov
Research Assistant Professor
831-656-7714
vldobr@nps.edu

Isaac I. Kaminer
Professor & NPS Director of Aerodynamic Decelerator Systems Center
831-656-3459
kaminer@nps.edu

Terry Alfriend
Visiting Professor
831-656-3929
ktalfrie@nps.edu

Morris R. Driels
Professor
831-656-3383
mrdriels@nps.edu

Matthew D. Kelleyer
Professor Emeritus
831-656-2530
mkelleher@nps.edu

Robert E. Ball
Distinguished Professor Emeritus
831-601-3819
reball@mac.com

Indranath Dutta
Professor
831-656-2851
idutta@nps.edu

Jae-Jun Kim
Research Assistant Professor
831-656-2716
jki1@nps.edu

Oscar Biblarz
Professor Emeritus
831-656-3096
obiblarz@nps.edu

Joseph Farmer
Visiting Professor
209-814-4911
jfarmer@nps.edu

Ramesh Kolar
Research Assistant Professor
831-656-2854
rkolar@nps.edu

Luke Brewer
Associate Professor
831-656-3382
lnbrewer@nps.edu

Anthony J. Gannon
Research Assistant Professor
ajgannon@nps.edu

Young W. Kwon
Professor
831-656-2238
vykwon@nps.edu

Christopher M. Brophy
Associate Professor & Academic Associate
831-656-2327
cmbrophy@nps.edu

Joshua H. Gordis
Associate Professor & Academic Associate
831-656-2866
gordis@nps.edu

Barry Leonard
Visiting Assistant Professor
831-656-7650
bleonard@nps.edu

Charles N. Calvano
Professor Emeritus
831-656-2334
calvano@nps.edu

Anthony J. Healey
Distinguished Professor Emeritus
831-656-3462
healey@nps.edu

John R. Lloyd
Distinguished Visiting Professor
831-656-3400
jrlloyd@nps.edu

Muguru Chandrasekhara
Research Professor
831-656-3585
mchandra@nps.edu

Douglas Horner
Research Assistant Professor
831-656-3821
dphorner@nps.edu

Claudia Luhrs
Associate Professor
ccluhrs@nps.edu
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tad D. Masek</td>
<td>Research Associate</td>
<td>831-656-1161</td>
<td><a href="mailto:tdmasek@nps.edu">tdmasek@nps.edu</a></td>
</tr>
<tr>
<td>Maximilian F. Platzer</td>
<td>Distinguished Professor Emeritus</td>
<td>831-656-3426</td>
<td><a href="mailto:mplatzer@nps.edu">mplatzer@nps.edu</a></td>
</tr>
<tr>
<td>Alan D. Scott</td>
<td>Senior Lecturer</td>
<td>831-656-2453</td>
<td><a href="mailto:adscott@nps.edu">adscott@nps.edu</a></td>
</tr>
<tr>
<td>Terry R. McNelley</td>
<td>Distinguished Professor</td>
<td>831-656-2589</td>
<td><a href="mailto:tmcnelley@nps.edu">tmcnelley@nps.edu</a></td>
</tr>
<tr>
<td>Jon Raggett</td>
<td>Senior Lecturer</td>
<td>831-656-3585</td>
<td><a href="mailto:jdragget@nps.edu">jdragget@nps.edu</a></td>
</tr>
<tr>
<td>Young S. Shin</td>
<td>Distinguished Professor</td>
<td>831-656-2568</td>
<td><a href="mailto:yshin@nps.edu">yshin@nps.edu</a></td>
</tr>
<tr>
<td>Sarath K. Menon</td>
<td>Research Professor</td>
<td>831-656-2551</td>
<td><a href="mailto:skmeno1@nps.edu">skmeno1@nps.edu</a></td>
</tr>
<tr>
<td>Marcello Romano</td>
<td>Research Assistant Professor</td>
<td>831-656-2885</td>
<td><a href="mailto:mromano@nps.edu">mromano@nps.edu</a></td>
</tr>
<tr>
<td>Raymond P. Shreeve</td>
<td>Professor Emeritus</td>
<td>831-656-2593</td>
<td><a href="mailto:shreeve@nps.edu">shreeve@nps.edu</a></td>
</tr>
<tr>
<td>Sebastian Osswald</td>
<td>Assistant Professor</td>
<td>831-656-2817</td>
<td><a href="mailto:sosswald@nps.edu">sosswald@nps.edu</a></td>
</tr>
<tr>
<td>I. Michael Ross</td>
<td>Professor</td>
<td>831-656-2074</td>
<td><a href="mailto:imross@nps.edu">imross@nps.edu</a></td>
</tr>
<tr>
<td>E. Roberts Wood</td>
<td>Professor Emeritus</td>
<td>831-656-2897</td>
<td><a href="mailto:wood@nps.edu">wood@nps.edu</a></td>
</tr>
<tr>
<td>Fotis A. Papoulias</td>
<td>Associate Professor</td>
<td>831-656-3381</td>
<td><a href="mailto:papoulias@nps.edu">papoulias@nps.edu</a></td>
</tr>
<tr>
<td>Turgut Sarpkaya</td>
<td>Distinguished Professor Emeritus</td>
<td>831-656-3425</td>
<td><a href="mailto:sarp@nps.edu">sarp@nps.edu</a></td>
</tr>
<tr>
<td>Oleg Yakimenko</td>
<td>Research Professor</td>
<td>831-656-2826</td>
<td><a href="mailto:oayakime@nps.edu">oayakime@nps.edu</a></td>
</tr>
</tbody>
</table>
MECHANICAL AND AEROSPACE ENGINEERING

AIRCRAFT COMBAT SURVIVABILITY FOR JASPO
Christopher A. Adams, Lecturer
Department of Mechanical and Aerospace Engineering
Sponsor: Joint Aircraft Survivability Program Office (JASPO)

OBJECTIVE: CSL Activities & Support - Development of a long-range relationship between the JASP and NPS/CSL (Naval Postgraduate School/Center for Survivability and Lethality). Activities that will be supportive of the goals and objectives of the CSL and be consistent with the JASP Education Goals.

SPACECRAFT SURVIVABILITY
Christopher A. Adams, Lecturer
Department of Mechanical and Aerospace Engineering
Sponsor: Lockheed Martin Space Systems Company

OBJECTIVE: Lockheed Martin has been selected by NASA to provide the Orion/Constellation Program with a safer, more reliable space transportation capability for crew transport in the question for human space exploration. The Orion design will be driven by the needs of current human exploration missions while maintaining a view toward future capability requirements, thereby providing the foundation for future missions, while providing an operationally improved asset to support the near-term missions and needs of NASA. As a result of the Columbia Accident Investigation Board future design for spacecraft survivability was identified as a critical need. The goal of this collaboration is to further develop the idea and improve the safety of human spaceflight with new techniques to enhance vehicle design and therefore vehicle safety, while living within tight spacecraft design constraints, and have applications reaching beyond Orion to Altair, Ares V, and Lunar and Mars surface systems.

APPLICATION OF ADVANCED WAVEFRONT SENSING AND CONTROL TECHNIQUES TO A HIGH ENERGY LASER BEAM CONTROL TESTBED
Brij N. Agrawal, Distinguished Professor
Jae Jun Kim, Research Assistant Professor
Department of Mechanical and Aerospace Engineering
Sponsor: HEL Joint Technology Office

OBJECTIVE: The scope of the project is to upgrade the Naval Postgraduate School (NPS) High Energy Laser (HEL) Beam Control Testbed by adding an atmospheric disturbance generator, a deformable mirror and a wavefront sensor in phase 1, and aircraft and ship vibration simulator in phase 2. The scope also includes development of the advanced control techniques such as adaptive control for acquisition, tracking, and pointing, and multi-channel transversal filter and robust control for beam correction under atmospheric disturbance, and validation of these techniques on the testbed to improve HEL beam control performance.

ADAPTIVE POINTING CONTROL FOR SPACECRAFT
Brij N. Agrawal, Distinguished Professor
Roberto Cristi, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NRO

OBJECTIVE: The objective of this research program is to develop and evaluate robust adaptive control techniques for accurate pointing and tracking of spacecraft with flexible appendages, external disturbances and unmodeled dynamics. This works is a continuing effort to the design of an adaptive controller which compensates for model uncertainties and flexible modes in dynamic systems. Typical applications are systems with flexible appendages deployed in space.
OBJECTIVE: The scope of the program is to provide summer internship opportunities for undergraduate and graduate students in the field of acquisition, tracking, and pointing for High Energy Laser (HEL) systems, beam control, adaptive optics, and free-electron lasers. The Naval Postgraduate School has developed excellent research programs in these areas in the past and several unique testbeds have been developed for these research programs. The focus of this program is to provide hands-on experience on HELP lasers and beam control technologies, and educate college students in this important area.

INERTIAL REFERENCE UNIT
Brij N. Agrawal, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: AFRL/RDTP

OBJECTIVE: The objective of this research program is to support SMC/R&D in research activities for acquisition, tracking, pointing, and beam control. Under this project, performance of an inertial reference unit developed by Applied Technology Associates (ATA) will be characterized at the Naval Postgraduate School (NPS) Jitter Control Testbed. The NPS Jitter Control Testbed will be upgraded to incorporate the inertial reference unit and additional passive and active optics, real-time control algorithms will be developed and implemented, and experiments will be performed to test laser tracking and jitter control performance.

INTEGRATED TACTICAL PLATFORM SIMULATOR FOR MARITIME HIGH ENERGY LASER BEAM CONTROL TEST BED
Brij N. Agrawal, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: ONR

OBJECTIVE: The objective of this program is to develop an Integrated Tactical Platform Simulator (ITPS) for the Maritime HEL Beam Control Testbed. The proposed ITPS eliminates the limitation by providing platform motion disturbance. Two axis rotational stages and multiple linear shakers are used to create a disturbance motion, which is controlled in real time to match the prescribed set of disturbance spectra of the various maritime tactical platforms. The ITPS will provide new research and education capability by allowing us to identify and develop platform-specific ATP and beam control technologies for maritime HEL systems. It will also benefit our DoD students from various services by providing opportunities to work on the HEL system with their choice of tactical platforms.
OBJECTIVE: For an imaging spacecraft to provide truly persistent surveillance capability, the satellite should be in a higher orbit, requiring large aperture lightweight deployable mirrors, in the range of 10-20 meters in diameter. Achieving high surface accuracy for these mirrors is very challenging and adaptive optics techniques are under development to meet this challenge. The objective of this research program is to develop key technologies for large segmented mirror space telescope. Spacecraft Design Center (SRDC) at NPS has been very active for the last several years in developing these technologies. SRDC has participated in the development of Segmented Mirror Demonstrator (SMD), Segmented Mirror Testbed (SMT), and Advanced Mirror Development (AMD). This participation has helped SRDC to identify the critical technologies to be developed in this area and has developed new surface control techniques and wavefront sensors. Several testbeds have been also developed to validate these techniques. In Fall 2009, NRO/ITT is transferring SMT to SRDC. This is a unique testbed to develop these technologies. In the first year, the emphasis will be in the four areas. First area will be system identification of SM mirror and increase of damping for critical modes using tuned mass dampers or alternative techniques. SMD finite element model will also be evaluated. Second area will be developing new control techniques for SMD surface control using SMD analytical model. Third area will be developing new wavefront techniques to increase dynamic range. Fourth area will be to make SMT operational for segment surface and alignment research. Since SRDC will not receive 3 m collimator mirror, it will not be operational for this research. Two alternate techniques will be robust control techniques for surface control, wavefront sensing techniques for segment alignment, and active and passive damping techniques. This project will also collaborate with AMD program. In addition to these primary areas, improved control techniques will be developed for jitter control and spacecraft slew maneuvers for flexible space mirrors.

MARITIME BEAM CONTROL
Brij N. Agrawal, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: ONR

OBJECTIVE: The objective of this project is to develop beam control technologies for future maritime Free Electron Laser (FEL) weapon systems and educate DoD officers in this important area. The emphasis on this project will be on improving these technologies to enhance acquisition, tracking, and pointing, jitter control, and adaptive optics for turbulence correction for maritime beam control. It is planned that a high energy laser (HEL) Beam Control Test Bed will be developed and field tests will be also performed. Phase I will consist of reviewing the requirements for maritime beam control. Phase II will consist of developing the HEL Beam Control Test bed. Phase III will consist of developing control algorithms to improve beam control performance. Phase IV will consist of modifying the test bed for field tests. Phase V will consist of performing field tests. This project will also support the FEL program on beam control issues.

MARITIME BEAM CONTROL
Brij N. Agrawal, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: ONR

OBJECTIVE: The overall objective of this project is to develop beam control technologies and demonstrate them on the NPS High Energy (HEL) testbeds for future maritime Free Electron Laser (FEL) and other HEL weapon systems, and to educate DoD officers and civilians in this important area. The emphasis of the project will be on maritime beam control technology and HEL testbed development, Redundant Spacings Calibration (RSC), and beam control using the segmented mirror telescope testbed. For maritime beam control technology and HEL testbed development the research will be on advanced maritime beam control technologies such as characterization of the maritime environment,
MECHANICAL AND AEROSPACE ENGINEERING

adaptive optics control, and jitter control. These technologies will be demonstrated on the current NPS beam control testbed and on the 2-10 kW HEL beam control testbed under development. We will educate DoD officers and civilians, including Naval Surface Warfare Center (NSWC) engineers, in this technology. In addition, a Redundant Spacings Calibration (RSC) wavefront sensing technique will be developed and validated. This technique will simplify the architecture of HEL beam control systems by combining target tracking with wavefront sensing thus eliminating the need for a beacon laser.

NPS also received the 3 meter segmented mirror telescope in December 2009 allowing for an educational facility to do large-scale research in adaptive optics. An advisory panel was formed to identify key research interests and develop productive collaborations. Group members represent NPS, ONR, NRO, LMC, ITT, NRL, AFRL, Boeing, Northrop Grumman, JPL, UCSC, LLNL, and Aerospace. We will make the 3 meter Segmented Mirror Telescope Laboratory at NPS operational for research in beam control for FEL and adaptive optics using Shack-Hartmann and Phase Diversity sensors.

MARITIME BEAM CONTROL/REDUNDANT SPACING CALIBRATION (RSC)
Brij N. Agrawal, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: ONR

OBJECTIVE: To develop an improved wavefront sensor based on Redundant Spacings Calibration (RSC) for the purpose of compensation for atmospherically-induced beam-wander of a HEL system in maritime environment and to allow amalgamation of wavefront sensing and target tracking apparatus and the elimination of a beacon laser. The RSC technique had previously been established for the calibration of piston phase errors only, affecting interferometric arrays. Here we propose to extend the analysis to allow calibration of higher order phase modes. By selectively sampling repeated (or redundant) spatial frequency components of the object light the aberration phase component can be separated from the object information. This should eliminate the need for a reference laser, with measurements being made from the image itself, and may also permit the combination of the wavefront sensing detector with imaging and aim point maintenance apparatus. Improvements are expected in dynamic range and speed of wavefront solution over other popular sensors. This wavefront sensing technique has many potential applications. We are currently investigating it for the phasing of segmented telescopes, but it can also apply to the calibration of phased arrays under atmospheric turbulence conditions.

ON-ORBIT SYSTEM IDENTIFICATION AND SLEW MANEUVER FOR FLEXIBLE SPACECRAFT
Brij N. Agrawal, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NRO

OBJECTIVE: The objective of this research program is to develop and evaluate techniques for on-orbit systems identification and slew maneuver control of flexible spacecraft with Control Moment Gyrosopes (CMGs). The research emphasis is to minimize residual vibrations and slew maneuver time for enhanced acquisition and pointing performance. With the current trend in spacecraft design of increased flexibility, multiple modular bodies, and stringent attitude control accuracy requirements, slew control design may need improvements to accomplish future spacecraft missions. During FY2008, input shaping techniques were investigated for three-axis slew maneuver problems, including the nonlinear term in the spacecraft equation of motion. This approach provides a simple way of designing a slew control within the available momentum space of the CMG array. Experiments using the Bifocal Relay Mirror Spacecraft (BRMS) simulator were also performed. In order to use the full momentum space of the CMG array, solving an optimization problem with nonlinear dynamic equations is required. Slew maneuver control design using a Sequential Linear Programming (SLP) technique was also investigated. In FY2009, the SLP optimization technique and system identification method using filter bank approach will be extended for three axis rotational flexible spacecraft and will be implemented on the experimental testbed. The adaptive filters will be also investigated in FY2009. The
star tracker sensor will be integrated on the BRMS simulator for accurate determination of the spacecraft attitude.

ROBUST ADAPTIVE CONTROL WITH EXTERNAL DISTURBANCES AND UNMODELED DYNAMICS
Brij N. Agrawal, Distinguished Professor
Roberto Cristi, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NRO

OBJECTIVE: The objective of this research program is to develop and evaluate robust adaptive control techniques for accurate pointing and tracking of spacecraft with flexible appendages, external disturbances and un-modeled dynamics. The main issues are the estimation of the inertia matrix and the need for compensating for vibration effects due to flexible appendages. The proposed controller must guarantee sufficient robustness and “well behaved” response to be deployed in space in an unsupervised environment.

SPACECRAFT DESIGN
Brij N. Agrawal, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: ONR

OBJECTIVE: The objective of this project is to perform preliminary design of an operationally responsive modular spacecraft with plug and play bus architecture and synthetic aperture radar payload for the maritime domain awareness mission.

SPACECRAFT DESIGN
Brij N. Agrawal, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: ONR

OBJECTIVE: The objective of this project is to perform preliminary design of an operationally responsive modular spacecraft with plug and play bus architecture and anti-jam communication payload.

SPACECRAFT SYSTEMS
Brij N. Agrawal, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: ONR

OBJECTIVE: The objective of this continuing project is to develop and operate spacecraft laboratories to provide noteworthy improvements to Space Systems Curricula. This project had resulted in the development of five state-of-the-art spacecraft laboratories at NPS. During 2007, several major achievements have been made in the development of the laboratories. For the FLTSATCOM Laboratory, technical support agreements and equipment procurements were completed for the TT&C system upgrade. In the Spacecraft Design Laboratory, five new workstation PC’s, updated spacecraft cost estimating software, upgraded Aerospace CDC collaboration software, and updates to all subsystem design software have been completed. In NPS-AFRL Optical RElay Mirror Laboratory, a new test bed has been developed for Adaptive Optics Control. Bifocal Relay Mirror Test bed has been upgraded by adding a laser source and target sensor on the tracking rail. AUS patent application is the process on jitter control. During 2006, under course AE 4871, the students completed a preliminary design of Watchdog. The function of the Watchdog in LEO is to provide surveillance of GEO satellites for a possible threat. For 2007, the spacecraft design project is classified. In 2008, the primary task for FLTSATCOM laboratory will be to complete upgrade of TT&C system using
OS-COMET and make it compatible with the NAVSOC system. In the Spacecraft Design Laboratory, the primary task will be to implement capabilities for remote design collaboration. In NPS-AFRL laboratory, the primary task will be to implement wide angle sensor. The new Adaptive Optics Beam Control laboratory will be made operational in a new clean room with a Beam Control Testbed. In 2009, in FLTSATCOM Laboratory, the primary task will be, in collaboration with NAVSOC, to add additional laboratory exercises and spacecraft systems scenarios. In Spacecraft Design Laboratory, the work stations and design software will be upgraded. In NPS-AFRL Laboratory, adaptive optics will be added to the beam control test bed.

**SPACECRAFT SYSTEMS**

Brij N. Agrawal, Distinguished Professor  
Department of Mechanical and Aerospace Engineering  
Sponsor: ONR

**OBJECTIVE:** The objective of this continuing project is to develop and operate spacecraft laboratories to provide noteworthy improvements to Space Systems Curricula. This project has resulted in the development of seven state-of-the-art spacecraft laboratories at NPS including the new Segmented Mirror Space Telescope Laboratory. During 2009, several major achievements have been made in the development of the laboratories. The Segmented Mirror Telescope testbed was delivered to the new Segmented Mirror Space Telescope Laboratory. For the Adaptive Optics Beam Control Laboratory, HEL Beam Control testbed, HEL Adaptive Optics testbed, segmented mirror testbed, and Redundant Spacing Calibration Wavefront Sensing testbed were upgraded. For the FLTSATCOM laboratory, new OS-COMET system was installed and custom hardware was developed to achieve end-to-end link to the FLTSATCOM ground validation satellite hardware. In the Spacecraft Design Laboratory, eight new workstations are acquired and custom software package for classes and design project were developed. In the NPS-AFRL Optical Relay Mirror Laboratory, the new star tracker became operational for the three axis spacecraft simulator. For the Smart Structures Laboratory, a new Smart Vibration Beam System Testbed is completed in 2009. During 2009, under course AE 4871, NPS students provided a preliminary design of the Operationally Responsive Space (ORS) NPS SAR Sat. In 2010, the TT&C system upgrade for FLTSATCOM Laboratory will be completed. For the Spacecraft Design Laboratory, the maintenance upgrading of the aerospace design tools and technical library will continue. In the Segmented Mirror Space Telescope Laboratory, the segmented mirror telescope will become operational for education and research. The Adaptive Optics Beam Control Laboratory will be significantly upgraded for student’s research work and laboratory demonstrations.

**TACTICAL HEL WEAPON ALIGNMENT SYSTEM ARCHITECTURE EFFICIENCIES**

Brij N. Agrawal, Distinguished Professor  
Department of Mechanical and Aerospace Engineering  
Sponsor: ONR

**OBJECTIVE:** Restricted.

**DIRECT MANUFACTURING USING 3-D DIGITAL PRINTER: MECHANICAL BEHAVIOR OF POLYCARBONATE STRUCTURES**

Luke N. Brewer, Professor  
Department of Mechanical and Aerospace Engineering  
Sponsor: DARPA Fellows Program

**OBJECTIVE:**
1. To assess the ability to use science and statistical methods to predict the mechanical behavior of digitally printed, polymeric components
2. To lead the DARPA DMACE (Digital Manufacturing Analysis, Correlation and Estimation) Challenge.
SUMMARY: Prof. Brewer was a co-PI for the DARPA-sponsored program entitled “Direct Manufacturing Using 3-D Digital Printer: Mechanical Behavior of Polycarbonate Structures.” This project was successfully funded for $150,000. In this short-term, high intensity program (six months), a team from the MAE Department and the Space Systems Academic Group collaborated with DARPA Service Fellows and Oak Ridge National Laboratory to accomplish two main OBJECTIVE: 1.) To assess the ability to use science and statistical methods to predict the mechanical behavior of digitally printed, polymeric components and 2.) To lead the DARPA DMACE (Digital Manufacturing Analysis, Correlation and Estimation) Challenge. The DMACE Challenge explored “crowd sourcing” as a means for optimizing a process. Teams from around the world competed to see who could best predict the failure strength of digitally manufactured components. The NPS team led the polymeric portion of the contest. Prof. Brewer took the lead on the statistical analysis of the data generated. He also was the lead author on the DARPA and NPS-internal reports.

PUBLICATIONS:

ADVANCED CONCEPTS STUDIES
Christopher M. Brophy, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: SSP

OBJECTIVE: Evaluate benefits, challenges, and technical readiness level (TRL) of alternative propellant concepts, thrust vector control techniques, and improved drag reduction geometries for forward aerospike on future D5 variant concepts.

SUMMARY: Computational modeling of aerodynamic benefits associated with new forward aerospike concepts is underway. Alternative propellant formulations, such as ALICE, have been considered for “greenness,” but do not show justification for further consideration. The evaluation of a supersonic-ball thrust vectoring nozzle is being investigated computationally with the expectation that an experimental component to the research will be added near the end of the FY.

ALUMINUM OXIDE CHARACTERIZATION IN HIGH ASPECT RATIO GRAINS
Christopher M. Brophy, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: ATK Thiokol

OBJECTIVE: Determine the particle size distribution within a high-aspect ratio propellant grain through direct observation at chamber pressures ranging from 250 psig to 1000 psig. Three propellant formulations are to be considered.

SUMMARY: The experimental slab burner was designed, built, and characterized for a student thesis. Initial checkout testing revealed a design flaw which has since been corrected on one of the window purge ports. Selected grains have been consumed and revealed size distributions smaller than what computational modelers have predicted.

PUBLICATIONS:
CPIAC JANNAF Joint Combustion Meeting Proceedings (Limited Distribution)

PRESENTATIONS:
CPIAC JANNAF Joint Combustion Meeting Proceedings (Limited Distribution)
MECHANICAL AND AEROSPACE ENGINEERING

THESES DIRECTED:


CONSTANT VOLUME COMBUSTION TECHNOLOGY RISK REDUCTION

Christopher M. Brophy, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Air Force Research Lab/DARPA

OBJECTIVE: Evaluate detonation ignition and initiation strategies for pulse detonation combustor development. Determine conditions required for gaseous and liquid fuels to reliably detonate at 1 atm in a 101.4 mm combustor at various Mach numbers between 0.1 and 0.4. Additionally, modify facility to permit testing of air-breathing systems with up to 15 lbs/s of clean-dry air and for durations exceeding 1 minute.

SUMMARY: A new heat exchanger system was acquired to replace the existing vitiator design used to heat the delivered air flow to 1000F. Additionally, the existing air storage system capacity was increase a factor of 4 to allow for longer run durations. The fuel/air detonation initiation testing produced unique transition obstacles for the rapid and efficient initiation of fuel/air detonations. Further details of this work are of limited distribution.

PRESENTATIONS:


PUBLICATIONS:


THESES DIRECTED:


DETONATION TRANSITION LENGTHS FOR PULSE DETONATION ENGINES

Christopher M. Brophy, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: Determine the diffraction limits for hydrocarbon/air detonations which traverse discrete diameter increases in concentric combustors with no forward confinement and short (<1D) transitions.

SUMMARY: The second year of this effort has continued the computational evaluation of the expansion limits of hydrocarbon/air detonations across concentric combustor “gaps” which are designed to provide an overall expansion ratio of 5, but with discrete steps and no forward confinement. Computational results have guided the experimental portion of the research which occurred during CY10. The results have been provide to both ONR and ONRG sponsors since the project involves interaction with NUS faculty.

PRESENTATIONS:

Brophy, C.M., “Tactical Missile Design at the Naval Postgraduate School,” 10th AIAA Aviation Technology,
MECHANICAL AND AEROSPACE ENGINEERING


PUBLICATIONS:


THESES DIRECTED:


NEW TECHNOLOGIES FOR ADVANCED STRATEGIC MISSILE SYSTEMS

Christopher M. Brophy, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Strategic Systems Programs

OBJECTIVE: The intent of this project is as follows: Determine feasibility of utilizing new propellants, such as NASA/Purdue ALICE or advanced CL-20 based composite propellants, for use in submarine launched missile applications and their applicability to any high performance missile. This effort will also investigate the utilization of trapped ball TVC designs for use in strategic systems, possibly in the current systems (as a life extension) or next generation submarine launched missiles. The implementation of new processes and/or materials associated with these designs that could be used to build a submarine launched missile nozzle with TVC capability will also be considered and investigated.

Pending the results of the above tasks, if possible, engineering models (Matlab) will be developed using results from the research. It is anticipated that these new approaches would significantly enhance the prediction capabilities required to meet the stringent environmental and operational requirements. A preliminary analysis of the safety issues associated with any new approach will also be reported. Since other groups and facilities are also engaged in related research activities, the appropriateness of leveraging and supplementing other efforts and resources at these facilities will also be considered.

A report will be provided with results and recommendations. This effort is to begin immediately and be completed by 30 Sept 2011.

STEADY AND UNSTEADY FLOW EXPERIMENTS ON ROTOR ISSUES

Muguru S. Chandrasekhar, Research Professor
Department of Mechanical and Aerospace Engineering
Sponsor: US Army Aeroflight Dynamics Directorate

OBJECTIVE: The proposal addresses two specific, but different fluid flow experimental research needs at the U.S. Army Aeroflight Dynamics Directorate at Moffett Field, CA. One is to develop and conduct very basic unsteady flow studies first on simplified geometrics with the goal of expanding the knowledge base in order to obtain better understanding of a helicopter rotor blade complex flow issues including compressible dynamic stall and its control. The other is to lend PI’s expertise necessary for other ongoing current and proposed roto flow control related experiments.
through developing new instrumentation, data acquisition techniques and applying them to document the research activities of the AFDD.

UNSTEADY AERODYNAMICS RESEARCH OF MANEUVERING UCAV
Muguru S. Chandrasekhara, Research Professor
Department of Mechanical and Aerospace Engineering
Sponsor: National University of Singapore

OBJECTIVE: To study and identify the unsteady aerodynamic characteristics of an unmanned combat aircraft while performing prescribed maneuvers in the NPS water tunnel.

SUMMARY: Funding for the third year was received based on acceptance of the progress report for the second year. The effort focused on load measurements in this year. Strain gage load data were acquired initially in steady flow at different angles of a UCAV 1303 design and also, for several flow speeds. A considerable number of experiments were conducted to establish the correct ensemble averaging procedure for capturing the unsteady load data since cycle to cycle variations can often produce results that can be misinterpreted. Angles of attack of up to 35 degrees were investigated. The purpose was twofold. One was to identify whether the tip stall and vortex bursting observed in the flow visualization studies of the earlier investigations on the same model in the NPS facility could be correlated with the observed pitch and moment breaks. Secondly, it helped to establish a comparison basis for the maneuver loads at different unsteady rates. The studies quantified Reynolds number effects, pitch effects: 0-35 deg, roll effects: +90 to -90 deg, and yaw effects: +10 to -10 deg both separately and in combined motion all at different rates to establish the effect of unsteadiness on aerodynamic performance. We have a large number of cases that are being correlated now and the results of this effort will form the bulk of LT. Phil Sosebee’s MS Thesis. Significant effects are seen in combined pitch/roll maneuvers also. The data can further enable obtaining the stability derivatives for the model. The aircraft is known to be marginally stable and so, this information is highly desirable.

THESES DIRECTED:

Ongoing, LT. P. Sosebee, “Visualization and Detailed Load Measurements over a Maneuvering UCAV 1303 Planform”, March 2011

LCS CLASS SHIP SHOCK MODELING & SIMULATION USING DYSMAS CODE
Jarema M. Didoszak, Research Assistant Professor
Department of Mechanical & Aerospace Engineering
Sponsor: NAVSEA, PMS 501

OBJECTIVE: The objectives of this project are as such (1) to perform FEM modeling of the two hull variants of the LCS Class in support of required survivability analysis, including underwater explosion testing and ship shock trials (2) to perform validation and verification of the LCS FEM models as specifically prepared for shock and vibration analysis and (3) to identify potential problem areas as related to the survivability of the LCS hull variants designed in Flight 0.

SUMMARY: This research supports the PMS 501 LFT&E ship shock trial program effort in the analysis, development and completion of the LCS alternate shock plan. In addition to continued review of the ship structure FEM models for LCS-1 and LCS-2, a surrounding fluid mesh was created and evaluated using the DYSMAS hydrocode. The coupled fluid structure interaction problem was further tested via parametric study for sensitivities stemming from the complex underwater explosion environment, identifying potential affects from factors unique to the littoral operating environment such as bottom reflection, ocean floor proximity and type and gas bubble loading effects. Full ship shock trial scenario simulations of the structural shock response using the SVCL HPC resources are ongoing.
OBJECTIVE: The work addresses the development and implementation onboard of SUAV of the real-time algorithms of cooperative path following and airspace deconfliction for multiple SUAVs operations.

SUMMARY: As the restricted airspace used in the experiments gets more crowded the issues of airspace management and deconfliction become of paramount importance. As a result NPS and AFSOC have developed new algorithms that address these issues both at the local level of several UAVs cooperating to execute as mission as well as at the Air Boss’s level.

At the local level a team of UAVs is assigned a box that it cannot leave. Each UAV then cooperatively generates real-time trajectories that guarantee deconfliction for each UAV as well as confine the UAV team to the assigned box. Trajectory generation is done in real-time using direct methods of optimal control that explicitly account for the communication structure of the underlying wireless network.

Status of each UAV team is displayed to the Air Boss by the Situational Awareness software that monitors the airspace under his control, detects potential conflicts and suggests potential conflict resolutions. The air boss may accept these suggestions or decide to execute an entirely different procedure. The paper includes description of the algorithms involved and of flight test results.

PUBLICATIONS:


Z. Li, N. Hovakimyan, V. Dobrokhodov, “Vision-based Target Tracking and Motion Estimation Using a Small UAV”, 49th IEEE Conference on Decision and Control, December 15-17, 2010, Atlanta, GA, USA.


*Z.Li, N. Hovakimyan, and V. Dobrokhodov, "Vision-based Target Tracking and Motion Estimation Using a Small UAV," 49th IEEE Conference on Decision and Control, December 15-17, 2010, Hilton Atlanta Hotel, Atlanta, GA, USA(subm.number 2036).

STUDENTS INVOLVED:

K. Andersson - PhD student of MAE dept.
MECHANICAL AND AEROSPACE ENGINEERING

ACCURACY MODEL IMPROVEMENT
Morris R. Driels, Professor
Department of Mechanical & Aerospace Engineering
Sponsor: ASC/XREW

OBJECTIVE: This proposal covers several tasks of interest to the Joint Technical Coordinating Group (JTCG) focusing on improving current accuracy models for various unguided and guided weapons systems. Individual tasks are attached.

COLLATERAL DAMAGE METHODOLOGY
Morris R. Driels, Professor
Department of Mechanical & Aerospace Engineering
Sponsor: ASC/XREW

OBJECTIVE: This proposal seeks to determine the validity of current methods for assessing collateral damage to buildings and whether new methods would lead to more accurate results.

SUPPORT GWTS CB
Morris R. Driels, Professor
Department of Mechanical & Aerospace Engineering
Sponsor: ASC/XREW

OBJECTIVE: Continued support as the JTCG/ME representative to the GWTS CCB.

SUPPORT CTEG TASK #5 - 3.01
Morris R. Driels, Professor
Department of Mechanical & Aerospace Engineering
Sponsor: JTCG/ME Program Office

OBJECTIVE: To travel to UK and Germany to discuss joint research projects between JTCG/ME and MoD and NATO research facilities.

MISCELLANEOUS AIR TO SURFACE TASKS
Morris R. Driels, Professor
Department of Mechanical and Aerospace Engineering
Sponsors: JTCG/ME –U.S. Army, Aberdeen Proving Ground, MD

OBJECTIVE: To improve delivery accuracy methodology for conventional weapons

SUMMARY: Continuing task addressing several aspects of conventional weapon usage including:
1. Improvement of delivery accuracy program for unguided weapons
2. Improvement of program for GPS/INS guided weapons
3. Review of collateral damage methodology
4. Working group participation for unified methodology development
OBJECTIVE: In many applications of multi-component micro-systems, large shear stresses exist at interfaces between dissimilar materials, and at least one of the materials adjacent to the interface is subjected to high homologous temperatures. This enables diffusionally accommodated sliding processes (interfacial creep) to operate at the interface, impacting the deformation behavior, dimensional stability, and reliability of the component. Furthermore, thin film interconnect structures in micro-systems often carry large electric current densities, which drive electromigration. As interconnect dimensions shrink, interfaces become the primary path for diffusion during electromigration, potentially leading to significant interactions between interfacial diffusive fluxes due to applied stress and electromigration. Thus, depending on the direction of applied current relative to the direction of the applied shear stress, electromigration-driven interfacial diffusion may either enhance or reduce interfacial sliding. With the emerging trend towards nan-scale miniaturization of multi-material assemblies in microelectronics, MEMS and functional nano-composites, and the commensurately explosive growth in interfacial area inside these assemblies, interfacial sliding is likely to become increasingly prominent, particularly since both thermomechanical and electrical loads are expected to increase in the future.

In this work, we propose a comprehensive experimental and analytical effort to obtain fundamental mechanistic insight into interfacial creep at thin film-substrate interfaces under thermomechanical, as well as thermomechanical-cum-electrical loads. The effort will combine creep testing with and without applied electrical current, detailed interfacial characterization, constitutive modeling and experimental/analytical investigations of microelectronic device structures.

The work will be of substantial fundamental importance since it will be the first-ever study of interfacial creep in thin film systems, and also the first-ever study to investigate the interaction between stress and electric current-driven diffusion in promoting/inhibiting interfacial sliding. Secondly, the work will be of great practical importance by generating kinetics data in a number of important engineering systems with applications in the micro-systems industry, and by developing a constitutive law which can be utilized for reliability predictions. Thirdly, the work will be of immense technological significance if interfacial sliding were ever to become performance-limiting in future micro-systems, since it will lay a framework for exploiting the interaction between stress and electric current to mitigate sliding through design considerations.

The broader impact of the work is related to its technological relevance to the entire micro/nano-systems industry by bringing to light a new phenomenon which may become performance limiting in a wide array of components in the future. Throughout the project, we will work closely with the industry to identify/address issues of emerging relevance. In addition to training graduate students and post-docs, we will hire summer high school student interns to work on the project through a local enrichment program, and hire high/middle school science teachers to work in our laboratory during summer and assist them in developing lesson modules relevant to the general area of this research.
ANALYSIS OF THE COMPLEX EXPONENTIAL METHOD FOR MODAL PARAMETER ESTIMATION FROM FSST DATA – PRELIMINARY INVESTIGATION
Joshua H. Gordis, Associate Professor
Jarema M. Didoszak, Research Assistant Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NSWC - Carderock

OBJECTIVE: The objectives of this project are as such: (1) conduct a review of the existing procedures used in the Damping Modeling Strategy for Naval Ship Systems completed by Ham and Shin in 2003, and other relevant research efforts involving ship structure damping, and (2) present a summary of literature review and recommend future direction for ship damping applications.

SUMMARY: In 2003 a study was conducted by Ham and Shin of the Naval Postgraduate School in which proportional damping coefficients were determined through the use of the Complex Exponential (CE) method in the extraction of modal parameters based on measured live fire test data from the DDG-53 shock testing. In order to develop an updated code for the complex exponential algorithm and potential new applications, a literature review and evaluation of current implementations of damping in naval ship structures was conducted. This preliminary work has lead to an ongoing project in which a MATLAB implementation of the CE code is currently underway.

DEVELOPMENT OF PHYSICS-BASED MODELING AND SIMULATION SYSTEM FOR FLEET/FORCE SUSTAINMENT
Joshua H. Gordis, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: The scope of this work is the continued development of a physics-based simulation system for fleet and force sustainment. This model will allow the rational assessment of candidate technologies. The model can then be used to identify technology gaps along with proposed solutions. Computable metrics, are established in order to evaluate the relative merit of different options.

CROSS FLOW FAN – IMPROVING EFFICIENCY
Garth V. Hobson, Professor
J. Gannon, Associate Research Professor
Department of Mechanical and Aerospace Engineering

OBJECTIVE: This project aims to embed a cross-flow fan in an aerofoil section in such a way as to allow for practical vertical take-off and then the transition to efficient forward flight. Being embedded in the wing resolves many of the disadvantages and safety issues of open rotor designs. It is thought that initial applications would be most likely in Unmanned Aerial Vehicles (UAVs).

SUMMARY: The work was a continuation of the previous year’s. It was desired to improve the efficiency of the existing cross flow fan which is basically a scaled down version of an industry designed fan from the 1970’s. As part of his research work a student investigated numerically what the effect of blade number on the fan efficiency was. He predicted that reducing the number of blades from 30 to 22 would be optimal for thrust application. Subsequently a modified rotor with 22 blades was manufactured and tested. There was agreement with the predictions and a small increase in the efficiency was found but as was expected there was a reduction in the stall margin.

THESES ADVISED:
**MECHANICAL AND AEROSPACE ENGINEERING**

**RAMPRESSOR – ROTATING RIG DEVELOPMENT**  
Garth V. Hobson, Professor  
B. J. Gannon, Associate Research Professor  
D. L. Seivwright, Research Associate  
Department of Mechanical and Aerospace Engineering  
Sponsor: Ramgen Power Systems, Inc.

**OBJECTIVE:** A private company Ramgen, is developing a high pressure ratio process gas compressor (rampressor). One of the intended applications is for Carbon Dioxide capture and sequestration. The Turbopropulsion Laboratory TPL was tasked with the development of a closed loop facility for the testing of a compressor to pump Carbon Dioxide. A design allowing the existing transonic test rig to be closed and run a gas other than air has been developed. It is hoped that other gases may be contained allowing for testing of process gas compressors in the future.

**SUMMARY:** The work was a continuation of the previous year’s. A complete design for the process gas facility was completed and the building modified to allow a heat exchanger to be included in the closed loop facility to remove heat added by the compressor. Extensive modification and stress analysis was undertaken on the compressor to be tested in the facility.

**TRANSONIC FAN STAGE – STEAM INGESTION STUDY**  
Garth V. Hobson, Professor  
A. J. Gannon, Associate Research Professor  
D. L. Seivwright, Research Associate  
Department of Mechanical and Aerospace Engineering  
Sponsor: NAVAIR/ONR

**OBJECTIVE:** The effect of steam and thermal ingestion into a fan stage and their effect on performance and operability have not been well understood in the design and development of fan and compressor stages. The present methodology uses Legacy databases, which are limited. Further the higher pressure ratio in the evolving gas turbine industry and the shrinking research and development funds are demanding analytical tools be developed, which could lower the test iterations to achieve shorter design and development time. NAVAIR, Propulsion and Power group initiated an analytical design effort a few years back by teaming with Industry, AFRL and NPS. NPS was funded to develop analytical tools and methodology to address Navy specific steam and thermal ingestion effects on the fan and compressor performance.

**SUMMARY:** Measurement and test techniques, that were developed with ONR and NAVAIR funds, during steam ingestion tests on a transonic fan stage were used on a scaled version of the F135 (and XTE-67/A1 demo engine) first stage fan. The thrust of the effort for this project has been to determine the effect of steam ingestion on the stall margin of the JSF F135 engine, as well as to quantify the performance of the first stage fan of the engine. A new titanium rotor blisk based on the geometry of the Pratt and Whitney first stage fan of the XTE-67/A1 demo engine, was scaled down to 11” diameter and machined for installation in the NPS transonic compressor rig at the Turbopropulsion Laboratory. Extensive modification of the rotating structure was necessary in order to support the new and heavier rotor. In addition, a new more versatile rotor casing system was designed and installed to allow greater ease and efficiency in instrumentation configuration and testing. These combined improvements provided for a very versatile test rig. Initial baseline measurements of the rotor have been made up to 27,000 RPM. In addition, extensive efforts will be initiated in out-years to develop a comprehensive model to predict the effect of steam and thermal ingestion and validated against data acquired at the NPS’s steam ingestion test facility.

**PUBLICATIONS:**

THESES DIRECTED:

Randall A. Boyter “Computational Fluid Dynamic Simulation of Transonic Compressor Fan Performance, Mar. 2010.

VSWMCM PROGRAM MANAGER AND SUPPORT
Garth V. Hobson, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: Feature Based Navigation for Multi-AUV Operations (Horner PhD). Currently multi-vehicles maintain tight formation control by ensuring that full communication exists between all vehicles. The goal of the research is to loosen that constraint. In other words is it possible to have multi-vehicles collaboratively conducting a combined surveillance without the vehicles maintaining a formation at all times? In the envisioned arrangement vehicles would dynamically come into and out of the network reporting sensory and navigation information. This ability requires development of several aspects of underwater robotics including: Networking, Control and Navigation (SLAM).

AUTONOMOUS USV NAVIGATION IN RIVERINE ENVIRONMENTS
Douglas Horner, Research Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: This third year ONR program is a joint collaboration with Virginia Tech for creating autonomous behaviors for navigating an Unmanned Surface Vessel in riverine environments. The second year effort successfully demonstrated an initial autonomous riverine capability on the Pearl River at Naval Special Warfare Special Boat Squadron TWENTY. This will greatly improve manned and unmanned riverine craft’s ability to safely navigate at night and navigate in uncharted and rapidly changing waters.

GREATER AUTONOMY FOR USVS IN RIVERINE ENVIRONMENTS
Douglas Horner, Research Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: The principal project goal is to develop the capability for an unmanned surface vehicle (USV) to operate fast and autonomously in unknown riverine environments. This requires development and implementation of technology, algorithms, and fundamental theory for greater levels of autonomy in USV systems. While the focus is on unmanned systems, the developed technology is also applicable to manned systems. (Note: The Naval Postgraduate School (NPGS) and Virginia Tech intend to work jointly to achieve the project goal. The collaboration was born out of an ONR 2006 Congressional Plus-up program which successfully culminated in a coordinated riverine UAUVUSV display at AUVFest 2007. NPGS and VT are submitting identical proposals that divide the research priorities in terms of expertise and interest.)

Successful autonomous navigation requires that the USV sense the surface and subsurface environments, discriminate waterways that are navigable from those that are not, identify stationary and moving obstacles, including other vessels, and then optimally plan and re-plan a route in real-time. Since speed is a vessel’s principal defense, all of these tasks must be done as efficiently as possible to ensure successful operation at the greatest possible speed.

To achieve this overall goal, this project will emphasize:
1. Operations in unknown and partially observed environments with both static (e.g., rocks) and dynamic uncooperative obstacles (e.g., other vessels). Initially, focus will be on static obstacles.
2. Operations where existing maps are inaccurate and incomplete.
3. Use of fast real-time algorithms to facilitate USV transit at the fastest speeds possible,
4. Field experiments in fully realistic and challenging environments.
5. Later multi-vehicle operations will be considered to include USVs and UAVs that share environmental data and route plans in order to increase efficiency.

OBSTACLE AVOIDANCE USING FORWARD LOOK SONAR
Douglas Horner, Research Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: This is an ONR program for developing reactive obstacle avoidance using a forward-looking sonar. It combines together advanced control techniques with computer vision so that an AUV can avoid damage and increase mission effectiveness by detecting and avoiding unknown undersea obstacles. The developed technology transfers to the University of Texas Applied Research Laboratory (UTARL) who is responsible for implementation of this capability on Navy AUVs.

STUDY ON AUTONOMY
Douglas Horner, Research Associate Professor
Department of Mechanical and Aerospace Engineering

OBJECTIVE: This is an OSD funded project that investigates the future use of unmanned systems for combat operations. Specifically it addresses the planning considerations and verification and validation of software systems for weaponized unmanned platforms.

VSW MINE NEUTRALIZATION
Douglas Horner, Research Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: Douglas Horner provides technical oversight for this ONR program for developing control algorithms for autonomous navigation of a simple AUV to detect and attach to a moored or bottom mine shape. The research couples a forward-looking sonar with Simultaneous Localization and Mapping (SLAM) software for mine neutralization. The consortium of researchers includes MIT, iRobot and SeeByte.

DISTRIBUTED SLAM FOR AUVS
Douglas Horner, Research Associate Professor
Department of Mechanical and Aerospace Engineering

OBJECTIVE: One of the important Naval problems highlighted by ADM Hogg (SSG - Strategic Study Group) was the ability to repetitively survey harbor areas. This research project is designed to address this issue by developing a multi-AUV collaborative surveying capability. The emphasis on the program is collaborative mapping through underwater acoustic communications. The advanced initiative combines sonar image processing with networking and control.
HERDING AND ACTIVE FORCE PROTECTION USING AUTONOMOUS AGENTS
Isaac Kaminer, Professor
Doug Horner, Research Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: This proposal addresses an issue critical to the USN planners and current and future USN UAV operators, namely, the question of airspace volume capacity that can be populated by multiple UAVs performing a single or multiple missions in a littoral environment in support of the warfighter. Clearly an answer to this question must include more than just a number of the UAVs, but their desired paths that perform the required mission(s) and stay inside the air box, the algorithms to track these paths and that coordinate between multiple UAVs by using the underlying wireless network. In fact coordination constraints, as is shown in this proposal, must be included in the initial air volume capacity/path planning step. The types of missions considered in this proposal include intelligent surveillance and reconnaissance, coordinated terrain following, support of small SEAL teams to name a few.

COMPETENCY EDUCATION PACKAGE FOR AIRCRAFT STRUCTURES
Ramesh Kolar, Research Assistant Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Naval Air Systems Command

OBJECTIVE: To develop and teach courses in Aircraft Fatigue and Fracture for NAVAIR and NADEP engineers in Structures Competency. Provide technical consultation in evaluation of proposals, design and analysis issues of fixed wing and rotary wing aircraft and UAVs.

STUDY OF COMPOSITE STRUCTURE WITH FSI UNDER IMPACT LOADING
Young W. Kwon, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: ONR

OBJECTIVE: The objectives are to understand and predict the effects of fluid-structure interaction on the dynamic responses and failures of composite structures used for naval applications; to compare dynamical responses, and failure mechanisms and modes of composite structures in water and air to enhance the understanding of the effects of fluid-structure interaction on marine composite structural behaviors; and to identify the major factors of fluid-structure interaction that affect composite structures

SUMMARY: A series of impact experimental tests was conducted for carbon composite plates with or without water support to determine the effects of Fluid-Structure Interaction (FSI) on the composite structures under dynamic loading. The experimental results clearly indicated that the FSI effect is significant for composite structures. Under the same impact loading condition, the FSI effect results in much greater impact forces and strains for a composite plate under water support compared to that under air support. A numerical modeling and simulation technique was developed to further study the impact testing. The numerical study confirmed the experimental results at least qualitatively. Furthermore, a series of parametric studies identified the important parameters associated with the FSI effect.

PUBLICATIONS:

Y. W. Kwon, “Study of Fluid Effects on Dynamics of Composite Structures”, ASME Journal of Pressure Vessel Technology, Accepted for publication. (DOI: 10.1115/1.4002377)
STUDY OF EFFECT OF VARYING STRAIN RATES
Young W. Kwon, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsors: ONR, NSWC-CD

OBJECTIVE: The objective of this project was to investigate the effect of varying strain rates on the material behaviors such as stiffness and strength.

SUMMARY: Strain rate affects the mechanical properties of ductile materials in terms of their stiffness and strength. In particular, yield and failure strengths and strains depend on the strain rate applied to the materials. When a metallic material is subjected to a typical dynamic loading, the material usually undergoes various strain-rate loading conditions. One of the main questions is whether the material is going to fail or not. To the authors’ best knowledge, there has been no failure criterion proposed for a varying strain-rate loading condition. This paper presents a failure criterion under non-uniform strain-rate loading conditions. Experiments were conducted to support the proposed failure criterion using aluminum alloy AA3003-H14. This study also investigated the failure envelopes in terms of strain rates and the normalized failure strengths. Furthermore, effects of strain rates on strength and stiffness properties were also examined.

PUBLICATIONS:

Damage Detection in Composite Interface through Carbon Nanotube Reinforcement
Young W. Kwon, Distinguished Professor
Randall Pollak, Assistant Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Air Force Office of Scientific Research

Objective: The primary objective of the proposed study is to qualify the capability of using electrical conductivity of percolated carbon nanotube networks to detect damage at interfaces in composite structures. To quantify the potential of such an approach to “hot-spot” monitoring, the proposed study will include a parameter-based experimental investigation of carbon nanotube networks to detect and monitor damage. Variables to be considered include carbon nanotube type, size, and volume percentage.

Direct Manufacturing Using 3-D Digital Printer
Young W. Kwon, Distinguished Professor
Luke N. Brewer, Associate Professor
Department of Mechanical & Aerospace Engineering
Sponsor: DARPA

Objective: The objective of this project was to investigate the correlation of the mechanical properties to the manufacturing parameters of a 3-D printer.

Summary: A 3-D digital prototype printer has been considered for direct digital manufacturing of components because this technology has many benefits compared to conventional manufacturing technologies. In order to assess the applicability of the direct digital fabrication to a critical structural component, mechanical properties of the digitally fabricated component should meet the design or performance requirements. Furthermore, it is necessary to be able to predict the mechanical properties of the fabricated component based on the input parameters of the 3-D digital printer. The present project measured the mechanical properties (i.e. strength and stiffness) of samples fabricated from a 3-D digital printer as a function of processing parameters, determined predictive model connecting the input parameters to the 3-D digital printer and mechanical properties of the fabricated samples by using a statistical design of experiments and multivariate regression, validated the model using crush-strength experiments on the NPS CubeSat structure, and to hosted the CubeSat challenge.

Publications:
OBJECTIVE: The objective of this collaborative task was to lay the foundation for a structural optimization methodology and demonstrate its applicability to the design/construction process using a simplified structural model provided by NGSB. This optimization procedure would then serve as a platform for further incorporation of more detailed engineering design criteria such as acoustic energy dissipation, shock response and structural damping in the future.

SUMMARY: The purpose of this CRADA was to collaborate with Northrop Grumman Shipbuilding, Inc., in conducting research and analysis in the area of structural optimization. Specifically, it was to develop an optimization process for implementation and validation of engineering design choices in the use of panel line module structures in place of hand welded frame structures. Demonstrate the procedure, analysis and resulting design options using a NGSB provided reduced model.

Collaborate to include items such as acoustic energy dissipation, shock response and structural damping, for further refinement of the optimization process and future incorporation as part of future phases of this effort.

PUBLICATIONS:


UNDERWATER SHOCK SIMULATION OF LCS
Young W. Kwon, Distinguished Professor
Jarema M. Didoszak, Research Assistant Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NAVSEA (Classified)

OBJECTIVE: The objective of this project was to understand the effects of underwater explosions on LCS. (Classified research)

SUMMARY: Physics-based modeling and simulation was conducted to investigate the effect of underwater explosion on LCS under various shock conditions.

PUBLICATIONS:


THESES DIRECTED: One PhD student was graduated and two MS students worked on the project.
MECHANICAL AND AEROSPACE ENGINEERING

EVALUATION OF NIAL PROPELLER BRONZE FOLLOWING FRICTION STIR PROCESSING (FSP)

Terry R. McNelley, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: This proposal is for funding to evaluate the mechanical properties of selected post FSP NiAl propeller bronze samples in order to determine the factor(s) involved in the observation of occasional high yield property relationships will be determined for test coupons and stir zones of materials provided by the NSWC - CD and Edison Welding Institute (EWI).

MICROSTRUCTURE - PROCESSING - PROPERTY RELATIONSHIPS IN FRICTION STIR PROCESSING (FSP) OF NIAL BRONZE

Terry R. McNelley, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: This proposal is for funding to conduct a three-year investigation into the mechanisms underlying microstructure evolution during multi-pass FSP of NiAl bronze and the related processing - microstructure - property relationships in these materials. The roles of process variables, including step-over distance, will be identified and models for processes of microstructure transformation and strengthening will be developed.

UNDERWATER CRACK REPAIRS IN HIGH-STRENGTH STRUCTURAL STEELS BY FRICTION STIR WELDING (FSW)

Terry R. McNelley, Distinguished Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: This proposal is for funding to determine the feasibility of performing crack repair on submarine control surfaces by underwater FSW of HY-80 steel. FSW will be conducted on 6.3mm (0.25in) thick HY-8-steel sheet in a dry condition as well as underwater in a laboratory environment using facilities that have been successfully used to conduct FSW of selected plain carbon and low allow steels. Microstructures and microstructure-property relationships will be established for the HY-80 material after FSW.

ADVANCED MARINE GAS TURBINE TECHNOLOGY PROGRAMS

Knox T. Millsaps, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Naval Surface Warfare Center

OBJECTIVE: This project supports the Advanced Technology Group Manager (code 91) in the Marine Gas Turbine Branch of NAVSEA for the life cycle support of the ship service and main propulsion gas turbines. This work includes providing analysis of test data and methodologies for the detection of engine degradation, engineering support for online compressor washing evaluation, and to provide seminar and short course to NAVSES.
MECHANICAL AND AEROSPACE ENGINEERING

CERTIFICATION, COMBUSTION STUDIES, AND FUELS CHARACTERIZATION OF BIO-DERIVED FOR TACTICAL NAVY GAS TURBINES AND DIESELs

Knox T. Millsaps, Professor
Jose Sinibaldi, Research Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: This project supports the ONR initiative to investigate and characterize the fuel and combustion properties of bio-fuels for JP-5 and F-76 turbine fuels. Conventional ASTM and MILSPEC tests will be used along with the emerging synthetic turbine fuel standards, and knowledge of “fit for performance” measures to assist the Navy in certifying and accepting for use pure and blended alternate fuels for navy tactical use in near shore and global demonstrations. In addition fundamental combustion tests will be conducted to identify potential problems, such as lean blow out, combustion instabilities, and flash-back. Requirements and protocols for certification and use in a variety of naval facility applications will be outlined.

SHIPS: DEVELOPMENT OF A SHIP-HUMAN INTEGRATED PERFORMANCE SYSTEM

Fotis A. Papoulias, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Office of Naval Research

OBJECTIVE: The scope of this work is to provide a methodology and to develop a tool for conducting a systematic set of design trade-offs with regards to manning considerations and human performance aboard Navy ships. The proposed work will utilize domain level experts at the naval Postgraduate School especially with regards to mission effectiveness, motion analysis, and human performance modeling. The results of the methodology and tools that will be developed will be tested and used in various NPS educational activities such as the Total Ship Systems Engineering (TSSE) program as well as the rest of the ACCeSS members.

SPACE SITUATIONAL AWARENESS: CUBESAT BUS, ATTITUDE CONTROL, AND UTILIZATION

James H. Newman, (Space Systems Academic Group)
Marcello Romano, Associate Professor
Alan D. Scott, Senior Lecturer
Department of Mechanical and Aerospace Engineering
Sponsor: Lawrence Livermore National Laboratory (LLNL)

OBJECTIVE: In support of LLNL’s Space Situational Awareness (SSA) activities, this effort is intended to accomplish three tasks focused on building capability for flying a very small satellite of relevance to SSA and looking at integration of new and previously unexploited data sources into the US Space Surveillance Network (SSN). This work includes procuring and/or obtaining a COTS-based CubeSat Bus able to accept a TBD LLNL SSA payload and provides opportunities for thesis research of national interest for NPS students. A follow-on proposal will be produced consistent with the goal of producing, with LLNL, a launch-ready SSA CubeSat in 2012.

SUMMARY: To fully leverage any new and previously unexploited sensors for integration into the SSN, numerous policy, doctrinal, security and operational integration issues will need to be addressed. The objective of this task is to determine how these new and unexploited SSA data sources might be used more effectively and to identify and conduct an initial analysis of the most significant challenges associated with the integration of such sensors. The following specific work is being performed:

1. In conjunction with LLNL, identify potential new and/or unexploited sensors, including foreign based sensors, which could be considered for integration into the SSN.
MECHANICAL AND AEROSPACE ENGINEERING

2. Also in conjunction with LLNL, determine the potential performance improvement of adding the identified sensors to the SSN.
3. Identify and conduct an initial analysis of the policy, doctrinal, security and operational issues associated with integrating those sensors which show the greatest potential for improving SSA capabilities.
4. Collaborate with the Joint Functional Component Command for Space (JFCC-Space), Joint Space Operations Center (JSpOC) and cognizant acquisition program offices to determine how new and unexploited capabilities can potentially be integrated into SSN operations.
5. Define and scope additional tasks for future effort in this area.

THESES DIRECTED:


AGILE ATTITUDE CONTROL SUBSYSTEM FOR NANOSATS BASED ON CONTROL MOMENT GYROSCOPES: FLIGHT PROTOTYPE

Marcello Romano, Assistant Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NRO

OBJECTIVE: The objective of the proposed research is to design, develop and test a fully functional flight prototype for a CubSat attitude control subsystem will enable agile attitude slewing and accurate pointing/tracking for spacecraft made of multiple (2-5+) CubSat units. These attitude control capabilities, currently unavailable for CubSats, are essential for several critical missions (e.g. Earth imaging, optical communications and situational awareness applications). The proposed attitude control subsystem is entirely contained in the volume of less than 1 liter and has a total mass of less than 1 kilogram. The design specifications include a 3 sigma pointing accuracy <0.01 deg, maximum torque > 10 mNm along each axis, momentum storage >24 mNms along each axis, 0.4 W typical power need, 1.2 W peak power need a max torque. The proposed attitude control subsystem uses miniaturized Control Moment Gyroscopes. CMGs, which have been used for decades for large agile high-performance spacecraft, are advantageous versus reaction wheels for having a higher torque/power and torque/volume ratio. The deliverables include a fully functional engineering development unit (EDU) at scale 1:1 of the attitude control subsystem, performance tests and control software. The EDU is considered to be a prototype for a flight unit.

The proposed research is intended to contribute to the following three functional capabilities among the NRO priorities, by enabling the development of new spacecraft concepts (as Tinyscope): Persistent Surveillance, Monitor Known Threats, Innovation Capabilities.

AUTONOMOUS GUIDANCE AND CONTROL OF SPACECRAFT APPROACHING A TUMBLING OBJECT AND AGILE NANOSATELLITE ATTITUDE CONTROL

Marcello Romano, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: AFRL

OBJECTIVE: The objective of this research is to perform a preliminary investigation on dynamic modeling and autonomous guidance/control algorithms for the close approach of a chaser spacecraft to an uncooperative tumbling Resident Space Object (RSO) of interest.
ANALYSIS, SIMULATION AND LAB EXPERIMENTATION OF GUIDANCE AND CONTROL OF A SPACECRAFT WITH ROBOTIC MANIPULATORS FOR PHYSICAL INTERACTION WITH A RESIDENT SPACE OBJECT

Marcello Romano, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NRO

OBJECTIVE: This is a proposal to investigate the Dynamics, Guidance and Control of a spacecraft equipped with one or multiple robotic manipulators for the physical interaction with a Resident Space Object. An innovative space asset of this kind may enable several critical missions including, for instance, servicing and defensive counter-measures in a mother-daughter spacecraft scenario, and on-orbit assembly of larger system starting from modular units. Two main possible approaches for the Guidance and Control of such a system will be studied: 1) an autonomous control approach based on optimal control and non-linear control theories, 2) a hybrid autonomous/tele-operation approach, which may be feasible and preferable, in particular, for low-earth-orbit operations.

The proposed study will involve an original combination of analytical-numerical research together with experimental testing on a floating spacecraft simulator test bed (existing spacecraft simulators will be modified with the addition of small on-board manipulators). The proposed research contributes to the education of the NPS students officers (of both the Space Systems Engineering and Space Systems Operations Curricula): four students are currently in Dr. Romano’s team, while three students recently graduated. The proposed research is intended to significantly contribute to the following Key Functional proposed research is intended to significantly contribute to the following Key Functional Capabilities, among the NRO priorities: Monitor Known Threats, Innovative Capabilities.

PROTOTYPE FLIGHT UNIT OF AN AGILE NANOSATELLITE ATTITUDE CONTROL SYSTEM: DEVELOPMENT, TESTING, AND INTEGRATION WITH AN EXPERIMENTAL NANOSATELLITE

Marcello Romano, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: AFRL

OBJECTIVE: A prototype flight unit of a novel nanosat attitude control system based on Control Moment Gyroscopes will be developed as part of this proposal. The preliminary design of this system has already been developed by Dr. Romano and his team. This new attitude control system will be first tested in the lab by using a new three axis simulator test-rig; then, flight testing will be conducted on-board the nanosat mission SCATT++, which is under development at NPS and will be launched on-board of the Space Shuttle at the end of 2010. The proposed attitude control system consists of four miniaturized single gimbal Control Moment Gyroscopes. The system is entirely contained in the volume of less than 1 liter and has a total mass of less than 1 kilogram. Each CMG consist of a flywheel, actuated by a brushless DC motor. The flywheel is encased in a gimbal structure. A second bushless DC motor with integrated harmonic drive gear allows the gimbal and flywheel to rotate about an axis normal to the rotation axis of the flywheel. Slip rings are used for electrical connection of the flywheel DC motor. The gimbal motor case is rigidly connected to the spacecraft. A non-contact magnetic encoder is used to accurately measure the angular position of the gimbal with respect to the spacecraft.

SPACE SITUATIONAL AWARENESS CUBESAT BUS

Marcello Romano, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: LLNL

OBJECTIVE: Investigation of the attitude control of a nanosatellite for Space Situational Awareness
MECHANICAL AND AEROSPACE ENGINEERING

TINYSCOPE, PRELIMINARY INVESTIGATION ON VERY SMALL THREE-AXIS STABILIZED SPACECRAFT FOR EARTH IMAGING APPLICATIONS FROM LEO

Marcello Romano, Associate Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NRO

OBJECTIVE: The possible use of tiny three-axis stabilized spacecraft for Earth imaging applications is proposed.

A NEW APPROACH FOR FAST WAVEFRONT RECONSTRUCTION

Isaac Michael Ross, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NRO

OBJECTIVE: Fast and accurate wavefront reconstruction is a major technical challenge in adaptive optics. Based on some preliminary research carried out at NPS, we propose a pseudospectral approach to wavefront reconstruction that holds the potential for significantly enhancing Zernike approximation. If successful, the results of this project will have a ripple effect in considerably enhancing image quality in segmented mirror telescopes.

CMG EXPERIMENTS

Isaac Michael Ross, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: SAF

OBJECTIVE: The objective of this proposal is to experiment advanced CMG maneuvers at NPS and other facilities. In addition CMG design studies will be supported for future systems.

FUEL EFFICIENT AND EMERGENCY RETURN TRAJECTORIES FOR MOON-EARTH TRANSFERS VIA PRACTICAL SINGULAR BURNS AND ACCESSORY ENGINES

Isaac Michael Ross, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NASA

OBJECTIVE: The objective of this proposal is to determine a practical implementation of a fuel-efficient singular burn for Moon-Earth transfer using some combination of the main and accessory engines. A complementary problem is to design an emergency return trajectory using the accessory engines alone.

MINIMUM FUEL RELATIVE MOTION TRAJECTORIES NEAR AN UNCOOPERATIVE TARGET

Isaac Michael Ross, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: NRO

OBJECTIVE: Classified. The unclassified objective of this proposal is to develop relative orbits and techniques for placing one spacecraft in relative orbit around another spacecraft where the latter is a non-cooperative satellite. This is a continuation of a previously funded outreach project.
OBJECTIVE: Restricted.

ROBOTIC ARM LABORATORY
Isaac Michael Ross, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: SAF/FMBIB-AFOY

OBJECTIVE: The objective of this proposal is to continue to develop the robotic arm laboratory at NPS to explore advanced control methods for path planning and collision avoidance of multi-link robotic arms.

SPACERCAFT AGILITY
Isaac Michael Ross, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: SAF

OBJECTIVE: The objective of this proposal is to analyze spacecraft agility. In addition CMG design studies will be supported for future systems.

SPACERCAFT EXPERIMENTS
Isaac Michael Ross, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: SAF/FMBIB

OBJECTIVE: The objective of this proposal is to experiment spacecraft maneuvers at various facilities. In addition CMG design studies will be supported for future systems.

TALON DARK MIRROR
Isaac Michael Ross, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Space Innovation and Development Center

OBJECTIVE: The objective of this proposal is to implement and experiment advanced CMG maneuvers at NPS’ DARK MIRROR Laboratory. The implementation and experimentation will be done along a spiral plan. Additionally technical support will be provide to the mission partners.
OBJECTIVE: The objective of the Naval Space Systems Engineering and Acquisition (SSEA) Chair is to promote and guide a focused instructional and research program in space systems engineering and acquisition at the Naval Postgraduate School (NPS) to support the design, development, integration, test, launch and on-orbit sustainment of naval space systems.

SUMMARY: The roles and responsibilities governing the Naval SSEA Chair are defined in a Memorandum of Agreement (MOA) signed by the President, Naval Postgraduate School and the Program Executive Officer for Space Systems. Annual proposal. Tasks as detailed in the MOA and annual proposal include, but are not limited to the following:

1. Promote collaboration between PEO SS and the NPS Space Systems Program through seminars, course development, sustainment and instruction, faculty and student research activities and advising/consulting. This task includes, but is not limited to the following activities:
2. Represent and promote Navy and NPS interests in the Space Acquisition and Integration Group (SAIG), Joint Space Academic Group (JSAG) and Space Professional Working Group (SPWG).
3. Monitor activities and initiatives of PEO Space Systems, appropriate SPAWAR components and the Navy Space Cross Functional Team, to ensure the NPS Space Systems programs is kept up to date on current Navy Space activities.

DOCUMENTATION:


CASE STUDY OF A NATIONAL SECURITY SPACE PROGRAM

OBJECTIVE: The objective of this project was to develop a case study of the program management and systems engineering practices employed by a major National Security Space (NSS) acquisition program. Case studies facilitate learning by emphasizing the long-term consequences of systems engineering and programmatic decisions on cost, schedule, and operational effectiveness of major programs. The proposed effort supported the thesis research of a Space Systems Operations student, and the resultant report is being used to supplement learning in the NPS Space Systems curricula and National Security Space (NSS) acquisition and systems engineering education programs.

SUMMARY: This project investigated and analyzed the systems engineering and program management practices employed during the execution of a recent National Security Space Program. The program examined was jointly selected by the sponsor and principal investigator. The participating student traveled to various sites to conduct interviews and perform research on the program to determine how the systems engineering and program management practices employed on the program contributed to its success or failure. The project produced a case study of the selected program using a framework developed for previous systems engineering case studies by George Friedman, Department of Industrial and Systems Engineering, University of Southern California and Andrew P. Sage, Department of Systems Engineering and Operations Research, George Mason University. The Friedman-Sage framework decomposes a case into contractor, government and shared responsibilities applied to areas of systems engineering and program management including Requirements Definition and Management, Systems Architecture Development, System/Subsystem Design, Validation/Verification, Risk Management, Systems Integration and Interfaces and System and Program Management.
PRESENTATIONS:


THESES DIRECTED:


PAYLOAD DERIVED POSITION ACQUISITION SYSTEM FOR PARACHUTE RECOVERY SYSTEMS
Oleg A. Yakimenko, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: Air Combat and Soldier Systems Directorate

OBJECTIVE: To develop, test and support novel software allowing obtaining inertial coordinates and an attitude of a test article during the entire trajectory from aircraft exit to ground impact based on the IMU data provided initialized at deployment by an aircraft.

SITUATIONAL AWARENESS IN URBAN AREAS
Oleg A. Yakimenko, Professor
Department of Mechanical and Aerospace Engineering
Sponsor: National University of Singapore

OBJECTIVE: The project is a joint effort between NUS and NPS in the field of Situational Awareness in Urban Areas. Researchers will explore the cooperative use of multiple air and ground platforms for robust monitoring of specific locations in an urban area. The project will leverage on the cooperative algorithm design capability in NUS and the hardware expertise and test facilities in NPS.

The main objectives are:

- Design a cooperative algorithm for air and ground platforms to monitor specific features of an urban landscape. The algorithm will be designed to be robust to camera failure, platform positioning and trajectory errors.
- Concept demonstration at Camp Roberts near NPS using actual platforms from the NPS UAV fleet with participation from our MDTS/graduate students.
DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

2010
Faculty Publications and Presentations


G. Boyarko, O. Yakimenko, M. Romano, Optimal Rendezvous Trajectories of a Controlled Spacecraft and a Tumbling Object, *AIAA Journal of Guidance, Control, and Dynamics*. Accepted for publication. Accepted for publication. To appear.


MECHANICAL AND AEROSPACE ENGINEERING


S. D. Faulkner and Y. W. Kwon, “Fracture Toughness of Composite Joints with Carbon Nanotube Reinforcement”, ASME Journal of Pressure Vessel Technology, Accepted for publication. (DOI: 10.1115/1.4002676)


Y. W. Kwon, “Study of Fluid Effects on Dynamics of Composite Structures”, ASME Journal of Pressure Vessel Technology, Accepted for publication. (DOI: 10.1115/1.4002377)


Y. W. Kwon, W. A. Schultz, D. C. Loup, and E. A. Rasmussen, “Experimental Study of Mode II Fracture of Hybrid Composite and metal-Wire Joints”, ASME Journal of Pressure Vessel Technology, Accepted for publication. (DOI: 10.1115/1.4002677)

Y. W. Kwon and K. S. Tan, “Failure of Ductile Materials Subject to Varying Strain Rates”, ASME Journal of Pressure Vessel Technology. (DOI: 10.1115/1.4002054)


**CONTRIBUTIONS TO BOOKS**


**CONFERENCE PUBLICATIONS & PROCEEDINGS**


MECHANICAL AND AEROSPACE ENGINEERING


Z. Li, N. Hovakimyan, V. Dobrokhodov, and I. Kaminer, “Vision-based Target Tracking and Motion Estimation Using a Small UAV”, *49th IEEE Conference on Decision and Control*, December 15-17, 2010, Atlanta, GA, USA, CDC-2010-2036


MECHANICAL AND AEROSPACE ENGINEERING


CONFERENCE PRESENTATIONS


TECHNICAL REPORTS


RESEARCH REPORTS


WHITE PAPERS


I. Dutta. Electric Current Induced Liquid Metal Flow and Metallic Conformal Coating of Inductive Templates, Navy Case No. 2008001.


M. Romano and P. Oppenheimer. Agile Attitude Control System for Small Spacecraft, Navy Case No. 20090004.
DEPARTMENT OF
METEOROLOGY

PHILLIP A. DURKEE
CHAIRMAN
OMETEOLOGY

OVERVIEW:
Since its arrival in Monterey from the U.S. Naval Academy in 1948, the Department of Meteorology has continued to provide graduate-level instruction in the science of meteorology and its application in support of military operations. To maintain expertise and provide support to student theses, the faculty performs research in the Navy and Air Force relevant areas of synoptic and dynamic meteorology, remote sensing, numerical modeling, tropical meteorology, boundary layer meteorology, and environmental effects.

In 1959, the Naval Oceanographic Command moved its numerical prediction center to Monterey as a new operational command - Fleet Numerical Weather Central (now the Fleet Numerical Meteorology and Oceanography Center-FNMOC). The Navy chose to move FNMOC to Monterey to take advantage of the presence of NPS and its large assembly of science faculty, who are intimately familiar with Navy operational problems in meteorology and oceanography. For similar reasons, the Navy Environmental Prediction Research Facility (now the Marine Meteorology Division of the Naval Research Laboratory (NRL) Monterey) moved to Monterey in 1971. This further augmentation of meteorological and oceanographic scientists in Monterey has made it the center of naval environmental science.

In 2003, under an agreement between the Air Force and Navy Secretaries, Air Force Weather officers returned to NPS and now receive an MS or PhD in Meteorology. These officers have reinvigorated classrooms and laboratories with new perspectives and ideas for improving weather support of DoD missions.

The Department of Meteorology serves a broad spectrum of research interests supported by ONR, NSF, NASA, NOAA, NGA, and other DoD and civilian national research sponsors.

CURRICULA SERVED:

- Meteorology
- Meteorology and Physical Oceanography
- Electronic Warfare

DEGREES GRANTED:

- Master of Science in Meteorology
- Master of Science in Meteorology and Physical Oceanography
- Doctor of Philosophy in Meteorology

RESEARCH THRUSTS:

Synoptic, Mesoscale, and Coastal Meteorology:
Distinguished Professor Russell Elsberry, Professor Wendell Nuss, Professor Patrick A. Harr, Professor Michael Montgomery, Assistant Professor Richard Moore, Assistant Professor Karl Pfeiffer (Military Faculty), and Research Associate Michael Bell

Numerical Weather Prediction (NWP):
Associate Professor Joshua Hacker, Assistant Professor Rebecca Stone (Military Faculty), and Research Associate Hway-Jen Chen

Environmental Analysis and Visualization:
Research Associate Mary Jordan

Air-Sea Interactions:
Professor Qing Wang, Research Professor Kenneth Davidson, Research Associate Paul A. Frederickson, Research Associate Professor Peter Guest, and Assistant Professor Rebecca Stone (Military Faculty)

Satellite and Ground-Based Remote Sensing:
Professor Philip Durkee, Research Associate Kurt Nielsen, and Research Associate Michael Bell
Tropical Meteorology:
Distinguished Professor Russell Elsberry, Distinguished Professor Chih-Pei Chang, Professor Patrick A. Harr, Professor Michael Montgomery, Research Associate Hway-Jen Chen, Research Associate Michael Bell, and Research Associate Stephanie Zick

Tropical Cyclone Motion:
Professor Patrick A. Harr, Professor Michael Montgomery, Research Associate Michael Bell, and Research Associate Stephanie Zick

Boundary Layer Meteorology:
Research Professor Kenneth Davidson, Professor Qing Wang and Research Associate Professor Peter Guest

Climate Dynamics:
Distinguished Professor Chih-Pei Chang, Research Associate Hway-Jen Chen, Research Associate Professor Tom Murphree

Atmospheric Factors in EM/EO Propagation:
Professor Kenneth Davidson, Research Associate Professor Peter Guest, and Research Associate Paul Frederickson

Polar Meteorology:
Research Associate Professor Peter Guest

RESEARCH FACILITIES:

George J. Haltiner Laboratory for Weather Analysis and Prediction:
The Haltiner Lab is designed to support complex data acquisition, analysis, and decision-making capabilities for a variety of environmental problems and DoD applications.

IDEA Laboratory:
The Interactive Digital Environmental Analysis Laboratory has Silicon Graphics workstations specifically designed and funded for instruction. The lab computers are used to analyze and display real-time satellite data and numerical model output.

RSL:
The Remote Sensing Laboratory operates a SeaSpace NOAA satellite receiver that collects and processes environmental data in support of atmosphere and ocean analysis.

SAFL:
The Synoptic Analysis and Forecasting Laboratory uses a suite of computers and advanced display devices to provide local and global, real-time, meteorological data and numerical products for instruction and research in operational weather forecasting.

ABLML:
The Atmospheric Boundary Layer Measurements Laboratory provides information from a special, nearcoastal, observation site at Fort Ord in support of instruction and research in boundary layer and coastal meteorology. Present instrumentation includes two radar wind profilers, an automatic surface weather station, and rawinsonde systems.
The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Meteorology is provided below:
**METEOROLOGY**

Philip A. Durkee  
Chairman & Professor  
831-656-2516  
durkee@nps.edu

Chih-Pei Chang  
Distinguished Professor  
831-656-2840  
cpchang@nps.edu

Kenneth L. Davidson  
Research Professor  
831-656-2309  
kldavids@nps.edu

F. Anthony Eckel  
MAJ, USAF  
Assistant Professor  
831-656-3430  
faneckel@nps.edu

Russell L. Elsberry  
Research Professor  
831-656-2373  
elsberry@nps.edu

Peter S. Guest  
Research Associate Professor  
831-656-2451  
pguest@nps.edu

Joshua Hacker  
Associate Professor  
831-656-2722  
jphacker@nps.edu

Robert L. Haney  
Professor Emeritus  
831-656-7571  
rjhaney@nps.edu

Patrick A. Harr  
Professor  
831-656-3787  
paharr@nps.edu

Scott Katz  
CAPT, USN  
Military Faculty  
831-656-2682  
sdkatz@nps.edu

Larry Mahrt  
Research Professor  
831-656-2296  
mtmontgo@nps.edu

Michael T. Montgomery  
Professor  
831-656-1041  
rwmoor1@nps.edu

Richard Moore  
Assistant Professor  
831-656-2723  
murphree@nps.edu

Wendell A. Nuss  
Professor  
831-656-2308  
nuss@nps.edu

Karl D. Pfeiffer  
LTCOL, USAF  
Assistant Professor  
831-656-3635  
kdpfeiff@nps.edu

Rebecca E. Stone  
CDR, USN  
Program Officer for METOC  
831-656-3269  
restone@nps.edu

Vicki Taber  
LCDR, USN  
Lecturer  
831-656-7712  
vltaber@nps.edu

Qing Wang  
Professor  
831-656-7716  
qwang@nps.edu

Carlyle H. Wash  
Professor Emeritus  
831-656-7776  
wash@nps.edu

Forrest R. Williams  
Senior Lecturer Emeritus  
831-656-3274  
fwilliams@nps.edu

Roger T. Williams  
Professor Emeritus  
831-656-2296  
rtwillia@nps.edu
METEOROLOGY

MULTI-SCALE OBSERVATIONAL ANALYSES WITHIN THE MARSUPIAL POUCH OF PRE-DEPRESSION TROPICAL DISTURBANCES
Michael M. Bell, Research Assistant Professor
Michael T. Montgomery, Professor
Department of Meteorology
Sponsor: National Science Foundation

OBJECTIVE: The prediction and understanding of tropical cyclogenesis remains one of the most challenging aspects of atmospheric science. A multitude of tropical disturbances emerge from the West African coast every year near the Cape Verde islands, but only a few of these develop into tropical depressions, storms, or hurricanes. To further our understanding of these potentially high impact events, the PRE-Depression Investigation of Cloud-systems in the Tropics (PREDICT) field experiment will deploy the NCAR G-V aircraft in the Atlantic basin in the heart of hurricane season to explore multi-scale interactions in tropical wave-like disturbances that promote or hinder the development of a tropical depression vortex.

Our research in with the PREDICT project will focus on the synthesis, analysis and interpretation of the analysis products and the observational dataset obtained by the G-V, NOAA and potential NASA aircraft. The deep tropospheric dropwindsonde observations, radar data, and in situ data at multiple flight levels offer a unique and unprecedented dataset for examining the development and growth of tropical cyclone precursors. By combining data from multiple instruments and platforms, mesoscale and synoptic scale composites of vorticity, divergence, moisture, and even potential vorticity, will be used to diagnose the structure and evolution of these disturbances in the Atlantic. Multi-scale analyses of the dataset will be accomplished through the use of objective and variational techniques that allow for quantitative study of the structures and budgets of key quantities related to the primary ‘marsupial’ hypotheses. Multi-dimensional composites of temperature and humidity have so far been limited or non-existent in most pre-depression disturbances, but the G-V aircraft provides an ideal platform for obtaining the measurements needed to construct these syntheses. The high-resolution vertical structure obtained from the dropsondes and microwave temperature profiler (MTP) complements the significant horizontal coverage of in situ data from the Gulfstream aircraft, allowing for unique compositing opportunities. The cloud and precipitation radar data from the G-V and NOAA aircraft will provide unprecedented possibilities for basic research into the wave-to-vortex transformation process. This research team will also compare and contrast these results with those obtained during the western Pacific T-PARC / TCS-08 field campaign, RAINEX, and BAMEX.

CONVECTION AND SHEAR FLOW IN TC DEVELOPMENT AND INTENSIFICATION
Chih-Pei Chang, Distinguished Professor
Department of Meteorology
Sponsor: Naval Research Laboratory Marine Meteorology Division

OBJECTIVE: To participate in TCS08 field program to study convection and vorticity generations in the vortex environment that may lead to the development and intensification of tropical cyclones.

REGIONAL NUMERICAL WEATHER PREDICTION FOR AEROSOL MODELING
Chih-Pei Chang, Distinguished Professor
Department of Meteorology
Sponsor: Naval Research Laboratory Marine Meteorology Division

OBJECTIVE: The objective of this research is to enhance Naval Research Laboratory’s (NRL) COAMPS-OS® (Coupled Ocean/Atmosphere Mesoscale Prediction System) numerical weather prediction model in order to provide new and emerging analysis and forecast capabilities to Fleet Numerical Meteorology and Oceanography Center (FNMOC) that address small-scale (meso-and micro-scale) atmospheric and coupled (atmospheric-land-ocean-wave).
OBJECTIVE: For decades satellite analysis techniques have primarily focused on single satellite systems to provide retrievals of environmental parameters (e.g.; AVHRR MCSST, TOVS temperature and water vapor profiles, SeaWiFS ocean optical analysis, etc.). With the development of the NPOESS constellation, in combination with METOP and specialty research satellites, the era when environmental analysis will not be constrained to a single satellite system is approaching. A point on the earth will be observed by numerous polar and geostationary satellites with high spatial, spectral, and temporal resolution. Polar orbiters will provide the best spatial and spectral resolution while the geostationary satellites will provide the best temporal information. Analysis techniques that exploit the synergies from the full set of satellite measurements will be able to provide a more comprehensive analysis over both space and time. This project will explore and develop methods to combine information from multiple satellite platforms into a comprehensive satellite analysis scheme. Each satellite data collection opportunity provides a measure of radiance at designed wavelengths, spatial resolutions, angles, and at a specific time. The measurement set from each satellite is unique in either its spectral, spatial, and/or temporal capabilities. A comprehensive satellite analysis will combine the unique measurements from individual satellites into a regional domain where the full set of observations will be used, as appropriate, to develop a regional analysis.

STATE-SPACE ANALYSIS OF MODEL ERROR: A PROBABILISTIC PARAMETER ESTIMATION FRAMEWORK WITH SPACIAL ANALYSIS OF VARIANCE

OBJECTIVE: The structural differences between a numerical model and a true system embody one form of model inadequacy, and are difficult to ascertain in the presence of multiple sources of error. Numerical weather prediction (NWP) is subject to temporally and spatially varying error resulting from both imperfect atmospheric models and the chaotic growth of initial-condition (IC) error. The aim of this proposal is to provide a method that begins to systematically disentangle the model inadequacy signal from the initial condition error signal. This will be achieved through:

1. the characterization of existing model-to-model differences via novel spatial Analysis of Variance (ANOVA) methods. This will inform
2. the development of a flexible representation for the various spatial and temporal scales of model error. This allows for
3. the estimation of parameters in 2. using a probabilistic approach to data assimilation (DA), namely the Ensemble Kalman Filter. Coming full circle, we have
4. the determination of whether incorporation of estimated error structure in 3. improves short-term forecasts, again using spatial ANOVA methods, this time within a formal statistical testing framework.

We propose to carry out a series of tests for the usefulness of our estimation framework by using two models alternately to define truth and a deficient model in a DA context. Disentangling IC and model error has proven a difficult task for decades, but it is a necessary prerequisite for unambiguously identifying irreducible uncertainty and objectively addressing deficiencies in both models and ICs. Ultimately, observations must be used to characterize the signature of model deficiencies in the prognostic model space. However, we do not feel the science is developed to a degree that enables any experiment using real data and real models to unambiguously identify model inadequacies. Therefore, we focus on the development of methods for identifying structural deficiencies. The use of synthetic observations in this case both avoids the extensive tuning required to produce an operational DA system, as well as providing a known “truth” with which we can clearly separate IC signal from model inadequacies.

To extract these model inadequacies, we look to novel statistical approaches that are Bayesian and spatial extensions to
traditional ANOVA methods. Tests constructed within ensemble DA systems can then be used to determine whether the model inadequacy signals identified can be used to understand the nature and source of structural model inadequacies, and to design better models. We seek to quantitatively and probabilistically describe model error; characteristics of the model error may suggest whether the errors are structural. The proposed study is thus a necessary step toward identifying specific structural errors and formalizing their behavior.

**METEOROLOGICAL MEASUREMENTS IN SUPPORT OF A PASSIVE IMAGING SYSTEM FOR MEASURING ATMOSPHERIC SCATTERING IN A MARINE ENVIRONMENT**

Paul A. Frederickson, Research Associate  
Department of Meteorology  
Sponsor: High Energy Joint Technology Office

**OBJECTIVE:** To obtain atmospheric and sea surface data from an instrumented land met-station and from a buoy off San Diego concurrently with multispectral scattering imager measurements obtained by MPL/SIO, for the purposes of analyzing, and supporting analyses by MPL, of the environmental impacts on air-sea horizon contrasts and air radiance gradients.

**METEOROLOGICAL SUPPORT FOR A PASSIVE IMAGING SYSTEM**

Paul A. Frederickson, Research Associate  
Department of Meteorology  
Sponsor: Air Force Research Laboratory

**OBJECTIVE:** To obtain atmospheric and sea surface data from an instrumented shore met-station and ceilometer deployed on Pt. Lorna, San Diego, and a research ‘flux’ buoy deployed offshore concurrently with multispectral scattering imager measurements obtained by MPL/SIO for the purposes of supporting the analyses by MPL of the environmental impacts on air-sea horizon contrasts and air radiance gradients.

**NEXT GENERATION EM/EO PERFORMANCE PREDICTION SYSTEMS**

Paul A. Frederickson, Research Associate  
Department of Meteorology  
Sponsor: SPAWAR

**OBJECTIVE:** To determine, quantity and rank the deficiencies and problem areas in the entire COAMPS-based EM propagation prediction system in the order of priority in which they need to be improved to enable high-fidelity predictions, and to identify and recommend solutions to the deficiencies as far as possible.

**EXTENDING THE NSLOT MODEL WAVELENGTH RANGE**

Paul A. Frederickson, Research Associate  
Department of Meteorology  
Sponsor: SPAWAR

**OBJECTIVE:** To determine the best methods for extending the wavelength validity range of the NSLOT model A and B coefficients to cover the missing wavelength region of 3 to 7.8 μm.
METEOROLOGY

ATMOSPHERIC PERFORMANCE SURFACES FOR SUBMARINE PERISCOPE DETECTION
Peter S. Guest, Research Associate Professor
Paul A. Frederickson, Research Associate
Department of Meteorology
Sponsor: SPAWAR

OBJECTIVE: The overall objective is to produce and validate Atmospheric Performance Surfaces (ATPS). The FY 2009 main objectives are (1) provide forecasts of submarine periscope detection ranges based on COAMPS predictions and (2) validate the ATPS produced for the 2008 Rim of the Pacific (RIMPAC) exercise.

STATE-SPACE ANALYSIS OF MODEL ERROR: A PROBABILISTIC PARAMETER ESTIMATION FRAMEWORK WITH SPATIAL ANALYSIS OF VARIANCE
Joshua Hacker, Associate Professor
Department of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: The structural differences between a numerical model and a true system are difficult to ascertain in the presence of multiple sources of error. Numerical weather prediction (NWP) is subject to temporally and spatially varying error, resulting from both imperfect atmospheric models and the chaotic growth of initial-condition (IC) error. The aim of this proposal is to provide a method that begins to systematically disentangle the model inadequacy signal from the initial condition error signal. We propose a comprehensive effort that uses state-of-the-science estimation methods in data assimilation (DA) and statistical modeling, including: (1) the characterization of existing model-to-model differences via novel spatial ANOVA methods; (2) the development of a flexible representation for the various spatial and temporal scales of model error; (3) the estimation of parameters in representing those scales using a probabilistic approach to DA, namely the Ensemble Kalman Filter; and (4) the determination of whether incorporation of estimated error structure in improves short-term forecasts, again using spatial ANOVA methods, this time within a formal testing framework. The research focuses on model error in boundary layer winds, and uses both the COAMPSTM and WRF model.

Primary outcomes of this research include a new method, or procedure, for characterizing distributions of scales of model spatial and temporal error. We propose a series of tests of this method, using two models alternately to define truth and a deficient model in a DA context. This avoids the extensive tuning required to produce an operational DA system using real observations, as well as providing a known “truth” by which we can clearly separate model signal from model inadequacies. Upon completion of the proposed research, the method will be ready for testing with real observations in a suitable observing network, with the goal of characterizing errors compared to the atmospheric system. A secondary outcome is demonstration of a new method for quantifying inter-and intra-model variability for mesoscale ensemble-prediction systems (EPSs), which may improve EPS design. In addition, we expect that the predictions generated to carry out this research will prove valuable for further research and education about model error.

The bulk of DoN day-to-day operations rely on accurate predictions of winds, seas, ceiling, and visibility. The focus of the proposed work is to identify inadequacies associated with the modeled boundary layer. Any discoveries that enable the improvement of boundary layer modeling will ultimately have a positive impact on Navy warfighters.
METEOROLOGY

EXAMINATIONS OF THE SPREAD IN ENSEMBLE FORECASTS OF TROPICAL CYCLONE TRACK AND INTENSITY AND THEIR RELATIONSHIPS TO FORECAST ACCURACY
Patrick A. Harr, Associate Professor
Department of Meteorology
Sponsor: 45th USAF Weather Squadron

OBJECTIVE: The proposal objective is to examine the spread versus skill relationship among forecasts of tropical cyclone track and intensity produced by operational numerical forecast models. Statistical techniques are used to establish the distribution of ensemble spread and forecast errors. These distributions are then used in a multi-stage approach for base distributions in the Tropical Cyclone Wind Probability Model that is used in operations at the National Hurricane Center.

EXTRATROPICAL TRANSITION OF TROPICAL CYCLONES OVER THE WESTERN NORTH PACIFIC: PHYSICAL CHARACTERISTICS, DOWNSTREAM IMPACTS AND PREDICTABILITY
Patrick A. Harr, Associate Professor
Russell L. Eslberry, Research Professor
Department of Meteorology
Sponsor: National Science Foundation

OBJECTIVE: In this proposal, the characteristic structure of an ET event is placed in a framework of three regions defined as; 1) the decaying tropical cyclone core, 2) the tropical cyclone-midlatitude interface, and 3) the midlatitude impact region. Specific objectives include:
1. Increase understanding of the dependence of the occurrence, amplitude, and extent of the downstream response to an ET event on the character of the interaction between the decaying tropical cyclone and the midlatitude circulation into which it is moving;
2. Define the relative roles of the decaying tropical cyclone characteristics and the midlatitude flow characteristics in downstream development with an ET event;
3. Assess the impact on predictability of downstream development due to improved representation of the structural characteristics associated with an ET event.

ITOP 2010 FIELD EXPERIMENT
Patrick A. Harr, Associate Professor
Russell L. Eslberry, Research Professor
Department of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: The long-term goal of this project is to increase understanding of the interaction between the ocean and tropical cyclones over the tropical western North Pacific. Tropical cyclones produce a three-dimensional response of the underlying ocean that includes surface currents, upwelling of the thermocline, and formation of a cold wake. These responses then impact the structure and intensity of the tropical cyclone. Specific objectives are to provide leadership to the ITOP field campaign in support of direct measurements of the ocean and tropical cyclone characteristics.
OBJECTIVE: This proposal has two primary components: (i) Improvement in understanding of the formation of tropical cyclones through a comprehensive observational and numerical modeling study focusing on the mesoscale contributions within specific synoptic-scale circulations in the western North Pacific; (ii) Improvement in understanding how the outer wind structure is related to the conditions during the formation stage and then are modified via external forcing mechanisms using both TCS08 observations and numerical modeling.

A MULTISCALE STUDY OF TROPICAL CYCLONE FORMATION, STRUCTURE CHANGE, AND PREDICTABILITY IN THE WESTERN NORTH PACIFIC REGION AND TCS08 EXPERIMENT SUPPORT
Michael T. Montgomery, Professor
Department of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: The objectives of this research are twofold: To develop an improved observational, theoretical and numerical weather prediction understanding of the role of bottom up and top down mesoscale mechanisms in the tropical cyclone formation process in the west-Pac region; To better understand and quantify the role of vortex-intrinsic processes in the predictability and structure change of west-Pac tropical cyclones.

FURTHER ANALYSIS OF TROPICAL CYCLONE FORMATION IN THE WESTERN NORTH PACIFIC REGION AS PART OF THE TCS08 DRI
Michael T. Montgomery, Professor
Department of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: The objectives of this research are twofold: To develop an improved observational, theoretical and numerical weather prediction understanding of the role of bottom up and top down mesoscale mechanisms in the tropical cyclone formation process in the west-Pac region; To better understand and quantify the role of vortex-
intrinsic processes in the predictability and structure change of west-Pac tropical cyclones.

RESEARCH AND DEVELOPMENT OF NEW THEORIES ON HURRICANE INTENSITY AND STRUCTURE CHANGE
Michael T. Montgomery, Professor
Department of Meteorology
Sponsor: NOAA

OBJECTIVE: This MOA between the Office of Oceanic and Atmospheric Research (OAR) Atlantic Oceanographic and Meteorological Laboratory (AOML), National Oceanic and Atmospheric Administration (NOAA), United States Department of Commerce (DOC), and the U. S. Naval Postgraduate School (NPS), provides a framework through AOML NOAA can exchange technical expertise, training, and scientific exchange activities with AIT in areas of mutual interest in the fields of meteorological and oceanographic research.

This memorandum is intended to support fruitful research collaboration between Professor Michael T. Montgomery of the U.S. Naval Postgraduate School (NPS) and NOAA's Atlantic Oceanographic and Meteorological Laboratory Hurricane Research Division (HRD). This collaboration will enable the development of new theories and analyses on hurricane dynamics that will aid in better forecasts and warnings of hurricane impacts. The information gained from these research and development efforts will be of mutual benefit to both parties.

ON THE MARSUPIAL THEORY F/TROPICAL CYCLOGENESIS WITHIN TROPICAL WAVE & MONSOON TROUGH ENVIRONMENTS
Michael T. Montgomery, Professor
Department of Meteorology
Sponsor: National Science Foundation

OBJECTIVE: Unavailable.

PRE-DEPRESSION INVESTIGATION OF CLOUD-SYSTEMS IN THE TROPICS (PREDICT)
Michael T. Montgomery, Professor
Department of Meteorology
Sponsor: National Science Foundation

OBJECTIVE: The proposed PRE-Depression Investigation of Cloud-systems in the Tropics (PREDICT) is a focused observational field campaign to investigate both the structure and evolution of tropospheric wave-like disturbances in the tropics and sub-tropics and the subsynoptic- and mesoscale processes operating within the waves that contribute to the formation of tropical depressions in the Western Atlantic sector. This new field project aims to test new scientific hypotheses as part of the “marsupial paradigm” of tropical cyclone formation.
USE OF NASA OBSERVATIONS AND NUMERICAL MODEL SIMULATIONS TO UNDERSTAND THE HURRICANE ‘FUEL’ AND ‘ANTI-FUEL’ PROBLEMS
Michael T. Montgomery, Professor
Department of Meteorology
Sponsor: NASA

OBJECTIVE: The proposed work is directly relevant to NASA’s national objectives to study the Earth system from space, develop new space-based and related capabilities, and improve scientific understanding of the a problem of national importance, specifically the formation and evolution of hurricanes in the Atlantic Ocean basin.

WAVE DYNAMICS IN TROPICAL CYCLONES
Michael T. Montgomery, Professor
Department of Meteorology
Sponsor: National Science Foundation

OBJECTIVE: Unavailable.

A MOIST PATHWAY TO EXTRATROPICAL CYCLOGENESIS AND ITS IMPLICATIONS FOR HIGH IMPACT WEATHER AND ATMOSPHERIC PREDICTABILITY
Michael T. Montgomery, Professor
Richard W. Moore, Research Assistant Professor
Department of Meteorology
Sponsor: National Science Foundation

OBJECTIVE: Recent theoretical and observational studies have shown that, in the presence of baroclinicity, a cyclonic vortex from and intensify via the synergistic interaction of cloud diabatic processes and the flow field associated with the cyclone itself. The resulting disturbance, termed a diabatic Rossby vortex (DRV), has been linked to a wide variety of atmospheric phenomena, all of which can spawn severe weather. It is therefore a great concern that these diabatically-dominated disturbances exhibit an alarming lack of predictability.

AUTOMATION OF OCEAN PRODUCT METRICS
Tom Murphree, Research Associate Professor
Department of Meteorology
Sponsor: PEO C4I

OBJECTIVE: Develop and apply METOC metrics data collection methods, databases, data analysis, modeling, and metrics computation systems for assessment and improvement of METOC ocean products.

CLIMATE DIAGNOSTICS AND PREDICTION WORKSHOP
Tom Murphree, Research Associate Professor
Department of Meteorology
Sponsor: Commander, Naval Meteorology and Oceanography Command (CMNOC)

OBJECTIVE: The objective of this project is to plan, conduct, and report on the 34th Annual Climate Diagnostics and Prediction Workshop in Monterey, CA, on 26-30 October 2009. This workshop directly supports the goals of CMNOC by: (a) promoting the development of improved long range support for warfighters by improving the capabilities of CMNOC to conduct advanced analysis and forecasting of the climate system (atmosphere, ocean, and land); and (b)
promoting coordination and collaboration between CNMO and related organizations, including NOAA, the civilian research community, and Air Force Weather.

**LIGHTNING LAUNCH COMMIT CRITERIA CLIMATOLOGY (LLCCC)**

Tom Murphree, Research Associate Professor  
Department of Meteorology  
Sponsor: Air Force Weather Agency

**OBJECTIVE:** The objective of this project is to design, develop, and test climatologies of lightning launch commit criteria (LLCC). The climatologies will describe the probability of violating the rules that help mitigate the risk of natural lightning and rocket induced lightning. The climatologies will have high temporal resolution (e.g., sub-daily to daily) and will span all months. The climatologies will be based on observations and reanalysis data (e.g., from NOAA NARR). The climatologies will support mission planning, development of launch forecasts, and assessment of the LLCCs. Potential collaborators include NOAA Climate Prediction Center and 14 WS. We anticipate that NPS graduate students will contribute to this research.

**LONG RANGE FORECASTING SUPPORT**

Tom Murphree, Research Associate Professor  
Department of Meteorology  
Sponsor: Air Force Weather Agency

**OBJECTIVE:** The objective of this project is to design, develop, and test climatologies of lightning launch commit criteria (LLCC). The climatologies will describe the probability of violating the rules that help mitigate the risk of natural lightning and rocket induced lightning. The climatologies will have high temporal resolution (e.g., sub-daily to daily) and will span all months. The climatologies will be based on observations and reanalysis data (e.g., from NOAA NARR). The climatologies will support mission planning, development of launch forecasts, and assessment of the LLCCs. Potential collaborators include NOAA Climate Prediction Center and 14 WS. We anticipate that NPS graduate students will contribute to this research.

**METOC METRICS FOR NAVAL SPECIAL WARFARE**

Tom Murphree, Research Associate Professor  
Department of Meteorology  
Sponsor: SPAWAR

**OBJECTIVE:** Unavailable.
METEOLOGY

METOC METRICS SCORECARD
Tom Murphree, Research Associate Professor
Department of Meteorology
Sponsor: Naval Research Laboratory

OBJECTIVE: The objective of this project is to plan, conduct, implement, and report on a system for quantitatively and objectively assessing: (1) the skill of meteorological and oceanographic (METOC) forecasts and other support products provided to warfighter by the Fleet Numerical Meteorology and Oceanography Center (FNMOC); and (2) the implied impacts of those products on warfighter mission plans and outcomes. This project will support a larger assessment effort being conducted by NRL Monterey. This project will be conducted in close collaboration with NRL Monterey.

SMART CLIMATOLOGY: OPERATIONAL IMPLEMENTATION
Tom Murphree, Research Associate Professor
Department of Meteorology
Sponsor: SPAWAR

OBJECTIVE: The overall objective of this project is to use advanced climate data sets and methods to: (a) improve the METOC support provided to warfighters; and (b) improve warfighter planning and outcomes.

FT ORD WEATHER FORECASTS FOR PRESCRIBED BURNS
Wendell A. Nuss, Professor
Department of Meteorology
Sponsor: U.S. Army Corps of Engineers

OBJECTIVE: The objective of this work is to provide accurate and timely weather forecasts in order to execute the prescribed burn program at Ft Ord. NPS will maintain equipment, web pages, and make daily forecasts to burn personnel to determine optimal burn conditions with minimal smoke impacts.

NEW TOOLS FOR ESTIMATING AND MANAGING AIR QUALITY IN PRESCRIBED BURNS
Wendell A. Nuss, Professor
Department of Meteorology
Sponsor: SERDP - U.S. Army Corps of Engineers

OBJECTIVE: Proposed research will utilize local high resolution observations to examine ways to improve numerical modeling of atmospheric processes that effect smoke dispersion in prescribed burns. NPS will assist in modeling and data gathering for a field experiment in late 2009.

QUANTIFYING SENSIBLE WEATHER FORECAST VARIABILITY
Wendell A. Nuss, Professor
Department of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: The objective of this research is to quantify the sensitivity of COAMPS model generated sensible weather forecasts to synoptic scale uncertainty. Synoptic scale ensemble forecasts will be used to generate COAMPS model mesoscale forecasts from each synoptic scale ensemble member. The mesoscale forecasts will be used to derive sensible weather element forecasts of selected parameters to assess the predictability and sensitivity of the synoptic
METEOROLOGY

scale variance. These experiments will help refine application of mesoscale forecast probabilities in operational decision-making by highlighting their predictability limitations. Tests will also be done to determine whether local observations can reduce the spread of mesoscale forecasts, particularly those sensitive to synoptic variability.

WEATHER FORECASTING FOR FT ORD PRESCRIBED BURNS
Wendell A. Nuss, Professor
Department of Meteorology
Sponsor: U.S. Army Corps of Engineers

OBJECTIVE: The objective of this work is to provide accurate and timely weather forecasts in order to execute the prescribed burn program at Ft Ord. NPS will maintain equipment, web pages, and make daily forecasts to burn personnel to determine optimal burn conditions with minimal smoke impacts.

AIRCRAFT MEASUREMENTS FOR UNDERSTANDING AIR-SEA COUPLING AND IMPROVING COUPLED MODEL PREDICTIONS
Qing Wang, Associate Professor
Department of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: The objective of this proposal is to obtain coordinated measurements in the atmosphere, the ocean, and the air-sea interface for the purpose of coupled model evaluation and improvements.

EVALUATION AND IMPROVEMENT OF HIGH-RESOLUTION MESOSCALE MODELS ON BOUNDARY LAYER SIMULATIONS USING GROUND-BASED OBSERVATIONS
Qing Wang, Associate Professor
Department of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: The specific objectives of the proposed work are:
1. to establish a comprehensive dataset and a set of variable matrix for high-resolution COAMPS evaluation;
2. to investigate new methods for model evaluation taking into considerations the model-observation differences are space and time dependent; and
3. to examine issues related to model physics in high-resolution (~km grid spacing) mesoscale models.

COLLABORATIVE RESEARCH: PHYSICS OF STRATOCUMULUS TOP (POST)
Qing Wang, Associate Professor
Department of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: Unavailable.
METEOROLOGY

SHIPBOARD MEASUREMENTS OF SURFACE FLUX AND NEAR SURFACE PROFILES AND ANALYSIS OF SURFACE FLUX PARAMETERIZATIONS
Qing Wang, Associate Professor
Department of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: The objective is
1. to make shipboard measurements of the surface flux and boundary layer profiles over a broad range of wind and wave conditions and
2. to understand the wave affected marine boundary layers and improve surface flux and boundary layer parameterizations for coupled models on various scales.

UNDERSTANDING AIR-SEA COUPLING PROCESSES AND COUPLED MODEL PREDICTIONS USING GOTEX MEASUREMENTS AND COAMPSINCOM
Qing Wang, Associate Professor
Department of Meteorology
Sponsor: Office of Naval Research

OBJECTIVE: The objectives of the proposed research are
1. explore and test new methods for turbulence flux analyses over inhomogeneous surfaces and generalize the bulk formula
2. understand current coupled COAMPSINCOM model behavior and identify error sources in the coupled model using the improved flux calculations
3. obtain further in-depth understanding of the coupled processes and improve physical parameterizations of the “coupled model.

To achieve these objectives, we plan to
1. calculate turbulence fluxes over heterogeneous surfaces using new methods involving wavelet filtering
2. perform atmospheric COAMPS and COAMPSINCOM simulations for all GOTEX cases and evaluate simulations through model-observation intercomparison with the GOTEX measurements and improved flux calculations
3. perform model sensitivity tests with the COAMPSINCOM simulations and test new surface flux and boundary layer parameterizations in coupled COAMPS in high-wind conditions.
DEPARTMENT OF METEOROLOGY

2010
Faculty Publications and Presentations


CONFERENCE PRESENTATIONS

Michael M. Bell, M. T. Montgomery and K. Emanuel. “Drag and enthalpy coefficients at major hurricane wind speeds”.

Michael M. Bell, and M. T. Montgomery. “Development of pre-depression Hagupit observed during TCS08”.

Galina V. Levina, and M. T. Montgomery “Helical features of tropical cyclogenesis”.


Michael T. Montgomery. Presented science seminar at collaborative meeting with Prof. H. Tan of Vietnamese University of Hanoi, Vietnam, January 4-15


Michael T. Montgomery. Presented summary of planned PREDICT experiment at NASA-GRIP meeting LAX Marriot, January 24-28 LAX, CA

Michael T. Montgomery. Presented summary of planned PREDICT experiment at NOAA Interdepartmental Hurricane Conference, February 28- March 5 Savannah GA


Michael T. Montgomery. Presented several co-authored talks at the 29th Conference on Hurricanes and Tropical Meteorology (hosted by the American Meteorological Society) in Tucson, AZ during 8-14 May.

Michael T. Montgomery. Presented one lead talk and one co-authored talk at the Western Pacific Geophysics Meeting a meeting in Taipei, Taiwan, June 16-26.


472


Michael Riemer, M. T. Montgomery and M. E. Nicholls. “A new paradigm for intensity change of tropical cyclones in vertical wind shear”.

Michael Riemer, and M. T. Montgomery. “Simple kinematic models of tropical cyclones in vertical shear”.

Blake Rutherford, G. Dangelmayr and M. T. Montgomery. “The role of Lagrangian coherent structures in tropical cyclone formation”.


Zhuo Wang, M. T. Montgomery and M. A. Boothe. “2009 NSF-PREDICT Dry Run: what have we learned?”
DEPARTMENT OF OCEANOGRAPHY

JEFFREY D. PADUAN
CHAIRMAN
OCEANOGRAPHY

OVERVIEW:

The Department of Oceanography has developed a broad research program focused on physical oceanography to meet the anticipated future needs of the Navy. Our basic research themes are the development of scientific capabilities to measure, analyze, and forecast fields of littoral ocean variables. These occur in association with synoptic/mesoscale processes over limited, regional, temporal domains. The areas of emphasis include coastal and nearshore ocean dynamics, air-sea interaction phenomena, and boundary currents. Regions of interest include the polar seas, coastal ocean regions, and strategic straits of the world. Our applied research themes are the application of analyses and forecasts of upper ocean synoptic/mesoscale variability to Naval operations. Areas of emphasis include the impact of littoral processes, eddies, and boundary currents on ocean surveillance systems, the effect of storms on acoustic propagation and ambient noise, and the impact that the wave climate exerts on nearshore processes and beach character as it pertains to mine/mine-countermeasure and amphibious warfare. These research themes require the development of numerical, ocean-prediction models and synoptic observing capabilities. They are achieved through the employment of modern dynamical and mathematical principles, numerical and statistical methods, computational and graphical facilities, and in situ and remote-sensing observations.

CURRICULA SERVED:

- Meteorology and Oceanography
- Operational Oceanography
- Oceanography
- Undersea Warfare

DEGREES GRANTED:

- Master of Science in Meteorology and Physical Oceanography
- Master of Science in Physical Oceanography
- Doctor of Philosophy in Physical Oceanography

RESEARCH THRUSTS:

- Coastal ocean monitoring using autonomous and remote sensing instruments
- Environmental acoustics
- Expeditionary warfare applications in the surf zone
- Observations of Arctic change
- Numerical modeling

RESEARCH FACILITIES:

- Rapid Environmental Assessment Laboratory
- Ocean Acoustic Observatory at Point Sur
- Computer Graphics Laboratory
- Monterey Inner Shelf Observatory
- Moored Equipment Laboratory
- Calibration Laboratory
- Tactical Environmental Support Laboratory
- Interactive Digital Environmental Analysis
The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Oceanography is provided below:
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary L. Batteen</td>
<td>Professor</td>
<td><a href="mailto:batteen@nps.edu">batteen@nps.edu</a></td>
</tr>
<tr>
<td>Eugene C. Haderlie</td>
<td>Distinguished Professor Emeritus</td>
<td><a href="mailto:haderlie@nps.edu">haderlie@nps.edu</a></td>
</tr>
<tr>
<td>Andrew Roberts</td>
<td>Research Assistant Professor</td>
<td><a href="mailto:afrobert@nps.edu">afrobert@nps.edu</a></td>
</tr>
<tr>
<td>Robert H. Bourke</td>
<td>Professor Emeritus</td>
<td><a href="mailto:rbourke@nps.edu">rbourke@nps.edu</a></td>
</tr>
<tr>
<td>Thomas H.C. Herbers</td>
<td>Professor</td>
<td><a href="mailto:thherber@nps.edu">thherber@nps.edu</a></td>
</tr>
<tr>
<td>Leslie Rosenfeld</td>
<td>Research Associate Professor</td>
<td><a href="mailto:lkrosenf@nps.edu">lkrosenf@nps.edu</a></td>
</tr>
<tr>
<td>Ching-Sang Chiu</td>
<td>Professor</td>
<td><a href="mailto:chiu@nps.edu">chiu@nps.edu</a></td>
</tr>
<tr>
<td>James H. MacMahan</td>
<td>Assistant Professor</td>
<td><a href="mailto:jhmacmah@nps.edu">jhmacmah@nps.edu</a></td>
</tr>
<tr>
<td>Albert J. Semtner</td>
<td>Professor Emeritus</td>
<td><a href="mailto:sbert@nps.edu">sbert@nps.edu</a></td>
</tr>
<tr>
<td>Peter C. Chu</td>
<td>Professor</td>
<td><a href="mailto:pcchu@nps.edu">pcchu@nps.edu</a></td>
</tr>
<tr>
<td>Wieslaw Maslowski</td>
<td>Research Professor</td>
<td><a href="mailto:maslowsk@nps.edu">maslowsk@nps.edu</a></td>
</tr>
<tr>
<td>William Shaw</td>
<td>Research Assistant Professor</td>
<td><a href="mailto:wishaw@nps.edu">wishaw@nps.edu</a></td>
</tr>
<tr>
<td>Curtis A. Collins</td>
<td>Professor</td>
<td><a href="mailto:collins@nps.edu">collins@nps.edu</a></td>
</tr>
<tr>
<td>Timour Radko</td>
<td>Associate Professor</td>
<td><a href="mailto:tradko@nps.edu">tradko@nps.edu</a></td>
</tr>
<tr>
<td>Rebecca E. Stone</td>
<td>CAPT, USN</td>
<td><a href="mailto:restone@nps.edu">restone@nps.edu</a></td>
</tr>
<tr>
<td>John A. Colosi</td>
<td>Professor</td>
<td><a href="mailto:jacolosi@nps.edu">jacolosi@nps.edu</a></td>
</tr>
<tr>
<td>Steven R. Ramp</td>
<td>Visiting Research Professor</td>
<td><a href="mailto:sramp@nps.edu">sramp@nps.edu</a></td>
</tr>
<tr>
<td>Edward Thornton</td>
<td>Distinguished Professor Emeritus</td>
<td><a href="mailto:thornton@nps.edu">thornton@nps.edu</a></td>
</tr>
<tr>
<td>Roland W. Garwood</td>
<td>Professor Emeritus</td>
<td><a href="mailto:garwood@nps.edu">garwood@nps.edu</a></td>
</tr>
<tr>
<td>D. Benjamin Reeder</td>
<td>CDR, USN</td>
<td><a href="mailto:dbreeder@nps.edu">dbreeder@nps.edu</a></td>
</tr>
<tr>
<td>Robin T. Tokmakian</td>
<td>Research Associate Professor</td>
<td><a href="mailto:rtt@nps.edu">rtt@nps.edu</a></td>
</tr>
<tr>
<td>Arlene Guest</td>
<td>Senior Lecturer</td>
<td><a href="mailto:aguest@nps.edu">aguest@nps.edu</a></td>
</tr>
</tbody>
</table>

---

Jeffrey D. Paduan  
Chairman & Professor  
831-656-3350  
paduan@nps.edu

Timothy P. Stanton  
Associate Chairman for Research & Research Professor  
831-656-3144  
stanton@nps.edu
OBJECTIVE: This is a three-year (2009-2011) project to complete the analysis of both the shelf and basin acoustic data collected from the Northeastern South China Sea (NE SCS) during the Windy Island Soliton Experiment (WISE). These data were collected between April 2005 and October 2006. The objectives of the basin acoustic data analysis are twofold: The first is to study and characterize the supertidal-to-seasonal-scale impacts of the transbasin nonlinear internal waves on long-range transmission loss. The second is to understand and quantify the variability of the observed ambient noise level in the basin. The second objective constitutes the primary focus of my data analysis effort in FY10.

SUMMARY: A hydrophone was moored at mid depth in the NE SCS basin from November 2005 to October 2006. Operated with a 1-min-on and 14-min-off duty cycle and sampled at 1.6 kHz, the measured time series captures the spectral characteristics and variability of the ambient noise in the 0-to-800 Hz band over an annual cycle. The relations between the observed noise levels and the relevant environmental variables are then examined using spectral estimation methods and scattered diagrams.

Using the measured acoustic data, the time-varying noise power spectral density was estimated at a 15-min interval over the annual cycle. From these spectral density estimates, time series of the noise spectrum levels and band levels were constructed. In order to gain insights into the predictability of the ambient noise field in this marginal sea, the interpretation of the noise levels was facilitated with the following environmental data:

1. Moored temperature time series, measured every 60 s or 90 s at various depths from May 2005 to Oct 2006.
2. Wind speed time series, from the US Navy Operational Global Atmospheric Prediction System (NOGAPS) surface wind analysis every 6-hours, interpolated to receiver location.
3. Precipitation time series, from the NOGAPS previous 12-hr precipitation accumulation fields, interpolated to receiver location.

Historical shipping density and vessel motion simulation, where the large commercial vessel density was based on 3-years of Lloyd’s Ship Movement data, the fishing vessel density was from Food and Agriculture Organization (FAO) statistics, and the single vessel motion simulation was based on Lloyd’s density and shipping lane structure.

PUBLICATIONS:


PRESENTATIONS:


OBJECTIVE: The proposed research will develop an effective and accurate theoretical model to investigate the generation, propagation, and transformation of large amplitude internal solitary waves over variable bottom topography, and then integrate the resulting internal wave model with an improved radar imaging model for remote sensing of the surface signatures of these strongly nonlinear internal waves. This highly interdisciplinary project will provide a comprehensive but practical tool for predicting and monitoring internal wave activity in the ocean.

DETERMINATION OF THE DETECTION AND CLASSIFICATION PROBABILITIES AND RANGE LIMITS OF INEXPENSIVE ACOUSTIC SENSORS AND DATA PROCESSING TECHNIQUES FOR MONITORING ODONTOCETI WHALES

OBJECTIVE: The objective of this project is to support Navy ASW training activities at SCORE (San Clemente Island) by mitigating the effects of mid-range sonar on marine mammals. The approach has been to evaluate and predict the performance of inexpensive passive systems for monitoring vocalizing Odontoceti whales using conditional statistical measures. These performance measures include detection and classification probabilities and range limit against false-alarm rate. FY08 activities included (1) developing methods to detect and classify marine mammal vocalizations, (2) recording data from an array of bottom mounted hydrophones in San Nicholas Basin, (3) determining the spatial and temporal variability of marine mammal vocalizations in San Nicholas Basin, and (4) understanding the physical characteristics of the basin that govern the propagation of acoustic energy and affect the behavior of marine mammals. The long range goal of these studies is to measure the response of marine mammals to acoustic energy that is introduced to the marine environment by anthropogenic means.

SUMMARY: Major accomplishments include continued data collection activities and coordination of N45 research activities at West Coast Universities and NOAA Laboratories. NPS FY10 data collection activities included maintaining an autonomous acoustic recorder on Sur Ridge, environmental moorings near SIO HARP packages which bracket either side of the SCORE range in San Nicholas Basin, collection of data from SCORE hydrophones, collection of environmental data on SIO/UCSD acoustic moorings in Southern California, and collection of AIS data along the Central California Coast. Principal data analysis activities included analysis of HARP data collected at Sur Ridge. SCORE data collected by NPS are being stored at the DoD’s Major Shared Resource Center at Stennis Space Center.

In FY10 the HARP mooring on Sur Ridge was continued. The purpose of this mooring is to provide information on marine mammal migrations into and out of the Navy training ranges to the north (Quinault and Gulf of Alaska) and south (SCORE). The recording cycle for the mooring was 5 minutes every 20 minutes, the sampling frequency is 200 kHz, and the frequency band recorded is 10 Hz to 100 kHz. These acoustic data recordings contain all sounds present in the environment at any given sampling period and thus are useful in exploring relationships between marine mammal behavior and anthropogenic sounds, including those produced by mid-range sonar and ship’s machinery. Analysis of passive acoustic recordings collected on top of Sur Ridge, near the Point Sur Ocean Acoustic Observatory (OAO) site, in 2008-2009 has been completed (Margolina, 2010). These recordings were scanned to detect and identify signals from various underwater acoustic sources. The spectrum level of the recorded pressure has been
analyzed in time/frequency space to reveal interannual, seasonal, and diel variability, as well as possible correlations of different sounds, with primary focus on anthropogenic activity and marine mammal vocalizations. A report on these results will be given at the ASA meeting in May, 2011, and subsequently submitted for publication.

The AIS receiver installed at Point Sur continued successful data collection in FY10. These data are being used by UCSD for graduate student research on the impact of merchant vessel traffic on marine mammal population. They will also be useful for studies of ambient acoustic noise recordings on Sur Ridge. The impact of anthropogenic noise on marine life is an important issue to both the scientific community and public policy makers. Human-generated noise has potential to disrupt critical marine mammal biological functions such as foraging, communication and navigation. Commercial shipping contributes significantly to the ocean sound scale, typically dominating the noise field at frequencies less than 500 Hz. Market conditions, trends in vessel design and propulsion, use of more economical ship routes, operational efficiency and environmental factors are all important variables that help shape the changing soundscape. To reliably model the temporal and spatial variability of a regional soundscape, accurate characterization of the sources of noise is needed. Acoustic recordings taken at the Point Sur Ocean Acoustic Observatory (OAO) and Automatic Identification System (AIS) reports broadcast by ships passing the OAS site have been used to determine ship source levels of the 25-600 Hz band, categorized by ship class and speed. Source levels are then applied to a model used to evaluate temporal variability of the noise at several sites along the central California coast based on AIS-reported shipping traffic transiting the region. These modeling and observational results will be presented at the May, 2011, ASA meeting.

Environmental moorings near SIO HARP packages which bracket either side of the SCORE range in San Nicholas Basin were redeployed in July, 2010, for the last time. The moorings are scheduled for retrieval in May, 2011, and processing of these data as well as analysis of the complete data set will be subsequently completed. The moorings have provided information on local water conditions as well as measuring the upper ocean transport across San Nicholas Basin. Data recordings at the SCORE hydrophones were continue to be collected by NPS. Beginning in FY11, SCORE has agreed to record for 2 weeks of every month (vs. the earlier not-to-interfere schedule). These data are being stored at the DoD’s Major Shared Resource Center at Stennis Space Center. Data collection activities on the old array will continue until the new array becomes operational.

Results of earlier analyses of historical ambient acoustic noise measurements are being published. The first report to be accepted for publication dealt with calibrated measurements of ambient noise and wind speed which were made in the Tongue of the Ocean in the Bahamas in the mid-1980s. These data were used to quantify the spectra and statistics of wind-generated noise. The Tongue of the Ocean is a deep basin which is topographically isolated from the Atlantic Ocean and, therefore, largely acoustically decoupled from the Atlantic Ocean deep sound channel. The quantitative effects of contaminating (non-surface wind-generated) noise sources within the basin were eliminated by careful measurement and robust statistical analysis methodologies. Above 500 Hz, the spectral slopes were approximately −5 dB per octave and independent of wind speed. Below 500 Hz, the ambient noise was no longer a linear function of wind speed. Below 100 Hz and for wind speeds greater than 18.5 knots, the ambient noise was independent of frequency. The minimum observed ambient noise level fell 13 dB below Erick’s “light shipping” level at 30 Hz and 2–5 dB below Wenz’s sea state zero level through the wind-dominated portion of the spectrum. The basin’s geographical isolation and the rigorous measurement and analysis methodologies employed make this two-decade-old data set a reasonable and justified proxy for pre-industrial era ocean noise levels in the 20 Hz to 20 kHz frequency band.

Coordination and funding of N45 efforts continued in FY10 using grants and interagency funding transfers. In addition to replicating FY10 activities, additional efforts were supported at Woods Hole Oceanographic Institution (Tyack, Ketten), the University of St. Andrews (Thomas), Cascadia Research Cooperative (Calambokidis, Baird, Falcone), Southall Environmental Associates, and Northeast Fisheries Fisheries Center (Van Parijs). Progress reports for N45 funded activities have been published and distributed by NPS and are listed as “Technical Reports” below.

PUBLICATIONS:

OCEANOGRAPHY

TECHNICAL REPORTS:


DURIP: PORTABLE, HIGH-EFFICIENCY, WIDE-BAND (500-1,200 Hz) MOORED SOUND SOURCES FOR SHALLOW-WATER LOW-FREQUENCY ACOUSTIC PROPAGATION STUDIES
Ching-Sang Chiu, Professor
Department of Oceanography
Sponsor: National Science Foundation

OBJECTIVE: All of the past acoustic propagation experiments conducted in shelf and slope regions in non-US waters as part of the Shallow-Water Thrust of the Ocean Acoustics Program of the Office of Naval Research (ONR) have been constrained by the lack of portable sound sources that have frequency ranges covering the upper half (550-1,000 Hz) of the low frequency regime. This limitation has prevented the collection of comprehensive data for studying propagation physics in this upper-half of the band, and for quantifying the boundaries and overlaps in the entire low frequency-range-angle domain within which one or more environmental factors controls the characteristics and statistics in signal intensity and coherences. In a downward-refracting sound channel, these environmental factors include sound-speed variability, bathymetry changes, sediment heterogeneity, and fish schools. In order to fill the data and knowledge gaps, the procurement of two wide-band moored sources, spanning 500-800 Hz and 800-1,200 Hz, is proposed. The design is based on the proven sweeper technology developed by Teledyne Webb Research Company to achieve high efficiency. The dimension of each is compact, with the transducer, electronics and batteries configured in two Slocum-glider hulls mounted in parallel, making them easily transportable and deployable in non-US waters. The first deployment will be in the next multi-institutional shallow-water acoustics experiment that is targeted for the FY11-12 timeframe. Similar to other Naval Postgraduate School (NPS) sea-going acoustic equipment, these new sources will be treated as community assets. Their placement and signaling schemes will be designed in a joined effort to support various scientific objectives including graduate student theses of NPS as well as those of other institutions collaborating in the experiment.
OBJECTIVE: A fast and accurate detection and classification system is essential for the side-scan sonar system. In this proposal, we will use the EMD method to establish such a system. This system will expedite mine clearing operations and many automate tasks such as identification and neutralization in the future.

SUMMARY: Automatic detection of sea mines in coastal regions is a difficult task due to the highly variable sea bottom conditions present in the underwater environment. Detection systems must be able to discriminate objects which vary in size, shape, and orientation from naturally occurring and man-made clutter. Additionally, these automated systems must be computationally efficient to be incorporated into Unmanned Underwater Vehicle (UUV) sensor systems characterized by high sensor data rates and limited processing abilities. Using empirical mode decomposition analysis, a fast, robust sea mine detection and change detection systems can be created. These decompositions project key image features, geometrically defined structures with orientations, and localized information into distinct orthogonal components or feature subspaces of the image. The performance of the new detection system is compared against the performance of an independent detection system in terms of probability of detection (Pd) and probability of false alarm (Pfa).

PUBLICATIONS:


THESES DIRECTED:


LITTORAL OCEANOGRAPHY FOR MINE WARFARE

OBJECTIVE: The goal of this program is to enhance the U.S. Navy’s Mine Warfare (MIW) capabilities through analyzing littoral oceanographic data sets and investigating impact of ocean environment on MCM operations.

LONG-TERM GOALS: The long-term goals are to enhance the capabilities on the U.S. Navy’s magnetic mine sweeping performance prediction and mine burial expert system. To meet the first goal, we plan (1) to analyze the sediment surface properties versus sediment properties to full electrical depth; (2) to express the Q and ED/AD variability in MEDAL to the planner given the general lack of TMMS-REA data and Oasis data; (3) to incorporate MACAS Q and ED/AD data with mine burial/bottom sediment data; (4) to use the selected Persian Gulf core conductivities from NAVO database (for areas of likely mine burial issues), the OMAL N-layer model, and quantifying and to compare the variability in the 3 components of the sweep magnetic field from the model with the variability in conductivity as a function of depth; and (5) to look up the range of conductivity values for that sediment type as a function of porosity. To meet the second goal, we plan (1) to communicate the Probability Distribution Functions (PDFs), (2) to properly bin the burial categories, and (3) to impact on MIW doctrine.

SUMMARY: In this program, we investigated new oceanic processes, developed new algorithms (conserved minimal adjustment scheme, transformed flux-form semi-Lagrangian scheme, and optimal linear fitting) for ocean data analysis/assimilation with application to mine warfare (MIW), mine burial prediction using the mine burial
expert system (MBES), and oceanography for magnetic mine sweeping.

**PUBLICATIONS:**

*Peer-Reviewed Journal Papers:*


*Peer-Reviewed Journal Papers (In Press):*


*Proceedings Papers/Technical Reports:*


PRESENTATIONS:

Invited:

Chu, P.C., Unmanned undersea vehicle (UUV) for Navy’s science/technology and operations. World Ocean Forum 2010, BEXCO, Busan, South Korea, 14-16 November 2010 (invited).

Chu, P.C., Unmanned undersea vehicle (UUV) for national defense and ocean research. Undersea Robot Workshop, Chinhae, South Korea, 12 November 2010 (invited).

Chu, P.C., Ocean data analysis using the optimal spectral decomposition. The 5th International Ocean-Atmosphere Conference, Taipei Taiwan, 28-30 June 2010 (invited).

Chu, P.C., and Y.-H. Kuo, Rossby wave propagation in the Kuroshio Extension with the effects on surface phytoplankton distribution. 2010 Western Pacific Geophysics Meeting, Taipei Taiwan, 22-25 June 2010 (invited).

Chu, P.C., and H.-C. Li, Temporal and spatial variation of δ18O in China since medieval warm period. 2010 Western Pacific Geophysics Meeting, Taipei Taiwan, 22-25 June 2010 (invited).

Contributed:


Chu, P.C., and C. Sun, Quality control on ocean temperature and salinity data. Global Temperature and Salinity Profile Program Workshop, UNESCO, Oostende, Belgium, 6-7 May 2010.


Chu, P.C., and C.W. Fan, A fully conserved minimal adjustment scheme for ocean data assimilation systems. Fourteenth Symposium on Integrated Observing and Assimilation Systems, American Meteorological Society, Atlanta, Georgia,
OCEANOGRAPHY

17-21 January 2010.


Chu, P.C., and Y.H. Kuo, Sea level and chlorophyll-a Variability in the Kuroshio Extension from altimeter and SeaWiFS. Twenty Second Conference on Climate Variability and Change, American Meteorological Society, Atlanta, Georgia, 17-21 January 2010.


THESES DIRECTED:


WAVE EFFECT ON UNDERWATER BOMG TRAJECTORY AND TAIL SEPARATION

Peter C. Chu, Professor
Department of Oceanography & Wayne Meyer Institute of Systems Engineering
Sponsor: Office of Naval Research

OBJECTIVE: The goal of this project is to investigate the wave effect on underwater bomb trajectory and tail separation. The proposed work include: (1) development of a new version of the NPS 6 DOF model with the capability to predict the bomb maneuvering in the water column due to sloping surface, (2) analysis on the underwater bomb trajectory and orientation due to wave propagation, and (3) determination of the wave effect on the tail separation.

SUMMARY: This program will develop a module to include the bomb impact on the sloping ocean surface. The new version of the 6 DOF model will have the ability to predict the bomb maneuvering in the water column due to the sloping surface with wave effects; develop drag/lift module for each specific bomb configuration. The best form of the module is to construct semi-empirical formulae for drag/lift coefficients which depend on Reynolds number and attack angle. For the ONR scheduled full-size inert weapon trajectory experiment (NAWC-China Lake), the impact points at the surface (0 ft) and bottom (40 ft) will be measured. We verify the accuracy of the NPS 6 DOF model by comparing the measured and predicted impact points.

PUBLICATIONS:

Peer-Reviewed Journal Papers:


Peer-Reviewed Journal Papers (In Press):


Fiorino, S.T., R. M. Randall, R. J. Bartell, A.D. Downs, P.C. Chu, and C. W. Fan, 2010: Climate change: anticipated effects on high energy laser weapon systems in maritime environments. Journal of Applied Meteorology and
OCEANOGRAPHY

Climatology, American Meteorological Society, in press.

Proceedings Papers/Technical Reports:


PRESENTATIONS:

Invited:

Chu, P.C., Unmanned undersea vehicle (UUV) for Navy's science/technology and operations. World Ocean Forum 2010, BEXCO, Busan, South Korea, 14-16 November 2010 (invited).

Chu, P.C., Unmanned undersea vehicle (UUV) for national defense and ocean research. Undersea Robot Workshop, Chinhae, South Korea, 12 November 2010 (invited).

Contributed:


EFFECTS OF EDDIES AND WAVES ON WESTWARD TRANSPORT OFF CENTRAL CALIFORNIA

Curtis A. Collins, Professor
Department of Oceanography
Sponsor: National Science Foundation

OBJECTIVE: The proposed study focuses on understanding the role of mesoscale variability and Rossby waves in the observed westward transport (WT) of the California Current System (CCS). In-situ observations, remotely sensed observations, and numerical modeling are used to nowcast meso-scale eddy variability in the CCS off Central California and to quantify associated WT. The goal is to understand how eddies, jets and waves as well as their interactions affect WT and to determine the scales responsible for this process. Parameterization schemes for WT will also be developed in a form sufficiently simplified to be verified from sparse observations and to permit biological and climate applications. This is a collaborative study with Dr. Leonid Ivanov of Moss Landing Marine Laboratories.

RESULTS: Recent analyses of observations and ocean model outputs have revealed coherent low frequency quasi-zonal jets in sea surface height (SSH) anomaly and model velocity fields. The jets were latent, i.e. were not detectable by eye, but detected and selected by a time averaging procedure. Temporal averaging, when applied to fields containing propagating features (eddies and waves), can create jet-like structures of a non-physical nature (artifacts). Criteria to distinguish real quasi-zonal jets from artifacts were developed, and it was demonstrated that quasi-zonal jets extracted from satellite altimetry off California were not artifacts. Three arguments support this point of view. First, quasi-zonal jets off California were stronger than artifacts: the observed intensities for the jets reached 4-5 cm, considerably larger than for predicted artifacts which had an intensity less than 0.9-1.2 cm. Second, observed jets were not always oriented along the paths of mesoscale propagating features and it took as long as 12 months for the
jets to change their orientation after the paths of the mesoscale features changed. This behavior differed from artifacts which must be oriented along paths of propagating mesoscale features. When mesoscale features changed their propagation direction, the associated change in artifact orientation cannot be longer than 2 months. Third, generation (amplification) of quasi-zonal jets was accompanied by phase synchronization (locking of flow scales) defined by modes in phase space which embedded the jets. Since artifacts are a result of linear averaging procedures, they cannot produce nonlinear interactions between these scales.

**PUBLICATIONS:**


**PRESENTATIONS:**


**NON-ASSIMILATION FUSION OF DATA AND MODELS**

Curtis A. Collins, Professor  
Department of Oceanography  
Sponsor: National Science Foundation

**OBJECTIVE:** The primary goal is to develop an innovative approach for representation and manipulation of data uncertainty and model error, and to use this approach for effective fusion of ocean data and model outputs in multiple metrics. This should lead to improved ocean state estimation and forecasting. Fuzzy logic is a key to understanding and quantifying the uncertainty and error, as well as to developing a fusion process.

**OCEANOGRAPHIC CONDITIONS OFF CENTRAL CALIFORNIA**

Curtis A. Collins, Professor  
Department of Oceanography  
Sponsor: National Marine Fisheries Service, NOAA

**OBJECTIVE:** The objective is to monitor the state of the California Current off Central California using quarterly research cruises.

**RESULTS:** Regional hydrographic surveys were conducted in July 2010 using NOAA Ship McArthur II and November 2010 from R/V Point Sur. Both surveys occupied a complete set of stations on CalCOFI Line 67 (off Moss Landing) and Line 60 (off Pt. Reyes). For the July cruise, the only technical problem that was experienced was that the CTD power wire corroded probably due to electrolysis (all that was left at the connection to the CTD was a black powder) but was quickly reterminated. For the November cruise, the CTD that we initially used failed about half way through the survey and was replaced with a second CTD. Both sets of CTD sensors were recalibrated after the cruise (it had been more than a year since they had been calibrated). These post cruise calibrations were used for data processing. On the November cruise, no dissolved oxygen data were collected so we were unable to check the post cruise oxygen calibrations. Also note that we have been unable to process the VMADCP data from McArthur II.

During the November survey, the currents along the continental shelf were directed poleward. In the upper 200 m, the thermocline was deepest at the mid-point of the survey. The inshore position of the California Current was marked
by a shallow front, a ~ 50 m subsurface salinity minimum (S<33), and a southward directed surface jet. Along Line 67, this front was located about 150 km from shore in November for both Line 60 and Line 67. Strongest surface currents, about 0.5 m/s, were directed to the south at this front along line 60 and also at the offshore station on Line 67. Inshore, along Line 67, currents were also directed southward at about 0.5 m/s just to the south of the entrance to Monterey Bay. Poleward flow, 0.25 cm/s, was observed along the upper slope along both Line 60 and Line 67. The main thermocline along Line 67 included anticyclonic eddy, about 50 km in diameter, in agreement with the observed current reversals.

During the July survey, the transition to subarctic waters (the California Current) was observed much farther from shore along Line 60, about 200 km but was only about 25 km offshore of its position in November along Line 67. The nearshore isopycnal slopes were consistent with poleward flow.

Statistical (EOF) analyses of the data indicated that temperatures were close to normal in July but were significantly warmer than normal in the upper 50 m in November. Both cruises, salinities appeared lower in the upper 100-200 m nearshore but were somewhat higher than normal off the coast. In November, the mean halocline temperature continued to decline was the coldest that we have observed since the beginning of our surveys in 1997, about 8.6°C. The mean salinity for waters warmer than 10°C was somewhat fresher than normal, 33.2, consistent with the EOF results.

**PUBLICATIONS:**


**PRESENTATIONS:**


C. Collins, Comparison of T7 XBT and CTD Temperature Profiles off California, XBT Bias and Fall Rate Workshop, University of Hamburg KlimaCampus, Hamburg, Germany, 25-17 August 2010.


**THESES DIRECTED:**

OBJECTIVE: In the interest of improving ocean acoustic modeling and prediction capability, this study seeks to establish the connections between oceanographic sound speed variability and observed acoustic fluctuations from both deep and shallow water environments. The basic science of this proposal is well aligned with the interests of the Navy and Department of Defense, as undersea acoustic surveillance and remote sensing relies critically on a clear knowledge of the oceanographic sound propagation environment and on a firm understanding of the appropriate acoustic propagation physics given a particular environment.

SUMMARY: This project started in October of 2008, and our main efforts to date have been the preparation and execution of the spring 2009 Philippine Sea pilot study, and the preparation and execution of the 2010-2011 year long study. During this year, analysis of the oceanographic measurements from the 2009 experiment have been completed, and are being written up. In addition theoretical work on ocean acoustic fluctuations has been done to pave the way for analysis of the 2009 and 2010-2011 acoustic data.

SPECIAL RESEARCH AWARDS IN OCEAN ACOUSTICS: POSTDOCTORAL FELLOWSHIP FOR TARUN CHANDRAYADULA

OBJECTIVE: This award will fund my NRC postdoctoral fellow Tarun Chandrayadula for his work in ocean acoustics. Additional funding was provided for equipment, and travel.

SUMMARY: In 2010 Dr. Chandrayadula analyzed data from the ONR, 2005 Long-range Acoustic Propagation EXperiment (LOAPEX), and he is writing up his results for publication in the Journal of the Acoustical Society of America (ASA). He has also presented his results at two ASA meetings, and one ONR program review. He has done additional research on the theory of sound propagation through ocean internal waves, which we are writing up now.

PUBLICATIONS:


OCEANOGRAPHY

PRESENTATIONS:

North Pacific Acoustic Laboratory Meeting, October 2010


Acoustical Society of America Meetings, Baltimore and Cancun Mexico 2010.

THESES DIRECTED:

LT. Ben Jones (PhD due Sept. 2012), "Statistical Characterization of Acoustic Scattering by Aggregations of Fish in a Range-Dependent Oceanic Waveguide”

ATMOSPHERE IMPACTS ON RADAR DETECTION AND SIGNATURE IDENTIFICATION, AND ON AIS TRANSMISSION FOR MARITIME DEFENSE AND SECURITY (MDS)

Kenneth L. Davidson, Research Professor (Department of Meteorology)
Arlene A. Guest, Senior Lecturer
Department of Oceanography
Sponsor: Maritime Domain Security Research Program

OBJECTIVE: Improve predictions of Rf detection/identification and AIS signal ranges, by exploiting knowledge of the atmospheric and surface conditions, with focus on coastal vessels that are potential threats to the US and US assets abroad.

SUMMARY: This work, for which funding just began in the late fall of 2010, seeks to investigate the relationship between AIS (Automated Identification System) signals from ships with meteorological conditions. Initial work has been to obtain upper air soundings from along the California coast and characterize the conditions in terms of Rf conditions. Maximum signal ranges from AIS data from NPS receivers along the California coast have been computed and case studies with anomalously long ranges are being examined. A data report is in preparation.

EVOLUTION OF OCEAN SURFACE WAVES ACROSS A MUDDY CONTINENTAL SHELF

Thomas H.C. Herbers, Professor
Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: The objective of this research is to understand and predict the effects of a muddy seafloor on the transformation of ocean waves across a continental shelf. Future Naval applications of the proposed work include remote sensing of seafloor properties to reduce uncertainties in planning for MCM, ASW, and expeditionary warfare in denied areas.

EVOLUTION OF OCEAN SURFACE WAVES ACROSS A MUDDY CONTINENTAL SHELF

Thomas H.C. Herbers, Professor
Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: We propose a comprehensive observational, theoretical, and numerical study of the evolution of ocean surface waves over a muddy seafloor to determine the dominant wave-damping mechanisms and their implications for the spectral energy balance, and to advance deterministic and stochastic modeling capabilities for wave predictions on
muddy coastlines. In particular, our research objectives include:

- Obtain detailed field measurements of wave evolution across a muddy continental shelf.
- Extended our deterministic, nonlinear model for wave evolution in variable depth to account for the attenuation of surface waves through the interaction with the soft bed; we propose implementation of two competing wave damping mechanisms (WDM), namely
  - WDM 1) The direct (linear) damping and dispersion effects of a viscous sub-layer on surface waves
  - WDM 2) A coupled-mode formulation describing the mutual interactions between surface and lutocline waves in a two-layer fluid-mud system.
- Test Competing hypotheses for mud-induced wave attenuation through comparison of observed wave evolution with predictions of the deterministic model
- Develop and implement a source term suitable for conventional third-generation stochastic waves models (SWAN, WaveWatchIII), and perform a high-resolution hind-cast for the full-scale field-experimental site to assess effects of a muddy environment on swell decay and fetch-limited wind wave growth.

IN-SITU WAVE OBSERVATIONS IN THE ONR HIGH RESOLUTION AIR-SEA INTERACTION DRI

Thomas H.C. Herbers, Professor
Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: This proposal requests funds for participation in the ONR High Resolution Air-Sea interaction Departmental Research initiative (DRI). The objective of this project is to advance observational and modeling techniques for monitoring the sea state around a vessel. The field experiment will be conducted off Point Conception, California, using the floating platform FLIP with a suite of meteorological and oceanographic instruments, airborne and ship-board radar systems, and an array of moored buoys. This proposal describes the in-situ wave measurement component using GPS-based, surface-following buoys.

MODELING WIND WAVE EVOLUTION FROM DEEP TO SHALLOW WATER

Thomas H.C. Herbers, Professor
Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: The primary objective of the proposed work is to improve the accuracy of operational third-generation (3G) wave prediction models for continental shelf and coastal applications by developing an integrated model representation of nonlinear (quadruplet and triad) wave-wave interactions that includes a smooth transition from deep-to shallow water. We will also contribute extensive field data sets from recent ONR-funded experiments to the team effort, to facilitate a comprehensive validation of the improved modeling capability.

WAVE-CURRENT INTERACTIONS IN COASTAL INLETS AND RIVER MOUTHS

Thomas H.C. Herbers, Professor
Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: The principal objective of the proposed work is to improve our understanding of the interaction between ocean surface waves and shear currents in coastal inlets and river mouths. In particular, we aim to: 1) develop observational capability using wave-resolving Lagrangian drifters to study wave-current interactions, and contribute to a comprehensive community data set of coastal inlet and river mouth processes, 2) determine the role of nonlinearity in wave-current interactions by comparing observations to theoretical models and MonteCarlo simulations, and 3) develop predictive modeling capability of wave statistics in a complex coastal environment with strong currents.
OCEANOGRAPHY

HIGH FIDELITY ACTIVE SONAR SIMULATION (HIFAST): FISH SCHOOL MODELS FOR HIGH FIDELITY SIMULATIONS OF BIOLOGIC CLUTTER

LCDR Benjamin Jones, Oceanography PhD Student
Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: Create a high fidelity model that generates time series of echoes from fish aggregations for a wide range of conditions. The development schedule for the proposed effort will be aligned with that of the SAST program under NAVSEA (PEO IWS-5A) to provide incremental transitions throughout the duration of the project.

PRESENTATION:


AUTONOMOUS WIDE APERTURE CLUSTER FOR SURVEILLANCE (AWACS)

John E. Joseph, Research Associate
Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: AWACS is a multi-disciplined team effort comprised of a number of collaborating academic and scientific institutions, fleet operation support communities and manufacturers of ocean sensors and platforms. The long-term objective of the AWACS program is to develop an undersea surveillance system consisting of a cluster of autonomous vehicles for use in complex littoral shallow water environments. The vehicles will be capable of sampling oceanographic, bottom and acoustic features in a local environment and, as a networked cluster, will collectively feed adaptive sampling and search algorithms leading to improved detection, classification and localization (DCL) of quiet targets.

The Naval Postgraduate School (NPS) contribution is focused on development, implementation and validation of a quasi-real time environment, transmission and ambient noise estimation system that assimilates data retrieved by the cluster of vehicles to recursively improve estimates of ocean, bottom and acoustic parameters with reduced error variances in the volume of interest, thereby improving probability of detection while reducing false alarm rates.

SUMMARY: This multi-year program is based on an extensive build-test-build approach in which AWACS components and algorithms are designed, built, tested and evaluated; then redesigned and rebuilt based on test results. The NPS effort in 2010 builds upon previous efforts to produce an improved estimation system incorporating noise estimation algorithms that are capable of providing near real time support with sufficient spatial and temporal resolution for a surveillance system consisting of a cluster of mobile assets. Use of parallelization computing methods has greatly improved acoustic processing time. This is being incorporated into noise prediction algorithms.

NPS established a small network along the central California coast using commercial-off-the-shelf receivers for analysis of ambient noise variability with shipping traffic over a moored hydrophone off the Point Sur. These reports are also fed to the Department of Transportation MSSIS system which provides much wider area AIS coverage. The MSSIS reports have been archived for two years (2009-10) and will help establish shipping statistics in support of noise prediction in various regions of interest.
OBJECTIVE: A persistent surveillance system can adjust to changing acoustic environment to improve overall performance by adapting search and sampling schemes such that the system is always optimizing probability of detection (PD) while minimizing the probability of false alarm (PFA). In challenging environments, signals from quiet targets can easily be masked by ambient noise (AN). Adaptation of search and sampling schemes should strive to maximize the directional signal-to-noise ratio (SNR) within the context of other operational constraints to be effective. The primary objective of this effort is to build and test a near real time SNR estimation system that supports a persistent surveillance system consisting of mobile sensors operating in a challenging ocean environment. The output of the system will be 3D fields of SNR estimates that can be used to develop a cost function for an optimization algorithm to provide guidance to mission planners and operators in making adaptive search and sampling decisions and fed to a surveillance system to optimize system performance. The specific technical objectives are:

• Develop methods and algorithms for extracting ambient noise information from available resources at a mission control site for assimilation into an ambient noise estimation system. Resources may include (but are not limited to) satellite information, commercial shipping traffic data, meteorological data, information returned through the AUV surveillance network and other sources including intelligence information.

• Develop algorithms for assimilating directional ambient noise data into a 3D gridded field providing a depiction of the current ambient noise environment in a small shelf-break region.

• Develop algorithms that can derive 3D directional SNR fields for scenarios that consider a potential target with expected acoustic characteristics and distribution density being detected with a passive receiver array operated over a range of bearings in a surveillance region of interest.

• Build scalability into the system to cover larger areas with sufficient resolution to support persistent surveillance operation in real time

• Provide measures of uncertainty associated with ambient noise and SNR estimates based on the age, location and source of assimilated data (including climatology)

SUMMARY: This effort is one component of a much larger and more comprehensive program known a Persistent Littoral Undersea Surveillance Innovative Naval Prototype (PLUS INP). PLUS INP is a mutli-year, multi-agency project involving research efforts at several educational institutions, Navy labs and small businesses. PLUS INP uses an integrated team approach which has resulted in various levels of collaboration in this project.

The NPS effort in 2010 has been focused on improving algorithms to estimate near-real time directional noise predictions. Comparisons of AIS data collected at NPS with the Navy’s historical shipping database shows there are areas with large differences in the “expected versus actual” shipping density which would result is significant difference in shipping noise prediction. Analysis is ongoing to determine accurate methods for including AIS data and data from other methods of ship tracking into a noise prediction system.

NPS participated in the ASWEET 2010 field test, providing near real time support for the 10-day test in conjunction with other EA and Optimization Team members. During the sea test, the teams demonstrated improve end-to-end support from data collection/assimilation from field assets, ocean modeling, acoustic modeling, system performance prediction and optimized system lay-down recommendations to mission planners (C2).
DEVELOPMENT OF A PARALLELIZED SYSTEM OF NOISE PREDICTION FOR MARITIME SECURITY

John E. Joseph, Research Associate
Arlene Guest, Senior Lecturer
Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: Develop a noise prediction system using fast parallel computing methods to improve Signal-to-Noise ratio (SNR) support for acoustic surveillance systems for Maritime Domain Security.

SUMMARY: The Navy’s acoustic noise prediction model (NSPE), is computationally slow and is constrained to a single point, one frequency and one depth per run. To adapt to SNR variability on a tactical scale, fast calculation of noise estimates over a grid of locations, at multiple depths and frequencies is needed. We have successfully ported the code to run in a parallel processing mode on hamming, NPS’ high performance computer. I have done numerous experiments to optimize the number of processors and other runtime environment factors for the fastest turnaround time. We are also relating AIS ship data with noise in order to improve estimates of shipping noise. Funding for this work began in the late Fall of 2010 and is ongoing.

COLLABORATIVE RESEARCH: DOES COUPLING BETWEEN THE INNER SHELF AND SURF ZONE REGULATE LARVAL SUPPLY TO INTERTIDAL POPULATIONS

Jamie MacMahan, Assistant Professor
Department of Oceanography
Sponsor: National Science Foundation

OBJECTIVE: The purpose of the proposed study is to investigate for the first time the role of surf zone hydrodynamics in the rate of delivery of cyprids of intertidal barnacles to the shore. The surf zone associated with rocky shores have been hardly studied, but sandy beach surf zones (particularly dissipative beaches) have been well studied. To exploit the greater physical oceanographic understanding of the hydrodynamics of sandy beach surf zones, this initial study will focus on cyprid settlement on hard substrates (settlement plates or rocks in beaches) in surf zones associated with sandy beaches.

COLLABORATIVE RESEARCH: OBSERVATIONS AND PREDICTIONS OF SAND GRAIN SIZE VARIABILITY AND MORPHODYNAMICS ON BEACHES

Jamie MacMahan, Assistant Professor
Department of Oceanography
Sponsor: National Science Foundation

OBJECTIVE: We propose to test whether nearshore morphodynamics and their accurate prediction depend on spatially and temporally varying grain sizes. The specific goals of the proposed study are

1. to analyze grain size data from four recent field experiments on beaches incised by rip channels for coherent spatial and temporal variations in bathymetric and grain size maps and to relate the variations to changes in wave forcing and tide level.
2. to perform a new field experiment to examine the importance of stratigraphy with a newly developed imaging technique for measuring grain size below the bed surface
3. to use the numerical process models to predict beach morphodynamics both with and without varying grain sizes, to better understand and improve the physics in the models based on comparisons with observations, and to assess the effects of varying grain size on the response of morphological systems.
OBJECTIVE: The scientific objective is to collaboratively examine through observations and advanced numerical modeling the three-dimensional velocity field in rip current systems on a strongly-forced complex natural sandy beach at temporal and spatial scales including turbulent, incident wave band, infragravity, very-low frequency and mean currents. Following progress in observations and modeling of increasingly complex beach systems in the last 30 years, this experiment provides an opportunity to measure and model a beach with consistently complex bathymetry and energetic wave forcing with a wide range of incident angles. Vortical motions (rip currents, transient rip currents, and surf zone eddies) co-exist with gravity waves (incident sea-swell and infragravity) in the surf zone, yet their importance has gone unrecognized owing to a lack of comprehensive field measurements and numerical model verification over complex morphology. Vortical motions contribute to the distribution of momentum and energy in the nearshore, and influence sedimentation patterns and transport and mixing of water masses and pollutants in this heavily utilized segment of the ocean. This proposal seeks support for a team from the Naval Postgraduate School, University of Delaware, and University of Miami to participate in a European field experiment aimed at understanding nearshore circulation associated with rip current morphology. Participation in the experiment includes four major components: 1) deployment of the primary in situ field instrument arrays composed of coherent co-located pressure and velocity sensors, pressure sensors, ADCPs, and a bottom boundary layer instrument array; 2) making Lagrangian observations using new surf zone differential GPS drifters to measure circulation patterns to fill in voids between fixed instruments; 3) using synergetic modeling collaboration required for understanding the hydrodynamics of a complex system; and 4) supporting the French field efforts to obtain a community data set describing rip current dynamics. High resolution velocity measurements with large spatial coverage will be to observe the vertical structure, horizontal variability, and temporal fluctuations of the rip current circulation flow field. The observations will be evaluated with well-established nearshore numerical models including NearCom, FunWave, and Delft3D, in both quasi- and full-3D modes with wave-current interaction. The field experiment is planned for the spring of 2008 and will be conducted at True Vert Beach on the Atlantic coast near Bordeaux, France. This beach features an energetic wave climate, strong tidal modulation, and a typically complex platform. It has crescentic bars, rip channels and an inter-tidal zone with ridge and runnel geometry. The funded ($3,500,000 US) French component of the experiment presently involves 24 scientists from six universities, with logistical support from the French Navy, with additional participation by British and Australian scientists.

DURIP: SHALLOW-WATER AUTONOMOUS VEHICLES
Jamie MacMahan, Assistant Professor
Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: The proposed instrumentation will augment ONR-sponsored core programs and DRI field efforts focused on obtaining in situ observations on macrotidal flat, riverine, and ocean environments through unique autonomous vehicles. Two instrumentation requests are proposed: 1) the purchase of a YSI EcoMapper Autonomous Underwater Vehicle, and 2) the purchase of instrumentation suite for a PI-owned SeaRobotics autonomous surface catamaran system. In addition to the research focus of this request, the autonomous systems, particularly the EcoMapper, will be integrated into Naval Postgraduate School (NPS) classroom exercises providing hands-on opportunities for naval officer students to use these instruments and to analyze the data. Naval students will also use this equipment for their thesis projects.
**OCEANOGRAPHY**

**NEAR REAL-TIME MONITORING OF INDIAN RIVER INLET SCOUR HOLE EDGE EVOLUTION SEAWARD OF THE BRIDGE PIERS**

Jamie MacMahan, Assistant Professor  
Department of Oceanography  
Sponsor: University of Delaware

**OBJECTIVE:** Bridge pier scour is a common problem that occurs in riverine and tidal environments. One of the most noticeable and rapidly changing locations of bridge scour under tidal influence occurs in the Indian River Inlet Bridge (IRIB) in Sussex County, Delaware. This collaborative project seeks to monitor the scour hole edge seaward of the IRIB piers. Typical bathymetry monitoring of the inlet occurs on multi-year time scales and does not allow for rapid, short-term processes to be realized in the broader context of long-term variability. In addition, lack of short-term scour hole information makes it difficult for managers and engineers to make informed decisions about bridge stability and safety. In this joint research effort, the collaborators main goal is to overcome the lack of, short-term information, by installing a near real-time monitoring system that will image the sea bed adjacent to the bridge piers. In addition, current meter data will yield critical forcing conditions that can be related to scour hole variability. The resulting data can be used to make informed management decisions and develop appropriate plans of action.

**RIVERINE FLOW OBSERVATIONS AND MODELING: SENSITIVITY OF DELFT3D RIVER MODEL TO BATHYMETRIC VARIABILITY**

Jamie MacMahan, Assistant Professor  
Department of Oceanography  
Sponsor: Office of Naval Research

**OBJECTIVE:**

- Establish the river flow response to horizontal (e.g., river width variations, bends, groins, etc.) and vertical bathymetric variability (e.g., channels and shoals, bars and dunes) with GPS-equipped surface drifters, dye sensors, an Unmanned Surface Vehicle (USV), and an Unmanned Underwater Vehicle (UUV) in two different riverine environments (e.g. unidirectional and bi-directional).
- Validate Delft3D river flow model with these unique observations and subsequently examine the sensitivity of Delft3D river flow model to bathymetric variability in general under a wide range of forcing conditions using an ensemble approach.

**A COMPREHENSIVE MODELING APPROACH TOWARDS UNDERSTANDING AND PREDICTION OF THE ALASKAN COASTAL SYSTEM RESPONSE TO CHANGES IN AN ICE-DIMINISHED ARCTIC**

Wieslaw Maslowski, Research Professor  
Department of Oceanography  
Sponsor: National Oceanographic Partnership Program, Office of Naval Research

**OBJECTIVE:** The proposed research combines state-of-the-art regional modeling of sea ice, ocean, atmosphere and ecosystem to provide a system approach to advance the knowledge and predictive capability of the diverse impacts of changing sea ice cover on the bio-physical marine environment of the coastal Alaska and over the larger region of the wester Arctic Ocean. The focus of this project on seasonally ice-free Alaskan coasts and shelves is in direct support of the Topic 4A: ‘Coastal Effects of a Diminished-ice Arctic Ocean’ and of littoral studies of interest to the U.S. Navy.
OBJECTIVE: The Arctic Ocean Model Intercomparison Project (AOMIP) is an international effort to determine the systematic errors in models of the Arctic Ocean forced with realistic atmospheric conditions. AOMIP involves the international ocean modeling community in a major test and intercomparison of model performance. The main goal of this project is to examine behavior of different models, their ability to simulate past, present and future variability of the Arctic Ocean climate and the major processes maintaining the ocean dynamics. Recent environmental changes in the Arctic Ocean present great challenges to the U.S. Navy, Department of Defense and Homeland Security. This project will advance understanding of the past and present changes and prediction of future environmental change in the Arctic.

SUMMARY: The AOMIP major activities have focused on: Synthesis (identify consistent errors across models, propose solutions, and find the most suitable and reliable coupled ice–ocean models for use in fully coupled regional and global climate models) and Process studies (improve models, investigate processes using model results and observations). Additional AOMIP contributions relate to regional Arctic climate modeling via collaboration with regional and global climate modeling communities. These research themes specifically address the emphasis area of the NSF Arctic Climate System Study (ARCSS) program major question on: “What do changes in the arctic system imply for the future?”.

PUBLICATIONS:


McGeehan, T. and W. Maslowski, Volume and Freshwater Export Through the Canadian Arctic Archipelago – Part I: Evaluation of Seasonal and Interannual Fluxes from a High-Resolution Model Results, J. Geophys. Res., draft manuscript.


PRESENTATIONS:


OBJECTIVE: This project will investigate possible changes in extreme precipitation and temperature events in the Arctic using observational records and multi-model output from regional and global climate programs. The guiding hypothesis is:

A robust understanding, detection and attribution of changes in extreme temperature or precipitation occurs through analysis that combines extreme temperature or precipitation events with the physical processes supporting them.

The supporting physical processes are discerned by the atmospheric state they create, such as circulation and temperature fields. Underlying this hypothesis is the recognition that these fields are better simulated than precipitation in climate models. A second hypothesis that will guide this work extends from this recognition:

Analysis of the atmospheric state producing temperature or precipitation extremes offers better potential for subcontinental detection and attribution compared to local precipitation or temperature analysis alone because it combines the extremes with fields such as large-scale pressure, circulation and temperature that tend to be more robustly simulated than the extremes themselves and that describe processes governing the extremes.

SUMMARY: This project has started in September 2010 and it involves minimal contribution from NPS focusing on the following issues:

1. Coordinate with other co-PIs the setup and execution of experiments designed to address the science goals as summarized in the Budget Impact Statement submitted by the lead institution, the Iowa State University
2. Contribute to the preparation of oceanic and sea ice fields as required by the lower boundary conditions for the atmospheric and climate model simulations
3. Participate in analyses of model simulation results in relation to oceanic and sea ice effects
4. Contribute to preparation of publications and presentations resulting from this research
5. Participate in an annual project PIs meetings.

TOWARDS ADVANCED UNDERSTANDING AND PREDICTIVE CAPABILITY OF CLIMATE CHANGE IN THE ARCTIC USING A HIGH-RESOLUTION REGIONAL ARCTIC CLIMATE SYSTEM MODEL (RACM)

OBJECTIVE: This grant is funding efforts to advance the science of climate change and prediction in the Arctic region. Its primary goals are to (i) develop a state-of-the-art Regional Arctic Climate system Model (RACM) including high-resolution atmosphere, land, ocean, sea ice and land hydrology components and (ii) to perform multi-decadal numerical experiments using high performance computers to minimize uncertainties and fundamentally improve current predictions of climate change in the northern polar regions. These goals are realized through evaluation studies of climate system components via one-way coupling and fully-coupled experiments. We examine effects of advancements in climate system components on their representation of main physics, time-mean fields and to understand variability signals at scales up to decades. This re-search directly addresses some of the major science objectives of the BER Climate Change Re-search Division (CCRD) regarding the advancement of decadal to centennial climate prediction.

SUMMARY: During the 2010 year we have completed work with coupling each climate model component to the
new NCAR flux coupler (CPL7). A fully coupled RACM version has been developed and is currently evaluated for its physical behavior in each respective component, in preparation for interannual simulations. This required efforts in many areas including technical integration of the WRF atmosphere model and the VIC land model into CCSM, WRF testing on the RACM Arctic grid, support of extended grids in the POP and CICE models, VIC standalone testing and validation, and testing of various active and data model configurations.

The following research activities have been realized at NPS in contribution to the RACM project:
- investigation of Arctic sea ice volume changes as an indicator of climate change
- evaluation of POP / CICE in an eddy-resolution (1/48-degree) pan-Arctic configuration
- long-term integration of regional POP, CICE and CPL7
- evaluation of ocean and sea ice output from initial test of the fully coupled RACM
- an extended new grid for POP-WRF coupling and preparation of input fields on this grid.

All personnel involved in the development of a regional climate system model attended two dedicated project workshops, the first in San Francisco (14-15 December 2007), second in Boulder (15-16 May 2008), and third in Seattle (5-6 December 2008). All PIs also attended the DOE CCPP program meeting in Indianapolis, 17-19 September, 2007, the Arctic System Model meeting organized by International Arctic Research Center in Boulder, 19-21 May, 2008. The project website (www.oc.nps.edu/NAME/name.html) has been continually updated to include basic information about the project, people involved, meetings, presentations, and relevant publications.

PUBLICATIONS:


PRESENTATIONS:


Maslowski, W., Toward advanced modeling and prediction of Arctic sea ice and climate, AAAS Annual Meeting, San Diego, CA 18-22 February 2010.

Maslowski, W., Oceanic forcing of ice melt in the western Arctic Ocean, Ocean Sciences Meet-ing, Portland, OR, 22-26 February 2010.


Maslowski, W., J. Jakacki, A. Craig, G. Jost, and J. Clement Kinney, 2010: Development of a Regional Arctic Climate
SYSTEMS MODEL (RACM): Evaluation of Results from POP/CICE simulation. DOE Integrated Climate Change Modeling Science Team meeting, Gaithersburg, MD, April 2010.


Maslowski, W., Advancements and limitations in understanding and predicting Arctic climate change, State of the Arctic Meeting, Miami, FL, 16-19 March 2010.

Osinski, R., and W. Maslowski, Mesoscale eddy dynamics in the Western Arctic from an eddy-resolving pan-Arctic ice-ocean model, State of the Arctic Meeting, Miami, FL, 16-19 March 2010.

TOWARDS PREDICTION OF ARCTIC SEA ICE-OCEAN-GLOBAL CLIMATE INTERACTIONS AT SEASONAL TO DECADAL SCALES

Wieslaw Maslowski, Research Professor
Department of Oceanography
Sponsor: NASA

OBJECTIVE: The main objectives of this project are: (1) to understand the present and past conditions of the Arctic sea ice and ocean, (2) to predict future scenarios of change in the Arctic Ocean, and (3) to address the general circulation model (GCM) limitations in representing Arctic climate using high resolution coupled ice-ocean model of the Pan-Arctic region forced with realistic atmospheric data and will validate/synthesize model output with available satellite and in situ measurements.

COASTAL OCEAN CURRENTS MONITORING PROGRAM

Jeffrey D. Paduan, Professor
Department of Oceanography
Sponsor: State of California (via San Francisco State University)

OBJECTIVE: The goal of this project is to establish a state-wide network of ocean surface current monitoring stations and demonstrate the network’s capability to support oil spill response, search and rescue, and coastal marine science applications.

SUMMARY: This program is part of a multi-year, statewide project to instrument California with shore-based high frequency (HF) radar ocean current mapping systems and to develop a surf zone transport monitoring system. The ambitious project is working to extend the mapping network that originated in Monterey Bay to cover the entire state in order to provide real-time mapping of surface transport for hazardous spill mitigation and search and rescue operations as well as archival support for dispersal-based management decisions. Prof. Paduan and NPS are responsible for the installation and operation of ten HF radar sites from the Big Sur coastline to Half Moon Bay as well as the interpretation of surf zone wave and current data. The overall project is a critical demonstration project in California and nationwide for the growing efforts to establish and Integrated Ocean Observing System (IOOS).
PUBLICATIONS:


In Review):


TECHNICAL REPORTS:


PRESENTATIONS:


OCEANOGRAPHY


CENCOOS: ENVIRONMENTAL MONITORING IN SUPPORT OF MARINE PROTECTED AREA MANAGEMENT

Jeffrey D. Paduan, Professor
Department of Oceanography
Sponsor: NOAA (via Monterey Bay Aquarium Research Institute)

OBJECTIVE: The goal of this project is to demonstrate the applicability of real-time ocean surface current mapping data from HF radar to the management of coastal marine protected areas.

SUMMARY: This program is part of the Integrated Ocean Observing System (IOOS) and the Central and Northern California Ocean Observing System (CeNCOOS) regional association. It seeks to utilize the in-place network of HF radar instruments and the resulting surface current mapping data to compute statistics of surface particle transport into and out of designated marine protected areas and national marine sanctuary boundaries under various conditions and seasons.

PUBLICATIONS (in press):


PRESENTATIONS:


BEARING SEA STUDIES AND DATA COLLECTION

Jeffrey D. Paduan, Professor
Department of Oceanography
Sponsor: University of Alaska Fairbanks

OBJECTIVE: Support at-sea deployment of deep-water mooring equipment in the Bearing Sea for researchers at the University of Alaska Fairbanks.
SUMMARY: This was a CRADA project with researchers at UAF who were in need of experienced seagoing technical support for a research cruise in the Bearing Sea. Travel and salary support was provided for Department of Oceanography staff member Marla Stone to participate in the UAF cruise and assist with onboard mooring operations.

COLLABORATIVE RESEARCH: FINGERING CONVECTION AT LOW PRANDTL NUMBER
Timour Radko, Associate Professor
Department of Oceanography
Sponsor: National Science Foundation

OBJECTIVE: Conduct numerical simulations of double-diffusive convection, a major mixing process in the Earth’s oceans and in the interior of several giant planets. Inferences from the theory and model runs will be used to formulate a parameterization scheme for the Oceanic General Circulation Models. The proposed work will foster partnership between UCSC and NPS.

COLLABORATIVE RESEARCH: STUDIES OF THE INFLUENCE OF THE ANTARCTIC CIRCUMPOLAR CURRENT ON THE ATLANTIC MERIDIONAL CIRCULATION
Timour Radko, Associate Professor
Department of Oceanography
Sponsor: National Science Foundation

OBJECTIVE: The objective of this project is to conduct numerical simulations of the oceanic thermohaline circulation in the mid-latitude Atlantic and in the Antarctic Circumpolar Current. The main goal of this modeling effort is to explain the role of the mesoscale variability in the dynamic connection of these two regions. Properties of the ocean thermal fronts and eddies determine the Undersea Warfare (USW) tactics in the areas of high mesoscale activity, and therefore our efforts to predict its distribution and strength are directly related to the Navy research interests in general and to the interests of the Oceanography Department of NPS in particular.

Students participating: Pierre-Ives Dare, Erick Edwards, Widener David, David Lewis

PUBLICATIONS:


OBJECTIVE: The objective of this project is to conduct numerical simulations of the oceanic thermohaline staircases and explain their dynamics. These experiments involve analysis of the acoustic scattering on the interfaces, a project of direct relevance to the Navy research interests in general and to the interests of the Oceanography Department of NPS in particular.

Students participating: Ana Wilson, Ivo Prikasky, Stephen Wall, Shelley Caplan, Greg Caro, Jeremiah Chaplin, David Smith, Mark Herbert

PUBLICATIONS:


NUMERICAL STUDIES OF DOUBLE-DIFFUSIVE CONVECTION IN THE INTERIOR OF GIANT PLANETS

OBJECTIVE: Theoretical and numerical modeling of double-diffusive convection under a variety of environmental conditions.

Students participating: Adrienne Traxler (UCSC)

PUBLICATIONS:


OCEANOGRAPHY

OCEAN-ICE INTERACTION IN THE AMUNDSEN SEA: THE KEYSTONE OF WEST ANTARCTIC STABILITY

Timothy P. Stanton, Research Professor
Department of Oceanography
Sponsor: National Science Foundation

OBJECTIVE: Lead investigator for the NPS ocean turbulence group. Responsibilities include design, construction, calibrating and field testing 4 profiler systems, as well as the data processing, archiving, analysis and integration into coupled ice/ocean models of the ice cavity structure and turbulent flux data sets. The analysis will be performed in collaboration with McPhee, Holland and other Pine Island Glacier Oceanography Program investigators.

VALIDATION, VERIFICATION, AND EXPLOITATION OF OCEAN MODEL NUMERICAL GUIDANCE FOR ASW DECISION SUPPORT

CDR Rebecca E. Stone, USN, Military Faculty
Department of Oceanography
Sponsor: Office of Naval Research

OBJECTIVE: The Naval Oceanographic Office (NAVO) Reach Back Cell (RBC) is ramping up its support to ASW operations by developing new ocean model areas, in more areas and at higher resolution than ever before. The RBC is also applying the numerical model output in new ways to support ASW planning decisions. Output is being used to produce not only predictions of ocean conditions, but time evolving, 3-D, threat-specific maps identifying areas where detection probability is relatively high (or low), and areas where dynamically changing ocean conditions can be exploited to provide an asymmetric advantage to our sensors. The new model areas and the Reach Back Cell support are major developments in both technology and CONOPS.

There is an urgent need for validation and verification of these new model areas and products as they are being brought on line over the next 1-2 years. A full understanding of the uncertainties-the variability of the ocean environment, and the predictive system’s ability to portray that variability-is needed in order to make operational plans that hinge on these predictions.

PRESENTATION:


OTHER:

Funded portion of the work is complete. Work will continue unfunded as part of PMP faculty workload. Further work will require access to DoD High Performance Computing Modernization Office mass storage devices at the Naval Oceanographic Office. Accounts and access have been granted.

A FEASIBILITY STUDY FOR UNDERSTANDING CLIMATE UNCERTAINTY WITH AN OCEAN FOCUS

Robin T. Tokmakian, Research Associate Professor
Department of Oceanography
Sponsor: National Science Foundation

OBJECTIVE: The project objects are to 1) run a designed experiment using the ocean and ice components of the Community Climate System Model (CCSM), 2) develop a statistical analysis of the uncertainty of the model components as related to their parameter space, and 3) extend what we find out about the model’s uncertainties to the model at higher resolution. We have completed the initial analysis of ten runs of the model (100 years each) and have
begun to create the ensemble of 100 runs at 100 years each. The analysis software has been developed to explore the uncertainty in the initial ten member ensemble. Various metrics are being examined to determine how effective they are in characterizing a model’s parameter uncertainty space. The initial set of analyses shows that the application of these advanced statistical methods can be useful when applied to a general circulation model with both linear and non-linear responses in its solution. A discussion of the methodology is described in Challenor and Tokmakian (2010).

**PUBLICATIONS:**


Tokmakian R., P. Challenor, & Andrianakis: 2010, An extreme non-linear example of the use of emulators with simulators using the Stommel Model, Ocean Modelling, in revision


*Conference/Seminars Papers:*


Tokmakian, R. and P. Challenor, A Design Experiment leading to Understanding Climate Uncertainty, Early Results, Ocean Sciences, 2010

Tokmakian, R., Understanding Uncertainty in Climate Model Components, Isaac Newton Institute for Mathematical Sciences, Mathematical and Statistical Approaches to Climate Modelling and Prediction, Cambridge University, 2010

Tokmakian, R., Understanding Uncertainty in Climate Model Components, University of East Anglia, Dept of Environmental Science, Invited Lecture, 2010

DEPARTMENT OF OCEANOGRAPHY

2010
Faculty Publications and Presentations


Galanis, G., P.C. Chu, G. Kallos, 2010: Statistical post processes for the improvement of the results of numerical wave


McGehee, T. and W. Maslowski, Volume and Freshwater Export Through the Canadian Arctic Archipelago – Part
OCEANOGRAPHY

I: Evaluation of Seasonal and Interannual Fluxes from a High-Resolution Model Results, J. Geophys. Res., draft manuscript.


OCEANOGRAPHY


Tokmakian R., P. Challenor, & Andrianakis: 2010, An extreme non-linear example of the use of emulators with simulators using the Stommel Model, Ocean Modelling, in revision


CONTRIBUTIONS TO BOOKS

OCEANOGRAPHY


CONFERENCE PUBLICATIONS & PROCEEDINGS


CONFERENCE PRESENTATIONS


Castro, R., M.O. Gutierrez Villanueva, A. Martinez, A.D. Mascarenhas, and C.A. Collins, Currents and Thermohaline Properties at the Sinaloa Shelf, Entrance to the Gulf of California, Eos Trans. AGU, 91(26), Abstract OS33B-08 presented at Meeting of the Americas, 8-12 August 2010, Foz do Iguaussu, Brasil.


Chu, P.C., Ocean data analysis using the optimal spectral decomposition. The 5th International Ocean-Atmosphere Conference, Taipei Taiwan, 28-30 June 2010 (invited).

Chu, P.C., Unmanned undersea vehicle (UUV) for Navy's science/technology and operations. World Ocean Forum 2010, BEXCO, Busan, South Korea, 14-16 November 2010 (invited).

Chu, P.C., Unmanned undersea vehicle (UUV) for national defense and ocean research. Undersea Robot Workshop, Chinhae, South Korea, 12 November 2010 (invited).


Chu, P.C., and Y.H. Kuo, Sea level and chlorophyll-a Variability in the Kuroshio Extension from altimeter and SeaWiFS. Twenty Second Conference on Climate Variability and Change, American Meteorological Society, Atlanta, Georgia, 17-21 January 2010.


Chu, P.C., and C. Sun, Quality control on ocean temperature and salinity data. Global Temperature and Salinity Profile Program Workshop, UNESCO, Oostende, Belgium, 6-7 May 2010.


Collins, C.A., Comparison of T7 XBT and CTD Temperature Profiles off California, XBT Bias and Fall Rate Workshop, University of Hamburg KlimaCampus, Hamburg, Germany, 25-17 August 2010.


OCEANOGRAPHY


Joseph, J. Presented NPS Plans at the SOCAL-10 Post-test/SOCAL-11 Planning Meeting (22-Nov, La Jolla CA)

Joseph, J. Presented Opt/EA Team Summary at ASWEET-10 Hot Wash (25-Oct, Reston VA)

Joseph, J. Presented Opt/EA Team support during ASWEET-10 field test (27 Sep – 04 Oct, San Diego CA)

Joseph, J. Presented Opt/EA Team plans for ASWEET-10 field test to ONR sponsors (08-Sep, Arlington VA)


Joseph, J. Participated in SOCAL-10 Behavioral Response Study (BRS) Planning Meeting (09-Mar, La Jolla CA)

Joseph, J. Presented Opt/EA Team progress report at PLU Team Leaders Mtg (27-Jan, Panama City FL)

Joseph, J. and Chiu, C.-S. Co-author presentation “Characteristics and variability of ambient noise in the South China Sea basin” at Acoustical Society of America Meeting (18-Apr, Baltimore MD)


Spydell, M.S., J. MacMahan, F. Feddersen and R. Guza, Surfzone Circulation at Imperial Beach from GPS-tracked Drifters, AGU Ocean Sciences Meeting, Portland, OR 2010.


Tokmakian, R., Understanding Uncertainty in Climate Model Components, University of East Anglia, Dept of Environmental Science, Invited Lecture, 2010

Tokmakian, R., Understanding Uncertainty in Climate Model Components, Isaac Newton Institute for Mathematical Sciences, Mathematical and Statistical Approaches to Climate Modelling and Prediction, Cambridge University, 2010

Tokmakian, R. and P. Challenor, A Design Experiment leading to Understanding Climate Uncertainty, Early Results, Ocean Sciences, 2010


Vesecky, J., K. Laws, and J.D. Paduan, “A system trade model for the monitoring of coastal vessels using HF surface


TECHNICAL REPORTS


RESEARCH REPORTS


PATENTS

W. Crane, J.K. Catterlin, A. Larraza. Terahertz (THz) Reverse Micromagnetron, Navy Case No. 2009010.


PHYSICS

OVERVIEW:
The Department of Physics has unique resources and faculty expertise in combat systems technologies, including sensor, acoustic, and weapon systems.

CURRICULA SERVED:
- Combat Systems Science and Technology
- Undersea Warfare
- Space Systems Engineering, Space Systems Operations
- Electronic Warfare, Information Warfare

DEGREES GRANTED:
- Master’s and Ph.D. degrees in Physics, Applied Physics, and Engineering Acoustics

RESEARCH THRUSTS:
- Optical and Electromagnetic Signal Propagation and Detection
- Weapons and Weapons Effects
- Underwater Acoustics and Communications
- Physical Acoustics
- Free-Electron Laser Physics
- Accelerator Physics
- Railgun Technologies
- Explosive Detonation Physics
- Dynamic Materials Properties
- MEMS-Based Sensors and Nanotechnologies
- Novel Detector and Sensor Development
- Autonomous Robotics
- Remote Sensing
- Radar Imaging, Non-Cooperative Target Recognition
- Terahertz Radiation, Sources and Imaging
- Physics of Networks
- Quantum-Well Infrared Detectors
- Quantum Cascade Lasers

RESEARCH CHAIR:
- Lawrence Livermore National Laboratory Chair

RESEARCH FACILITIES:
The Department of Physics has numerous advanced research facilities, including: a dedicated free-electron laser and linear accelerator facility; a gas gun laboratory; a railgun laboratory; a large, acoustic anechoic chamber; underwater acoustic tank facilities; a class 1000 clean room; a sensors research lab (including a laser vibrometer, a Fourier transform infrared spectroscopy, and a low-temperature photocurrent measurement system); a dome for telescope systems; and several advanced electron microscopes (a JEOL scanning electron microscope with variable temperature cathodoluminescence and transport imaging capabilities, a NovelX scanning electron microscope, and a Nanonics atomic force microscope with nearfield optical-scanning capability).
PHYSICS

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Physics is provided below:

Size of Program: $9.2M
PHYSICS

Andres Larraza
Chairman & Associate Professor
831-656-3007
larraza@nps.edu

Bruce Denardo
Associate Chairman of Research & Associate Professor
831-656-2952
denardo@nps.edu

Robert L. Armstead
Associate Professor
831-656-2125
armsted@nps.edu

David Ford
Research Professor
831-656-2540
dkford@nps.edu

Fred Kruse
Research Professor
303-499-9471
fakruse@nps.edu

Steven R. Baker
Associate Professor
831-656-2732
srbaker@nps.edu

Dragoslav Grbovic
Assistant Professor
831-656-2276
dgrbovic@nps.edu

John Lewellen
Associate Professor
831-656-2420
jlewellen@nps.edu

Joseph Blau
Research Assistant Professor
831-656-2635
blau@nps.edu

Nancy M. Haegel
Professor
831-656-3954
nmhaegel@nps.edu

James H. Luscombe
Professor and Chairman
831-656-2941
luscombe@nps.edu

Brett Borden
Professor
831-656-2855
bhborden@nps.edu

Richard M. Harkins
Senior Lecturer
831-656-2828
rharkins@nps.edu

William B. Maier
Senior Lecturer
831-656-2806
maier@nps.edu

Ronald E. Brown
Research Professor
831-656-2635
rebrown@nps.edu

John Harris
Research Assistant Professor
831-656-2941
jrharris@nps.edu

Richard C. Olsen
Professor
831-656-2019
olsen@nps.edu

Keith Cohn
Research Assistant Professor
831-656-2322
krcohn@nps.edu

Robert S. Hixson
Professor
831-656-2121
rshixson@nps.edu

Sebastian Osswald
831-656-2817
sosswald@nps.edu

William B. Colson
Distinguished Professor
831-656-2765
colson@nps.edu

Joseph Hooper
Assistant Professor
831-656-2601
jhooper@nps.edu

Jonathan Phillips
Research Professor
jphillip@nps.edu

Peter Crooker
Senior Lecturer
831-656-2232
ppcrooke@nps.edu

Daphne Kapolka
Senior Lecturer
831-656-1825
dkapolka@nps.edu

Joseph A. Rice
Research Professor & Engineering
Acoustics Chairman
831-656-2982
rice@nps.edu

D. Scott Davis
Associate Professor
831-656-2877
sdavis@nps.edu

Gamani Karunasiri
Professor
831-656-2886
karunasiri@nps.edu

Jose O. Sinibaldi
Research Associate Professor
831-656-2601
josiniba@nps.edu
Craig F. Smith  
Professor & LLNL Chair  
831-656-2185  
cfsmith@nps.edu

Kevin B. Smith  
Professor  
831-656-2107  
kbsmith@nps.edu

Richard Swent  
Research Associate Professor  
831-656-2872  
rlswent@nps.edu

David Trask  
COL, USAF (Ret.)  
MASINT Chair  
831-656-2219  
dmtrask@nps.edu

Donald L. Walters  
Professor  
831-656-2267  
walters@nps.edu
VIBRATION MEASUREMENTS ON PHALANX BLOCK 1B CIWS DURING LIVE-FIRE TESTING, FY2010

Steven R. Baker, Associate Professor
Department of Physics
Sponsor: Naval Sea Systems Command

OBJECTIVE: 1) To participate in the collection of vibration data at selected locations on the PHALANX Block 1B Close-In Weapons System (CIWS) during live-fire testing, to be conducted in FY09; 2) To analyze the linear vibration measurements using MATLAB and to report the results in a NPS Technical Report; 3) To create a DVD archive of the linear vibration measurements, to include the raw data, the MATLAB code, and the technical report.

SUMMARY: Live-fire testing of a PHALANX Close-In Weapon System was conducted on 17 & 18 Aug 2009 at China Lake. The primary purpose of the testing was to gather linear accelerometer vibration data at the same locations and under the same collection conditions (as best as possible) as NPS collected during a similar live-fire exercise conducted in 1996. The main difference here was that both the older MK149 rounds and the newer MK244 rounds were fired, whereas only the MK149 rounds were available in 1996. Also, a new FLIR camera prototype was employed. The goal of the vibration testing was to determine whether or not the use of the newer (MK244) rounds results in increased vibration levels being transmitted to the FLIR camera. The results of NPS’ vibration analysis will be considered by NAVSEA in writing the procurement specifications for a new FLIR camera. NPS participated in this testing and received the linear accelerometer vibration data for analysis. However, funding for a thorough analysis effort was not available in FY09. A spectral analysis of the data was performed in FY10. A technical report summarizing the findings was essentially completed in CY10. It will be published in Q1 CY11.

KEYWORDS: PHALANX, Close-In Weapons System (CIWS), structural dynamics, vibration.

UNDERWATER ACOUSTIC DETECTION AND TRACKING OF SELF-PROPELLED SEMI-SUBMERSIBLES (SPSS)

Jeremy Biediger, Physics Student
Joseph Rice, Research Professor
Department of Physics
Sponsor: SPAWAR Systems Center

OBJECTIVE: Coordinate with JIATF-S to deploy and test Seaweb networked acoustic sensors for detection and tracking of Self-Propelled Semi-Submersibles (SPSS).

ADVANCED METHODS IN RADAR IMAGING

Brett Borden, Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: To examine the nature of radar image artifacts and their relationship to scattering model mismatch with radar measurements. To develop a generalized radar imaging model that allows for arbitrary pulse shape and collection geometries (including moving targets).

SUMMARY: The research — now mostly complete — has successfully developed a generalized radar imaging theory appropriate to:

1. moving and stationary targets;
2. multistatic radar environments;
3. general waveforms.

Moreover, the theory reduces to all known traditional radar imaging methods in the appropriate data limits.
The image quality for this approach has been characterized by a generalized image point spread function (which we have shown to be related (in a non-trivial way) to the radar ambiguity function. Future work, if any, will concentrate on exploring the practical nature of this PSF.

PUBLICATIONS:

Book Chapters


Conferences


Journal Papers/Articles

M. Cheney and B. Borden, “Imaging Moving Targets from Scattered Waves,” Inverse Problems, 25, 123005 (2009) (invited Topical Review). (This paper was also selected to be part of a celebratory collection of Inverse Problems’ 25th Anniversary Highlights. These papers are representative of the exceptional efforts made by all of our authors and referees over the past 25 years and the collection includes an outstanding paper from each year of publication.)

AAW IM TECHNOLOGY INTEGRATED DEMONSTRATION & TRANSITION

Ronald E. Brown, Research Professor
Department of Physics
Sponsor: Naval Air Warfare Center-Weapons Division

OBJECTIVE: Project details are restricted.

DYNAMICALLY INDUCED SUPER-ENERGETIC EXPLOSIVE BEHAVIOR ON SHAPED CHARGE JETTING

Ronald E. Brown, Research Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Project details are restricted.

EFFECTS OF HYDRO-REACTIVE JETTING

Ronald E. Brown, Research Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Project details are restricted.
PHYSICS

FOLLOW-ON INVESTIGATIONS OF THE EFFECT OF HYDRO-REACTION DURING HYPERVELOCITY IMPACT AND PENETRATION

Ronald E. Brown, Research Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Project details are restricted.

INVESTIGATION OF THE EFFECT OF HYDRO-REACTION DURING HYPERVELOCITY IMPACT AND PENETRATION

Ronald E. Brown, Research Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Project details are restricted.

SUPER-ENERGETIC EXPLOSIVE BEHAVIOR: PROOF-OF-PRINCIPLE EXPERIMENT DOCUMENTATION

Ronald E. Brown, Research Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Project details are restricted.

SUPER-PRESSURE DETONATION BEHAVIOR

Ronald E. Brown, Research Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Project details are restricted.

FREE ELECTRON LASER PROGRAM

William B. Colson, Distinguished Professor
B. Rusnak, Research Associate Professor
Department of Physics
Sponsor: Raytheon

OBJECTIVE: In conjunction with Raytheon, the Naval Postgraduate School (NPS) will study and compile data on ship vibration, temperature, humidity, etc. as those variables affect sensitive equipment for accelerator technology.

SUMMARY: Raytheon engineers and NPS faculty conduct physics and engineering feasibility design on superconducting RF (SRF) and room temperature RF cavities that may be applicable for shipboard integration. Raytheon engineers and NPS faculty will conduct design studies to propose possible accelerator locations in current naval vessels as well as Navy of the Future DDX and CGX. Raytheon collaborated with NPS faculty and will support the NPS studies with empirical knowledge and expertise gained from Raytheon’s experience integrating state of the art technology into naval vessels. NPS has studied design recommendations for ruggedized SRF or normal conducting cavity designs for future integration on Navy platforms.
PHYSICS

FEL OPTICAL WAVEFRONT ANALYSIS, THz FEL ANALYSIS, OSCILLATOR/AMPLIFIER PHYSICS

William B. Colson, Distinguished Professor
Joseph Blau, Research Associate Professor

Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Develop methods for analyzing FEL optical wavefronts, study THz FELs using waveguides, and improve simulation models of FEL oscillators and amplifiers.

SUMMARY: Developed 4D simulations of FEL oscillators and amplifiers, with the capability to import and export particles and optical fields to and from external codes. We added a new method for analyzing FEL optical wavefronts using Hermite-Gaussian modal decomposition. We developed a new analysis of THz FELs using waveguides.

PUBLICATIONS:


PRESENTATIONS:


THESES DIRECTED:


PARTICLE ACCELERATOR RUGGEDIZATION AND TEST BED FOR NAVAL INTEGRATION AND WEAPONS OF MASS DESTRUCTION DETECTION

William B. Colson, Professor

Department of Physics
Sponsor: Raytheon Company

OBJECTIVE: This collaborative research will focus on the development of ruggedized accelerators to be used for Weapons of Mass Destruction (WMD) detection for shipboard operation using modeling and system physics analysis. The collaborators will study and compile data on ship vibration, temperature, humidity, etc. as these variables affect sensitive equipment for accelerator technology. Raytheon and NPS will conduct physics and engineering feasibility design on Superconducting Radio Frequency (SRF) and Room Temperature RF (RTRF) cavities that may be applicable for shipboard integration. In addition, the partners will conduct design studies to propose possible accelerator locations in current naval vessels as well as next generation Navy vessels such as the DDX Destroyer and CGX Cruiser.
PHYSICS

THZ FEL SHIP INTEGRATION
William B. Colson, Distinguished Professor
Joseph Blau, Research Associate Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: This project supports the ONR development and applications of Free Electron Lasers to be deployed on Navy ships.

SUMMARY: Ship integration is studied in collaboration with University of Texas’ Center for Electromechanics, Austin TX. A model of the Navy’s electric ship is developed and studied resulting in publications, presentations, and NPS student theses. The electric ship model includes propulsion, sonar, radar, as well as an electromagnetic gun, and free electron laser. In addition, space physics applications were explored for the proposed ONR MW-level directed energy weapon after it is deployed on ships.

PUBLICATIONS:

PRESENTATIONS:


THESES DIRECTED:


ONR FEL DEVELOPMENT AT NPS – INP
William B. Colson, Distinguished Professor
Joseph Blau, Research Associate Professor
Keith Cohn, Research Assistant Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: This project supports the development of the ONR sponsored Innovative Naval Prototype FEL, but only started at the end of the year, November 2010.

SUMMARY: This past year, the contract to build the Innovative Naval Prototype (INP) FEL was awarded to Boeing. NPS worked closely with Boeing as they prepared their proposal by modeling their designs, teaching them FEL theory, and teaching them how to run our FEL simulations. Now that Boeing has won the contract, ONR has funded
us to continue supporting Boeing’s work on the INP. This research project supports the simulation and modeling of INP amplifier and oscillator designs being considered by Boeing. Additionally, it supports upgrades to the existing NPS FEL codes to better interface with external codes; this facilitates the start-to-end simulations currently pursued by Boeing. Some of the NPS upgrades include the capability to import/export optical fields from/to external optical propagation codes and to import electron distributions from external particle tracking codes. The former enables the creation of a 4D FEL oscillator model by linking the NPS 4D amplifier code to the Boeing optical code OSSim. This past December, CAPT Younhoan Bae was presented the NAVSEA award for his outstanding thesis research in this field.

PRESENTATIONS:


THESES DIRECTED:


NPS AND UMD THZ SOURCE DEVELOPMENT

William B. Colson, Professor
J. Blau, Professor
J. Lewellen, Professor
J. Harris, Professor
K. Cohn, Professor
B. Rusnak, Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: The Naval Postgraduate School Free electron Laser Group will study the design of a THz source based on the free electron laser mechanism.

WATER WAVE AND ACOUSTIC RADIATION FORCES

Bruce Denardo, Associate Professor
Department of Physics
Sponsor: NAVSEA

OBJECTIVE: The time-averaged force on a body due to a wave is referred to as a radiation force, which occurs because waves carry momentum. In our water wave research, we previously performed laboratory experiments that established the validity of the theory, and we published the results. The current objective is to obtain funding to computationally and experimentally quantify the effect for ships undergoing ship-to-ship replenishment at sea. Waves produce an attractive force that can cause the ships to collide. The goal is to supply commanders with guidelines so that the procedure can be performed safely for various types of sea states. In our acoustics research, a small body is attracted to a high-intensity source of diverging sound waves as a result of radiation pressure. A goal was to perform an experiment to measure the force and to compare the values to the theory. A possible application is an ultrasonic purifier for fluids, where unwanted particles are attracted to a sound source and collected electrostatically or by another means. Such a device could be used to replace centrifuges for oil on submarines.

SUMMARY: Estimates show that the force of attraction of two ships can be substantial. Funding is currently being sought for research to establish guidelines for ship-to-ship replenishment at sea. A collaborator who is interested and able to perform the difficult computer simulations was found (Dr. Thai Nguyen, Naval Surface Warfare Center, Panama City Division, Panama City, FL). Regarding our acoustics research, experiments were performed in an anechoic chamber with an aluminum ball suspended from an analytical balance. A baffle rests on the enclosure of a
loudspeaker. Reasonable agreement between the radiation force theory and experimental data occurs when the drag on the ball due to the jetting from the hole in a baffle is included in the theory. However, the results were found to be sensitive to the experimental arrangement. For this and other reasons, we abandoned the baffle, and were able to obtain funds for an acoustic transducer that measures particle velocity, which is necessary for the experiment when a spherical wave (as from a baffle) does not occur.

PRESENTATIONS:


USE OF BUBBLES FOR PRESSURE MINE SWEEPING
Bruce Denardo, Associate Professor, Department of Physics
Support: ONR

OBJECTIVE: When bubbles are introduced into water, a pressure drop in and below the bubble field is expected because the decrease in average density of the bubbly water causes a reduction of hydrostatic pressure. Pressure mines operate by monitoring for a pressure drop that is characteristic of that due to the Bernoulli effect of a passing ship. If such a pressure drop is detected, the mine will detonate. The idea of this research project is to use bubbles to simulate the pressure drop due to a passing ship, in order to harmlessly detonate a pressure mine. One issue is the actual nature of the change in pressure due to a bubble field. Because the system is dynamic rather than static, hydrostatic calculations were found to be substantially inaccurate. The motion of the bubbles will induce an upward flow that is expected to contribute to the lowering of the pressure due to the hydrostatic effect. Calculations of this effect are very difficult, and can only be made with many approximations. Experimental investigations must therefore be undertaken.

SUMMARY: As part of Phase II for this ONR-funded research, NPS thesis research student John Actkinson, myself, and our collaborators conducted experiments in the tow tank in Spanagel Hall. The bubbler consisted of a system of porous tubes connected to an pressurized air source. Rough scaling arguments suggest that the pressure drop for a much larger apparatus (by a factor of 10) would be sufficient for pressure mine sweeping. We later performed successful experiments with such a bubbler in the David Taylor Test Basin at the Carderock Naval Test Facility in Maryland. Continued funding was expected. However, a certain small type of boat was specified to be used to deploy the system, and these boats are too small to carry the compressors required to generate the bubbles, so the project was terminated.

QUASIPERIODIC MOTION
Bruce Denardo, Associate Professor, Department of Physics
Support: NAVSEA

OBJECTIVE: Quasiperiodic motion in an oscillatory system is a permanent nonsteady motion that corresponds to a frequency that is irrationally related to the primary frequency. The most interesting occurrence of quasiperiodicity (QP) is in driven damped nonlinear systems. QP is often unwanted in practical systems, for example, heavy rotating machinery, and an understanding of QP can lead to its avoidance. QP also produces sound which could be used for identification and tracking. In addition, the study of QP is part of the NPS course PH4459 (Nonlinear Oscillations and Waves). Due to the importance of QP, the subject was recently split from chaos. However, much of the material of QP still needs to be established, including analytical calculations, computer simulations, and demonstrations. One purpose of our research is to help fill this need. The main objective of this thesis is to explore QP in the common case of nonlinear isotropic oscillators which have two identical orthogonal modes. One mode is driven and the other mode can be excited due to the nonlinear coupling between the modes. Preliminary experiments have shown that QP can occur in such systems.
PHYSICS

SUMMARY: Extensive computer simulations of the standard model system do not yield QP. Except for an unusual form of QP, the motion settles into a steady state with constant amplitudes of the two modes. Further simulations show that QP also does not occur in several alternative model systems, including weakly anisotropic oscillators. However, a number of experimental systems do yield QP. These experiments were carefully described and quantified. Suggestions are made on future research regarding how QP can be understood and predicted, and how the contradiction between theory and experiment may be resolved.

THESES DIRECTED:


INVESTIGATION OF ASYMMETRIC FLOW FIELDS INDUCED BY LOCALIZED THERMAL GRADIENTS

David K. Ford, Research Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Investigate possible aerodynamic and optical instabilities created by localized, asymmetric entrainment of air near a source of strong, localized thermal gradients introduced into the boundary layer of supersonic tactical missiles. The effort will develop matched asymptotic expansions of the thermo-continuum mechanical equations of motion connecting heat transport and vorticity production across the boundary layer, intermediate layer and farfield (Euler) flow.

SHOCK WAVES IN COUNTER DIRECTED ENERGY APPLICATIONS

David K. Ford, Research Professor
Department of Physics
Sponsor: ONR

OBJECTIVE: The overall objective of this work is to investigate the effect of shock induced disturbances in the atmosphere on the propagation of Directed Energy Weapons.

SUMMARY: Several nations (China, Russia, USA) are actively pursuing the development of Directed Energy Weapons (DEW). There is a need for defensive strategies to counter the disastrous effects of when deployed against US aircraft, drones, missiles, etc.

I am investigating two issues related to the use of shock waves in Counter Directed Energy Applications (CDEW).

1. What potential role might shock interactions play in developing a rapidly deployable CDEW “shield”? For example the effects of ultrasound generated diffraction gratings on optical wavelengths is fairly well understood. The behavior of non-linear density, temperature, entropy fluctuations (induced by strong shock interactions) on the propagation of nonlinear optical sources is less understood.

2. There is also recent activity in the development of LASER resistant materials and coatings as a defensive mechanism for missiles and aircraft. If these material development efforts are successful and the missile, say, survives a prolonged (several seconds) encounter with a DEW, what are the aerodynamical and stability implications of the presence of a persistent, localized source of energy in the flow field of a (sometimes hypersonic) target? Will the missile fail for aerodynamic stability reasons even if it survives the DEW attack?
PHYSICS

PRESENTATIONS:


HIGH Z MATERIALS FOR NUCLEAR RADIATION DETECTION: SYNERGY OF GROWTH, CHARACTERIZATION AND DEFECT PHYSICS FOR ROOM TEMPERATURE DEVICES

Nancy M. Haegel, Professor
Department of Physics
Sponsor: National Science Foundation/Department of Homeland Security

OBJECTIVE: The objective of this work is to develop new “high Z” materials for room temperature nuclear radiation detectors. These detectors must be able to absorb a significant fraction of high energy radiation, but almost must be thin to be able to be manufactured and utilized in large quantity. This collaborative effort with UC Berkeley and other materials suppliers will investigate complex oxide materials for this application. The NPS contribution is to develop a bulk, non-destructive, non-contact method using the scanning electron microscope to characterize the transport properties of these new materials.

PUBLICATIONS/PRESENTATIONS:


THESES DIRECTED:

Major Kevin Blaine, USA
Major David Phillips, USA

NEAR FIELD TRANSPORT IMAGING OF NANOWIRES

Nancy M. Haegel, Professor
Department of Physics
Sponsor: DARPA

OBJECTIVE: In this work, near-field transport imaging will be applied to nanowire structures in collaboration with DARPA supported programs at NIST Boulder, Georgia Institute of Technology and Magnolia Optical and organizations developing nanowire materials for sensing and energy harvesting applications. The PI will travel to the institutions listed above to present the unique NPS capability in transport imaging and to establish collaborations. The materials of interest include GaN and ZnO nanowires. Measurements will then be made at NPS to provide characterization of minority carrier diffusion length on samples provided by the collaborators.

PUBLICATIONS/PRESENTATIONS:


“Imaging Transport: Monitoring the Motion of Charge through the Detection of Light,” Physics Department Colloquium, Georgia State University, Sept. 9, 2010.

“Imaging Transport: Monitoring the Motion of Charge through the Detection of Light,” Physics Department Colloquium, Georgia Institute of Technology, Sept. 10, 2010.


**THESES DIRECTED:**

LT Adam Cole, USN

**NEXT GENERATION REMOTELY TRIGGERED PLED EMITTERS FOR IIFF FOR SPECIAL OPERATIONS FORCES**

*Nancy M. Haegel, Professor*  
*Department of Physics*

**Sponsor:** US Special Operations Command, OSD Technology Transition Initiative

**OBJECTIVE:** The objective of this project is to produce the next generation individual identification friend or foe (IIFF) patch for mitigation of shooter-on-shooter fratricide. This work is done in conjunction with Add-Vision, Inc. These devices will be designed to be lighter and brighter than previous generations and will be part of the Technology Transition Initiatives from OSD in FY09. 100 devices will be produced in Spiral 1 with field testing and evaluation planned for Summer 09.

**PUBLICATIONS/PRESENTATIONS:**


Presentation at Navy Special Warfare, Dam Neck, VA January 8, 2010

**THESES DIRECTED:**

LT Karl Burnett, USN

LT Yvette Davis, USN

LT Aaron Woolsey, USN

**NPS NEXT GENERATION VEHICLE MOUNTED IDENTIFICATION FRIEND OR FOE (VMIFF) AND COBRA GOLD 2010 DEMONSTRATION/EVALUATION**

*Nancy M. Haegel, Professor*  
*Department of Physics*

**Sponsor:** Office of the Secretary of Defense (RRTO)

**OBJECTIVE:** The objective of this work is to develop a next generation device that offers a low cost solution for the mitigation of air to ground fratricide by leveraging existing targeting and ranging systems. The devices employ a triggered emitter, which will provide immediate warning signal in both thermal and near IR bands if a vehicle is targeted by friendly forces. Two prototype devices were designed and initially demonstrated and evaluated, in collaboration with the Marine Corps Experimentation Center of MARFORPAC, at Cobra Gold 10. Subsequent testing with dedicated F18 support was also performed at China Lake in Sept. 2010, reaching new records for remote activation and observation.

**PRESENTATIONS/PUBLICATIONS:**

Presentations at Cobra Gold 2010 (Feb. 2010), Marine Corps MAWTS Yuma (June 2010), China Lake Naval Air
PHYSICS
Station (Sept. 2010), ONR Code 30 Force Protection Thrust Area Program Review (Oct. 2010)

THESES DIRECTED:
LT Karl Burnett USN
LT Aaron Woolsey USN
LCDR Robert Kerchner USN

REMITELY TRIGGERED VEHICLE MOUNTED IFF (VMIFF)
Nancy M. Haegel, Professor
Department of Physics
Sponsor: Office of Naval Research (ONR)

OBJECTIVE: Based on the successful Cobra Gold demonstrations and positive feedback from both air and ground observers, we propose the design and construction of 10 VMIFF4 designs that would integrate both near IR and MWIR response in a single device for optimized performance. These devices would be fabricated to demonstrate a fieldable design. The program will be carried out in collaboration with the US Marine Corps Forces Pacific Experimentation Center (MEC) which will coordinate a focus team workshop and provide assessment and documentation. Device design and fabrication would occur in the period from April through August 2010 with assessment and demonstration in September-October 2010 depending on exercise availability.

PUBLICATIONS/PRESENTATIONS:
Presentations at Cobra Gold 2010 (Feb. 2010), Marine Corps MAWTS Yuma (June 2010), China Lake Naval Air Station (Sept. 2010), ONR Code 30 Force Protection Thrust Area Program Review (Oct. 2010)

THESES DIRECTED:
LCDR Robert Kerchner, USN

REMITELY TRIGGERED VEHICLE MOUNTED IFF (VMIFF)
Nancy M. Haegel, Professor
Department of Physics
Sponsor: Office of Naval Research (ONR)

OBJECTIVE: The Vehicle Mounted IFF (VMIFF) is a device that emits a warning signal to air or ground troops in the event of targeting a friendly vehicle. The VMIFF remains covert unless illuminated (ranging or targeting) by US forces. If triggered, VMIFF emits either a near IR (visible with NVGs) or MWIR thermal (visible in thermal imagers on targeting pods) in order to interrupt the targeting sequence. Single VMIFF prototypes have been both activated and observed from the air at tactically significant ranges during Cobra Gold 08 (near IR at night) and Cobra Gold 10 (MWIR during the day). In FY10, ten integrated devices with both MWIR and near IR response were designed and fabricated. In FY11, these devices will be evaluated in a series of field experiments, under the direction of the MARFORPAC Marine Corps Experimentation Center (MEC).

Objectives for FY11 include:
• Preliminary field demonstration and evaluation at the Marine Corps Weapons and Tactics Instructors (WTI) course at MWATS/Yuma in Fall 2010.
• First field demonstration and evaluation of new devices at Cobra Gold 11
• Full field demonstration and evaluation of new devices at WTI Spring 2011

NPS will provide:
• Subject matter experts for field testing
• Analysis of range data and optimization of device performance
• Experimental support for determining optimum operational performance

THESES DIRECTED:

LCDR Robert Kerchner, USN
LT Spencer Talley, USN

SPIRAL 2 PLED EMITTERS FOR IIFF FOR SPECIAL OPERATIONS FORCES
Nancy M. Haegel, Professor
Department of Physics
Sponsor: SOCOM/SAO-L-T

OBJECTIVE: Support design, evaluation and transition of Spiral 2 IIFF (Individual identify friend or foe) patch for Special Operations Forces.

TRANSPORT IMAGING, NUCLEAR RADIATION DETECTORS, COMPLEX OXIDES
TRANSPORT IMAGING OF SEMICONDUCTOR NANOWIRES
Nancy M. Haegel, Professor
Department of Physics
Sponsor: National Science Foundation

OBJECTIVE: The objective of this work is to demonstrate direct imaging of charge transport in semiconductor nanowires using a unique method of near-field collection of luminescence associated with carrier recombination. A near field optical scanning microscope (NSOM) is operated inside an SEM to collect the distribution of luminescence from point source generation at the nanometer scale. Initial focus is on transport in SiC films and wires and doped Si nanostructures.

PUBLICATIONS/PRESENTATIONS:

THESES DIRECTED:

LT Richard Adam Cole, USN
CDR Dan Chisholm, USN
OBJECTIVE: The Naval Postgraduate School (NPS), in conjunction with Case Western Reserve and Bristol Universities began a two-year robotics and systems development program to address critical topics in the field of autonomous amphibious vehicles. This is a two year funded program and has been extended at no cost to complete in September 2011.

In recent years there has been significant interest in the development of robots capable of autonomous operation within turbulent ocean surf-zones environments. This region, also referred to as the near-shore zone, encompasses the area between the outermost breakers and the bore area where wave water rushes onto the beach. The water in this locale is shallow, sometimes between 5 and 10 m deep; consequently, most waves there are unstable and extremely challenging for navigation and maintenance of stability. Areas within this region can be submerged during high tide and open during low tide, therefore demanding the capacity for locomotion in both regimes. Potential utilities for such a robot include: mine clearing, terrain mapping, and scouting potential approach lanes for amphibious naval operations. Shallow water mines, in particular, are a very significant hazard that necessitates robotic operation through land and water in this expanse.

Although no mature examples of autonomous robots capable of operation in land and water exist today, many animals have developed singular modes of locomotion that are efficient in both terrestrial and aquatic substrates. For example the preferred form of locomotion for crabs and lobsters is crawling, yet they maneuver smoothly both in and out of the water utilizing their appendages. There is a clear need for a methodology enabling the design and fabrication of vehicles with some fraction of this capacity. Such a vehicle could be a robot capable of the following mission sequence:

1. Deployment offshore from an underwater or aerial venue (e.g. from an aircraft or submarine),
2. Crawling underwater or swimming to a target zone (e.g. an area arrayed with shallow-water mines),
3. Locomoting successfully over land and underwater obstacles to reach critical areas (e.g. areas with submerged or buried explosives), and
4. Transmitting critical data (visual, acoustic, chemical, electronic, etc) from its position to other vehicles and/or a remote operator. Ideally, the vehicle would be able to exit a given target zone aquatically or terrestrially to move to another region of interest.

Research in this program is driven by unresolved issues in this arena related to remote sensing, search and mapping, and mine countermeasures in the ocean littoral and/or rivers and streams. Specifically, we present work aimed at addressing mobility and autonomous control issues in beach and ocean surf-zone regions. Challenges in this region include uneven substrates, rocks, boulder fields, shoals, wave surge, tidal currents, algal beds, etc. A robot operating in this region will be expected to navigate based on a specified compass heading, with GPS signals accessible while on land. Its controller must traverse terrain obstacles (large and small rocks, wet sand, etc.) without disrupting higher-level navigation sequences. Fundamentally the design of such a vehicle must address the tradeoff between complex mechanical designs facilitating mobility over several substrates, verses the difficulty of controlling these structures with enough rigor for full autonomous operation.

In order to meet these demands, we introduce a hybrid wheel-leg platform (dubbed Whegs™) drawing inspiration from cockroach mobility principles. In past work, our laboratory tests, demonstrations, and field testing have shown intriguing potential for combining active and passive control mechanisms to achieve the autonomy and robustness necessary for operation in the rocky terrain, hard sand, and soft sand that characterize the surf-zone environment.

SUMMARY: In Year I of this program we report the completion of the design and simulation of an autonomous amphibious robot, Pelican Whegs™, capable of navigating the challenging terrain of the ocean surf-zone region based on abstracted biological inspiration. Abstracted biological inspiration attempts to distill salient biological principles and implement them using presently available technologies; its efficacy lies in the successful fusion of organic and inorganic architectures such that the proper level of influence of biology is established for optimum performance.
Pelican Whegs™ benefits from insect inspired mechanisms of locomotion for movement over challenging and different terrains. Design innovations will allow the robot to navigate on rough terrain and underwater, and to accomplish tasks with little or no low-level control. Because of the ability of Pelican Whegs™ to swim, in future operations, the robot could be deployed far out to sea, swim toward shore, and then walk along the ocean floor through the surf zone and onto the beach. It could search for objects on land or on the ocean floor and swim over obstacles that pose any risk of trapping it, making it ideal for mine sweeping, surveying and civilian applications. The robot’s mechanics are an integrated and essential part of its control system. It does not have, or need, sensors and control circuits to actively change its gait. Instead, its mechanics cause it to passively adapt its gait appropriately to very different terrains. Therefore, subsequent work in motor control circuits (in Year II) will be reduced to controlling broad directives of the robot. The confluence of active and passive control mechanisms in the robot will ultimately result in a system with the simplicity of a wheeled vehicle that nevertheless facilitates the mobility of a legged vehicle. Prototype fabrication and control system implementation will be completed in Year II of the research program.

In year two the program included prototype fabrication and control system testing. Implementation will and testing will occur in the Spring of 201, with a planned demonstration in the summer of 2011 in Singapore.

**GENERATION AND DYNAMICS OF INTENSE CHARGED PARTICLE BEAMS**

*John R. Harris, Research Assistant Professor*

*Department of Physics*

*Sponsor: Unfunded*

**OBJECTIVE:** To study the generation, transport, and control of intense charged particle beams, including halo formation and space charge wave propagation.

**SUMMARY:** The generation and dynamics of high-current, high-quality charged particle beams is dominated by the self electric and magnetic forces in the beams. These forces are collectively referred to as “space charge forces,” and beams in which they dominate are known as “intense.” Such beams are of great importance for a number of defense-related technologies, including free-electron lasers (FELs) for ship defense, flash x-ray radiography for nuclear stockpile stewardship, and high-power microwave tubes for radar and directed energy applications. For the shipboard FEL application in particular, minimizing the weight required for radiation shielding, and minimizing the radioactivation of the machine due to neutron generation at beam energies above 10 MeV, are crucial. One of the sources of such radiation is the beam halo, consisting of beam particles ejected from the beam core, but continuing to travel down the beam pipe with high energy. Such particles will not be transported efficiently, and will be lost by collisions with the beam pipe, generating unwanted radiation. This project, a collaboration between NPS, Lawrence Livermore National Laboratory, and the University of Maryland, is investigating the formation of beam halo in the presence of beam density fluctuations and longitudinal space charge waves.

**MEASUREMENTS AND MODELING OF THE STATIC AND DYNAMIC BEHAVIOR OF THE POROUS MATERIALS OF PLANETARY SCIENCES**

*Robert S. Hixson, Professor*

*Department of Physics*

*Sponsor: NASA*

**OBJECTIVE:** There is a significant need in the planetary physics community for new physics models that describe the fundamental processes occurring in dynamic compression of porous materials. Porosity may be the dominant property that determines the outcome of impact events that have shaped the solar system. However, in spite of the fact that it is important to better understand these dynamic processes, very little high quality data and physics models constrained by such data exist for the relevant planetary materials. Here we propose to use current state-of-the-art experimental and theoretical tools to determine physics models that are vital to obtaining a better understanding of how porous planetary materials respond to dynamic compression. We have the right tools to make significant progress on this important problem.
NEW ARMOR CONCEPTS BASED ON FUNDAMENTAL PHYSICS
Robert S. Hixson, Professor
Department of Physics
Sponsor: NASA

OBJECTIVE: We propose to define new kinds of armor systems based on fundamental dynamic physics concepts. These lead us to consider novel materials and combinations on materials with properties that allow armor effectiveness to be improved. We have defined an initial concept, and in this proposal define the theoretical/simulation approach, as well as the experimental approach to solving this problem.

MEMS DIRECTIONAL ULTRASONIC SENSOR
Gamani Karunasiri, Professor
Department of Physics
Sponsor: National Security Agency (NSA)

OBJECTIVE: The objective of the proposed program is to develop an directional ultrasonic sensor based on a recently developed MEMS directional sound sensor that operates similar to the *Ormia ochracea* fly’s ears.

SUMMARY: In the proposed program, optimized sensors that operates near 20 kHz will be designed using COMSOL Multiphysics finite element modeling. The performance of the sensors under sound excitation will be modeled by coupling a sound filed including the effects resulting from the surrounding Si substrate. The structures will be fabricated using SOIMUMS fabrication process using SOI substrates having 25 μm thick device layer. detection frequencies of the sensor will be optimized to match with the requirements in the field. The fabricated sensors will be characterized optically using laser vibrometer and electronically using the integrated comb finger capacitors.

REAL TIME THZ DETECTION USING MICROBOLOMETER FOCAL PLANE ARRAY
Gamani Karunasiri, Professor
Department of Physics
Sponsor: Air Force Office of Scientific Research (AFOSR)

OBJECTIVE: The objective of the research is to develop a real time terahertz imaging system using microbolometer focal array technology.

SUMMARY: The aim of the proposed research is to develop a real time terahertz imaging system using microbolometer focal array technology originally developed for infrared imaging in the 8-12 μm band. The successful conclusion of the research project will lead to the incorporation of microbolometer technology for real time imaging at THz frequencies. Such imaging systems can be utilized in standoff detection of concealed objects and medical imaging with deeper penetration compared to infrared thermography.

THESES DIRECTED:


PHYSICS

HIGH SENSITIVE THZ CAMERA FOR APPLICATIONS IN SPACE SITUATION AWARENESS
Gamani Karunasiri, Professor
Dragoslav Grbovic, Assistant Professor
Department of Physics
Sponsor: AS&T, NRO

OBJECTIVE: The detection of colder objects in the space environment requires the use of sensors operating in longer wavelengths (30 to 300 µm) than that used in conventional infrared bands; these objects can include debris, or intentionally quiescent man made satellites. The terahertz region of the electromagnetic spectrum (1 to 10 THz) covers these wavelengths and is highly suitable for sensing in this spectral band. This region of the spectrum has not been fully utilized due to the lack of highly sensitive detectors. Recently, we have successfully demonstrated real time imaging at THz frequencies using an uncooled microbolometer camera which was designed for infrared wavelengths. The major advantages of this technology for space applications are low power consumption and light weight in addition to the low cost. The aim of the proposed research is to develop THz optimized highly sensitive real time THz imaging system using micro-electro-mechanical-system (MEMS) based bi-material focal plane array technology. The successful conclusion of the research project will lead to a highly sensitive light weight THz camera for applications involving space situation awareness.

MEMS ACOUSTIC SENSOR
LCDR Michael Touse, Physics Student
Gamani Karunasiri, Professor
Department of Physics
Sponsor: Space and Naval Warfare Systems Center-San Diego

OBJECTIVE: To design, fabricate, package, and test a micro-electromechanical directional microphone.

MEMS BI-MATERIAL FOCAL PLANE ARRAY FOR REAL TIME THZ IMAGING
Gamani Karunasiri, Professor
Dragoslav Grbovic, Assistant Professor
Department of Physics
Sponsor: Office of Naval Research (ONR)

OBJECTIVE: The objective of the project is to perform research and develop a highly sensitive real time terahertz (THz) imaging system using micro-electro-mechanical-system (MEMS) bi-material technology.

SUMMARY: The proposed research is planned over three years, with the initial phase devoted to the design, fabrication and characterization of metamaterial based high THz absorbing thin films. Fabrication of bi-material pixel arrays will be carried out using Stanford University Nanofabrication Facility and Oak Ridge National Lab’s Center for Nanophase Materials Sciences, and the optical readout system will be developed. Extensive characterization of the camera will be carried out using the existing QCL-THz sources as well as the compact THz-FEL source under development at NPS.
MEMS-BASED MINIATURE MICROPHONE FOR DIRECTIONAL SOUND SENSING
Gamani Karunasiri, Professor
Jose Sinibaldi, Research Associate Professor
Department of Physics
Sponsor: National Science Foundation (NSF)

OBJECTIVE: The objective of the proposed research is to develop an integrated MEMS-based miniature microphone system for directional sensor.

SUMMARY: The proposed research is to develop an integrated MEMS-based miniature microphone system for directional sensing of sound similar to that of *Ormia ochracea* fly. The fly employs a unique coupled mechanical bar system to extract the direction of sound with ears separated only about 500 μm. A set of such sensors can be used for pinpointing explosions by monitoring the direction of sound which can be deployed using micro air vehicles. In addition, a network of these sensors can be used for unattended movement monitoring.

THESES DIRECTED:

A THZ MICROMAGNETRON
Andres Larraza, Associate Professor
Department of Physics
Sponsor: NSF

OBJECTIVE: The overall objective of this work is to investigate and develop MEMS based reverse-magnetron designs as sources of THz radiation, for applications on Improvised Explosive Device (IED) detection. Because terahertz radiation can penetrate paper and clothes, it can be used as means to detect terror material in envelopes and packages and can become useful for airport security.

SUMMARY: There is a need for more readily available intense sources of THz radiation for imaging and other applications, especially in the area of IED detection. Most current sources of THz radiation are either very dim (e.g. nonlinear down conversion of optical lasers generate typically nW outputs), inefficient, or both (e.g. far IR lasers have output in the THz region of few mW but efficiencies of about .01%). Unfortunately, the intense sources are uniformly bulky and difficult to transport (e.g. free electron laser & synchrotron radiation sources.) This research focuses on a new magnetron MEMS-based design, where the anode is located at the center of the magnetron, surrounded by a cathode ring. In this case, electrons move radially inward in the combined electric and magnetic cross-fields and can reach orbiting angular frequencies in the THz region, even with a field of the order of 1T.

We have designed a THz source consisting of several hundred reverse magnetrons in a 1cm × 1cm chip. The integration of the chip in a confocal cavity provides feedback among the reverse magnetrons. Once integration is finally accomplished – chip, chip mount, magnet, cavity, electric power, and heat management – the device is expected to occupy a volume equal to about two soda cans. This will make the design portable and bright, which is a highly desirable condition for field applications.

PUBLICATIONS:

PRESENTATIONS:
THESES DIRECTED:


Hun Lo Chee, Design and testing of a THz micromagnetron, December 2010 (advisor).

NAVAL SEA SYSTEMS COMMAND, THESES AND CURRICULUM SUPPORT
Andres Larraz, Associate Professor
Department of Physics
Sponsor: NAVSEA

OBJECTIVE: Provide direct support between Curriculum Sponsor (COMNAVSEASYSCOM), curriculum students, faculty and their research. The proposed funding is provided for sponsorship of the NPS Combat Systems Science and Technology (CSS&T) Curriculum. Participants will work directly with the faculty in the study of missile systems as well as student thesis research. This curriculum includes topics that are of direct interest and have application to NAVSEA including Theater Air Missile Defense, Radar Missile design, and advanced sensors, and improvements to better prepare the student in future air and surface threats.

SUMMARY: NAVSEA recognizes the need to participate directly with the faculty in the study of military systems and in curriculum development, educational upgrades, and student thesis research. NAVSEA also recognizes the importance of directly linking the curriculum students to the programs managed by NAVSEA. Central funding at the (Physics) department level is requested in order to enable better coordination with individual research projects and to initiate efforts that further the science and technology goals of NAVSEA in the following areas:

1. Open Architecture. An important aspect of the system integration efforts is that of Open Architecture. Under the capstone course Advance Applied Physics Laboratory, PC401, students will learn system requirements and system integration modeled after the Open Architecture protocols established by PEO IWS.
2. Atmospheric propagations of high power laser beams. One of the most significant problems facing the delivery of energy on target for DEW is the atmospheric variability. Development of course material (even a full) course will be undertaken to address these technical issues.
3. Total Ship Systems Engineering (TSSE). Revisit the TSSE track of the CSS&T curriculum in order to increase participation in the design project that incorporated Combat Systems Integration

CURRICULUM RESEARCH AND THESIS ACTIVITIES:
1. Development of techniques for neutralizing explosive threats.
2. Directed energy weapons concepts.
3. THz source and detector development for IDE detection and imaging.
4. Advanced methods in radar imaging.
5. Imaging transport instrument for material research.
6. Field experiments on IIFF’s.
7. Cyber security.
9. Counter DEW technologies
10. New weapons concepts systems onboard electric ships (including railgun and FEL).
11. New sonar technologies, including vector sensor technologies.
PHYSICS

ADVANCED SUPERCONDUCTING RF CAVITY STUDY, BEAM HALO ANALYSIS, PHOTOTHERMAL CATHODE STUDY (INP)
John Lewellen, Associate Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: Experimental accelerator physics in the areas of advanced superconducting RF (SRF) accelerating cavities and SRF cavities as electron photo-guns, beam halo formation and minimization in electron guns, and photothermal cathode investigations is needed to compliment theoretical and simulation work at NPS and to support work by industry and other collaborators on the ONR FEL INP.

MW-CLASS FREE ELECTRON LASER INJECTOR TECHNOLOGY VALIDATION
John Lewellen, Associate Professor
Department of Physics
Sponsor: High Energy Laser Joint Technology Office

OBJECTIVE: This project will study the properties of advanced cathodes for high-average-current, high-brightness injectors. In particular, the quantum efficiency of dispenser photocathodes will be measured as a function of time and position on the cathode surface. Studies to determine the ability of the cathode to regenerate the quantum efficiency following damage is also of interest.

Diamond pyramid field emission cathodes will also be investigated, for Ion-term operational performance, in particular emission uniformity and stability, as well as resistance to ion impact damage.

SRF INJECTORS
John Lewellen, Associate Professor
Department of Physics
Sponsor: Office of Naval Research

SUMMARY: This year saw a major success, with the first operation of the NPS Mark I superconducting RF electron injector (SRF gun) at Niowave, Inc.’s test facility in Lansing, MI. This represents an important series of firsts:
- First operation of a quarterwave-based SRF gun, anywhere;
- First operation of a standalone SRF injector in the US; and
- First operation of a superconducting beam source funded by the US Navy.

The initial trials proceeded well, with measured results consistent with simulation. The entire effort represented a close collaboration between the Naval Postgraduate School, Niowave, Inc., and Boeing. We have presented the results of the research at several conferences, and a paper is in final review for publication. At the urgings of ONR, we also began the design of a 2nd-generation SRF gun with significantly enhanced capabilities, based upon the initial success at Niowave.

Field Emitter Test Stand

I continued to develop and refine the design of the Field Emitter Test Stand; however, under the ongoing radiation safety standdown, I was unable to proceed experimentally.

Multifrequency beam source

I performed additional simulation development of multifrequency electron beam sources.
**Electron beam propagation**

I collaborated with Dr. Harris on the study of intense electron beam propagation, via simulation.

---

**RAILGUN TECHNOLOGY**

**William B. Maier II, Senior Lecturer**

**Department of Physics**

**Sponsor:** Office of Naval Research

**SUMMARY:** NPS research focuses on innovative solutions to difficult technical problems in practical employment of railguns.

- Measuring mechanical pressures in the monolithic gun. (LT Salvia)
- New projectile designs should reduce rail erosion and improve flight stability.
- High speed tests of rail materials, interface, and projectile materials and designs to improve bore life. (LT Kearns and LT Cox)

**IMPORTANT CONCLUSION:** The monolithic railgun is a very promising device for a direct-fire weapon. Its potential in this application exceeds the potential of all other electromagnetic guns currently under investigation. Although the US military does not currently fund this device adequately, there is reason to believe that Russia and China may be doing so. In any case, it would be in the best interests of the US military to provide significantly more support to develop the monolithic railgun into an operational weapon.

---

**GROUND SYSTEMS SUPPORT (LPA)**

**Richard C. Olsen, Professor**

**Department of Physics**

**Sponsor:** Secretary of the Air Force

**OBJECTIVE:** The proposed research supports work in the area of ground systems for military satellite systems.

---

**INTEGRATED SIGNATURES PROGRAM**

**Richard C. Olsen, Professor**

**Department of Physics**

**Sponsor:** JIEDDO Program Office

**OBJECTIVE:** The proposed effort is in support of the JIEDDO URSUS-2 program.

---

**MAPPING STRUCTURES AND TRAILS USING SPECTROMETRY AND LIDAR**

**Richard C. Olsen, Professor**

**Department of Physics**

**Sponsor:** Office of the Secretary of Defense

**OBJECTIVE:** The proposed research is to study the use of imaging spectrometry and LIDAR systems for the mapping of trails and structures.
PHYSICS

MASINT OUTREACH/LIAISON PROJECT
Richard C. Olsen, Professor
Department of Physics
Sponsor: Defense Intelligence Agency

OBJECTIVE: The proposed effort is in support of the Defense Intelligence Agency. The NPS MASINT chair will support the Defense Intelligence Agency in projects for the National Consortium for MASINT Research.

REMOTE SENSING RESEARCH
Richard C. Olsen, Professor
Department of Physics
Sponsor: Office of the Secretary of Defense

OBJECTIVE: The proposed research supports the work of the OSD Special Capabilities Office in the areas of remote sensing, and the application of social network analysis to technology problems.

REMOTE SENSING RESEARCH IN SUPPORT OF OSD SPECIAL CAPABILITIES OFFICE
Richard C. Olsen, Professor
Department of Physics
Sponsor: Office of the Secretary of Defense

OBJECTIVE: The proposed research supports the work of the OSD Special Capabilities Office in the areas of Counter-Narcotics, Unmanned Aerial Vehicles, and Irregular Warfare.

RS TECHNOLOGY RESEARCH (IPA)
Richard C. Olsen, Professor
Department of Physics
Sponsor: Undersecretary of Defense for Intelligence

OBJECTIVE: The proposed research supports the work of the Special Capabilities Office in the areas of Counter-Narcotics, Unmanned Aerial Vehicles, and Irregular Warfare.

SNOW COVER RESEARCH WITH MULTISPECTRAL SENSORS
Richard C. Olsen, Professor
Department of Physics
Sponsor: National Geospatial-Intelligence Agency

OBJECTIVE: The proposed effort is in support of the spectral research efforts at NGA.

SPACE SURVEILLANCE ISSUES
Richard C. Olsen, Professor
Department of Physics
Sponsor: Office of the Secretary of Defense

OBJECTIVE: The proposed research supports the work of the OSD Special Capabilities Office in the area of space surveillance.
PHYSICS

SPECIAL CAPABILITY SATELLITE DEVELOPMENT OF THE NANOSATELLITE PROGRAM
Richard C. Olsen, Professor
Department of Physics
Sponsor: USAF/Space & Missile Systems Center

OBJECTIVE: The proposed research supports the work of the USAF in the area of small satellite development.

SPECIAL CAPABILITIES SUPPORT TO THE OSD
Richard C. Olsen, Professor
Department of Physics
Sponsor: Office of the Secretary of Defense

OBJECTIVE: The proposed effort is in support of the Office of the Secretary of Defense.

SPECIAL CAPABILITIES SUPPORT TO THE USD
Richard C. Olsen, Professor
Department of Physics
Sponsor: Office of the Secretary of Defense

OBJECTIVE: The proposed effort is in support of the Undersecretary of Defense for Intelligence.

SPECIAL PROGRAM SUPPORT
Richard C. Olsen, Professor
Department of Physics
Sponsor: Office of the Secretary of Defense

OBJECTIVE: The proposed effort is in support of the Defense Intelligence Agency.

SPECTRAL ANALYSIS - INDIAN HEAD
Richard C. Olsen, Professor
Department of Physics
Sponsor: National Signatures Program

OBJECTIVE: The proposed effort is in support of the spectral and polarimetric research efforts at the National Signatures Program Office.

SPECTRAL ANALYSIS FOR NATIONAL SIGNATURES PROGRAM
Richard C. Olsen, Professor
Department of Physics
Sponsor: National Signatures Program

OBJECTIVE: The proposed effort is in support of the spectral research efforts at the National Signatures Program Office.
PHYSICS

SPECTRAL AND POLARIMETRIC ANALYSIS FOR NATIONAL SIGNATURES PROGRAM
Richard C. Olsen, Professor
Department of Physics
Sponsor: National Signatures Program

OBJECTIVE: The proposed effort is in support of the spectral and polarimetric research efforts at the National Signatures Program Office.

SPECTRAL TEST PLANNING AND GROUND TRUTH SUPPORT
Richard C. Olsen, Professor
Department of Physics
Sponsor: National Geospatial-Intelligence Agency

OBJECTIVE: The proposed effort is in support of the spectral research efforts at NGA.

SUPPORT FOR DOD ACCESS TO DATA AND INFORMATION
Richard C. Olsen, Professor
Department of Physics
Sponsor: Office of the Secretary of Defense

OBJECTIVE: The proposed effort is in support of the Undersecretary of Defense for Intelligence.

SUPPORT TO NSG FOR AGI/ONIR
Richard C. Olsen, Professor
Department of Physics
Sponsor: National Geospatial-Intelligence Agency

OBJECTIVE: The proposed effort is in support of ONIR research efforts at NGA.

TECHNICAL ANALYSIS SUPPORT TO ISSO
Richard C. Olsen, Professor
Department of Physics
Sponsor: Office of the Secretary of Defense

OBJECTIVE: The proposed effort is in support of the Defense Intelligence Agency.

TECHNICAL SUPPORT TO THE SCO
Richard C. Olsen, Professor
Department of Physics
Sponsor: Office of the Secretary of Defense

OBJECTIVE: The proposed effort is in support of the Undersecretary of Defense for Intelligence.
OBJECTIVE: The proposed effort is in support of the work by Mr. Hibbeln for NSWC Crane.

**TRACKING AND DETECTION WITH NON-IMAGING SYSTEMS**

Richard C. Olsen, Professor  
Department of Physics  
Sponsor: National Geospatial-Intelligence Agency

OBJECTIVE: The proposed effort is in support of ONIR research efforts at NGA.

**URSUS-2 SENSOR SELECTION**

Richard C. Olsen, Professor  
Department of Physics  
Sponsor: US Army Engineering Research and Development Center

OBJECTIVE: The proposed effort is in support of the JIEDOO URSUS-2 program.

**CONCEPT FOR A DEEP-WATER UNDERSEA ACOUSTIC NETWORK**

Lt. Scott R. Thompson (Combat Systems)  
Joseph Rice, Research Professor  
Department of Physics  
Sponsor: Space and Naval Warfare Systems Center-San Diego

OBJECTIVE: To examine the Deep Seaweb concept whereby US Navy Seaweb technology would be employed in ocean basins by exploiting the ocean’s deep sound channel to communicate across large horizontal distances.

**DEEP SEAWEB SURVEILLANCE**

Joseph A. Rice, Research Professor  
Department of Physics  
Sponsor: Navy Irregular Warfare Office

OBJECTIVE: The objective of this project is to conduct studies, designs, and measurements that will be used to develop a program plan leading to the operational deployment of Seaweb acoustic networks in the SOUTHCOM area of focus with minimal risk and cost. This capability addresses the proliferation of maritime threats such as go-fast and SPSS vessels. It fills a gap in our ability to effectively sense these targets in the maritime environment.

SUMMARY: Seaweb sensor networks are rapidly deployable, scalable architectures providing wide-area surveillance. Sensor placement on the seabed is known to be optimal, and a distributed placement of such sensors can yield a tripwire or barrier or chokepoint coverage as the initial step in countering the activities of threat vessels. Current Seaweb implementations have been developed and extensively tested and utilized at shallow depths. Analysis has shown that sensors in deeper water will be more cost effective due to increased detection ranges, better propagation, and lower ambient noise conditions. In this project we will develop the designs for the deep Seaweb components in order to better estimate the costs of a deep network. In addition we will build a small number of record-only sensors and network relays with reduced capabilities (lower cost) and deploy them for a short duration in potential operational areas to measure noise levels, detection footprints, and communications ranges. These measurements will be used to
define the requirements for operational Seaweb networks and the associated costs and schedule for delivering these networks.

THESES DIRECTED:


PUBLICATIONS:

Conference Papers:


Conference Presentations (without publication):


G. Wilson, M. Barlett, J. Rice, C. Fletcher, B. Creber, “Seaweb Thunderstorm Spiral-3 Performance,” Spiral-3 Data Analysis Workshop, MIT Lincoln Laboratories, May 26, 2010


TECHNICAL REPORTS:

J.A. Rice, Seaweb ASW Network, FY10 project report for ONR 321MS, September 30, 2010
OPERATIONAL ADAPTATION USING SEAWEB MARITIME SURVEILLANCE

Joseph A. Rice, Research Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: The objective is to demonstrate capability for first-alert protection of a high-value port facility against asymmetric maritime threats that intelligence sources indicate are arriving via watercraft.

SUMMARY: Underwater passive acoustic directional sensors and Seaweb through-water networked acoustic communications are implemented in the Intracoastal Waterway at Morehead City, North Carolina on the U.S. eastern seaboard. Battery-powered acoustic sensors are rapidly deployed at widely separated chokepoint locations in shallow 5-10 meter water. These sensors autonomously detect the passage of a maritime vessel and generate a contact report indicating time, location and heading of the target. Seaweb through-water acoustic communications delivers the contact report via a scalable wide-area underwater network including multiple acoustic repeater nodes and a radio/acoustic communications (Racom) gateway buoy. The Racom gateway telemeters the contact report via Iridium satellite communications to an ashore command center with low latency. The in situ acoustic detection is corroborated using shore-based video surveillance to classify the contact as friendly or actionable.

PUBLICATIONS:


PRESENTATIONS:

PHYSICS

Group (MAR) ASW Systems Technical Panel (TP-9). Leading the TTCP MAR TP-9 Undersea networking (Unet) Key Technical Area (KTA). Participating in the NGAS sea trials, including analysis of NGAS09, execution of NGAS10, and planning of NGAS11. Providing Seaweb wide-area network (WAN) technology for interoperable through-water communications amongst heterogeneous ASW sensor nodes being developed by participating nations, including U.S., Canada, Norway, Italy, Germany, and Great Britain. Providing Radio/acoustic communications (Racom) gateway buoy and Seaweb server for end-to-end communications between the NGAS underwater network and the ashore command center, with near-real-time delivery of ASW contact reports and sensor remote control. Advancing the Seastar concept of an underwater local-area network (LAN) composed of short-range (<500m) acoustic links.

PUBLICATIONS:


J.A. Rice, Seaweb ASW Network, FY10 project report for ONR 321MS, September 30, 2010

PRESENTATIONS:


THESES DIRECTED:


**PHYSICS**

**SEAWEB SENSOR NETWORK**

*Joseph A. Rice, Research Professor*

*Department of Physics*

*Sponsor: OUSD Rapid-Reaction Technology Office*

**OBJECTIVE:** This project is demonstrating acoustic detection and reporting of maritime vessels in operational environments.

**SUMMARY:** Participated in the DoD Thunderstorm Spiral-3 exercise involving integrated surveillance of maritime surface targets of interest. Deployed a Seaweb sensor network in the Florida Straits and in the Western Caribbean Sea. Telemetered contact data from seabed sensors through the water via a distributed acoustic network to a gateway buoy at the sea surface, with space-borne telemetry via satellite and SIPRnet to the JIATF-S watch floor.

**PUBLICATIONS:**


**PRESENTATIONS:**

G. Wilson, M. Barlett, J. Rice, C. Fletcher, B. Creber, “Seaweb Thunderstorm Spiral-3 Performance,” *Spiral-3 Data Analysis Workshop*, MIT Lincoln Laboratories, May 26, 2010

---

**TIME/FREQUENCY RELATIONSHIPS OF AN FFT-BASED ACOUSTIC MODEM**

*ENS William F. Jenkins II, USN (Undersea Warfare Curriculum)*

*Joseph A. Rice, Research Professor*

*Department of Physics*

*Sponsor: Space and Naval Warfare Systems Center-San Diego*

**OBJECTIVE:** The goal of this research is to implement MFSK modulation for underwater acoustic communications in an adaptive manner by exploiting basic time-frequency relationships. Signal parameters such as spectral bandwidth and symbol duration maybe adjusted on a packet-by-packet basis such that transmitted acoustic signals are well matched to the physical through-water communications medium and its prevailing channel scattering function.

This research will be an analytical comparison of the advantages and disadvantages of using bandwidth scaling and bandwidth multiplexing at the high frequencies at which Seastar short-range underwater acoustic modems operate. As such, the scope of this research will be defined by any case studies that are modeled, and by any experimental data that are acquired either from the laboratory or from sea trials.

The immediate contribution of this research will be to determine a more efficient method of transmitting digital data at high frequencies through the short-range (50-500 m) underwater acoustic channel. Currently, NPS is in possession of two high frequency modems as part of the Seastar project. The results of this research will directly impact their operational roles in the development of the Seastar network, as well as the greater Seaweb network. Organizations that will benefit from this work include SPAWAR and NRL.

---

**NPS MW-CLASS ON-AXIS RF COUPLER WORK**

*Brian Rusnak, Professor*

*Department of Physics*

*Sponsor: Joint technology Office - High Energy Lasers*

**OBJECTIVE:** The proposed work seeks to advanced the design of high average power couplers for superconducting RF cavity applications, as they are an essential technology for realizing multi-MW-class electron beams needed for ship-board PELs.
COLLABORATIVE RESEARCH ON BLAST RESISTANT STRUCTURES FOR MILITARY VEHICLES
Jose O. Sinibaldi, Research Associate Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: The Office of Naval Research (ONR) supports a Multidisciplinary University Research Initiative (MURI) on “An integrated cellular materials approach to force protection”. The research has two key aspects. One is concerned with designs and basic understanding of the response of ceramic/metal/organic systems that defeat ballistic threats at lower weight than conventional designs. The other is concerned with cellular material concepts for defeating blast-generated impulses caused by buried explosives. The main purpose of the proposed experiments is to provide high fidelity measurements of the dynamic parameters required for calibration and development of a numerical code that can be used for simulating the response of panels to glass bead blasts. In addition testing against EFPs and SC Jets will be performed in years 2 & 3. In addition NPS’s light gas gun will be utilized in year 3 to experimentally determine proper sand EOSs under these dynamical situations.

PHYSICS OF UNDERWATER MISSILE LAUNCH
Jose O. Sinibaldi, Research Associate Professor
Department of Physics
Sponsor: Strategic Systems Program (SSP), Missile Branch

OBJECTIVE: Develop the proper procedures to use the advanced features of Star-CCM+ for Underwater Launch phenomenology, perform code validation with simpler geometries, validate from sub-scale experiments, compare OpenFOAM, Star-CCM+, and other computation fluid dynamic codes against experimental data from LMCO/US NAVY experiments, perform studies to investigate various effects from launch depth, velocity, axial flow velocity, and bubble dynamics, and develop Matlab engineering models using the data from the studies. It is anticipated that these new approaches would significantly enhance the prediction capabilities required to meet the stringent environmental requirements. In addition any safety issues associated with this approach should be investigated. The applicability of utilizing other efforts and resources at other facilities should be investigated. A report is to be provided with results and recommendations. This effort is to begin immediately and be completed by 30 Sept 2011.

ACOUSTIC VECTOR SENSOR CALIBRATION
Kevin B. Smith, Professor
Daphne Kapolka, Senior Lecturer
Department of Physics
Sponsors: ONR 321MS and NUWCDIVNPT

OBJECTIVE: To examine issues related to the calibration of underwater acoustic vector sensors

SUMMARY: Acoustic vector sensors measure particle velocity in addition to pressure. The measurement of both pressure and particle velocity at low frequencies is complicated by the fact that standing wave pressure nodes coincide with particle velocity antinodes and vice versa. Furthermore, a rigid container used to establish a standing wave in water at low frequencies needs to be quite long. Because of this, it is desirable to use a calibration tube which can produce traveling waves for the calibration. This project investigates the pressure and particle velocity data from a traveling wave calibration tube to determine whether sufficient signal quality exists for a robust calibration.
OBJECTIVE: The overall objective of this work is to study the three-dimensional response of the acoustic vector field in the presence of environmental variability, and the analysis of acoustic inversion techniques for environmental properties using meta-heuristic approaches and properties of the complex intensity field.

SUMMARY: A primary element of this work was to continue the study of features of the 3-D acoustic vector field in the presence of environmental variability. This involved the extension of the FY09 efforts to explore the shallow water variability introduced by non-linear internal (soliton) waves. The focus in FY09 was on confirming predictions of the influence of a single, analytically defined, soliton wavefront on the coupling and/or refraction of acoustic modal intensity. In FY10, this was expanded to incorporate measured, multiple soliton wavefronts (a “train” of non-linear internal waves), and the comparison of observed features with measured acoustic data from the SW06 experiment. This was done in collaboration with URI Ph.D. student Georges Dossot (Prof. Jim Miller, advisor) to aid in his data analysis. Technical guidance was provided for his efforts.

In collaboration with UDel Ph.D. student Joseph Senne (Prof. Mohsen Badiey, advisor), various versions of the MMPE model were also combined for the purposes of computing the influence of a 2-D rough surface on the 3-D acoustic propagation. This included the incorporation of a dynamic surface model, allowing not only numerical predictions of the scattered field but also estimates of the associated Doppler spread. Such analysis is being used to investigate observed features collected during previous experiments conducted by UDel collaborators. Preliminary results are promising, and work continues in FY11.

Continuing on FY09 efforts, work was performed in support of URI Ph.D. student Steve Crocker (Prof. Jim Miller, advisor). His studies include investigation of standard inversion methods incorporating vector sensor data and the impact of the non-neutrally buoyant condition of the sensors buried in the sediment. That work continues to progress in FY11.

PUBLICATIONS:


PRESENTATIONS:

SUPPORT FOR STUDIES ON CURRENT TRANSDUCTION SYSTEMS AND MEASUREMENT INFRASTRUCTURE
Kevin B. Smith, Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: The objectives of this work are to provide support, to ONR, Code 321MS, in the survey and analysis of the current state-of-the-art in US acoustic transduction systems, and the existing infrastructure in the national labs and businesses for the production and calibration of such systems.

TECHNICAL CHALLENGE SUPPORT FOR VECTOR SENSOR ARRAY DEVELOPMENT
Kevin B. Smith, Professor
Department of Physics
Sponsor: Office of Naval Research

OBJECTIVE: The overall objective of this work is to assist the Office of Naval Research, Code 32IMS, in the review and coordination of technical efforts to investigate the performance of the latest generation of acoustic vector sensors under a variety of environmental conditions, sensor configurations, and array construction designs.
DEPARTMENT OF PHYSICS

2010
Faculty Publications and Presentations
PHYSICS JOURNALS


PHYSICS
MANUALS


CONFERENCE PUBLICATIONS & PROCEEDINGS


the TELUS Convention Centre in downtown Calgary, AB, Canada.


CONFERENCES PRESENTATIONS


W. B. Colson, “Compact THz Free Electron Lasers For Laboratory Laser-Matter Interactions”, Invited talk to the Stefan Frontier Conferences, La Jolla CA (May 2010).
W. B. Colson, “Development of the FEL From Early Origins”, Invited talk at the “Poole Fest” Meeting, Daresbury, UK (June 2010).


M. Graswald, R. E. Brown, H. Rothe, Novel Ammunition Consumption Model for Vulnerability/Lethality Analysis to Defeat Air Targets. Accepted for presentation and publication, Int’l Symposium on Ballistics, (2010)


N. M. Haegel “Imaging Transport: Monitoring the Motion of Charge through the Detection of Light,” Physics Department Colloquium, Georgia State University, Sept. 9, 2010.


John Lewellyn, “(Some) Gun Requirements for ERLs,” presented at the 2010 Future Light Sources Workshop (invited)

John Lewellyn, “The NPS SRF Photoinjector,” presented at the 2010 Future Light Sources Workshop

John Lewellyn, “The NPS SRF Photoinjector,” presented at the LBNL “Mini-Workshop” on Compact X-Ray FELs Using High-Brightness Beams


G. Wilson, M. Barlett, J. Rice, C. Fletcher, B. Creber, “Seaweb Thunderstorm Spiral-3 Performance,” Spiral-3 Data Analysis Workshop, MIT Lincoln Laboratories, May 26, 2010


TECHNICAL REPORTS


RESEARCH REPORTS


John Lewellyn , “First Beam from Navy’s Superconducting Injector,” drafted for ONR after initial beam formation at Niowave facility. (variants released by Boeing, Niowave and ONR), 2010.

J.A. Rice, Seaweb ASW Network, FY10 project report for ONR 321MS, September 30, 2010


DEPARTMENT OF SYSTEMS ENGINEERING

CLIFFORD WHITCOMB
CHAIRMAN
OVERVIEW:

Systems engineering focuses on the development of large and complex systems: how do the parts work together in an integrated system given the precise specification of the structure and behavior?

CURRICULA SERVED:

The Naval Postgraduate School (NPS) Department of Systems Engineering (SE) has 37 faculty members with primary appointments, 21 with joint appointments, and 4 administrative staff. We offer Master’s degrees and in 2011 began offering a doctorate in systems engineering. We have about 75 resident students and about 450 non-resident students.

We work closely with the Wayne E. Meyer Institute of Systems Engineering at NPS, especially for student research programs. Our website is http://www.nps.edu/se/.

RESIDENT PROGRAMS OF STUDY:

The Systems Engineering Department supports two resident programs of study:

- Curriculum 580, the resident Master of Science in Systems Engineering (MSSE), is a seven quarter degree program intended for technically oriented military officers, federal government civilians, and qualified international applicants. Students enrolling in the MSSE program may choose from one of three tracks:
  - Combat Systems Engineering
  - Network-Centric Systems Engineering
  - Ship Systems Engineering
- Curriculum 308, the resident Master of Science in Systems Engineering and Analysis (MSSEA), is an eight-quarter degree program intended primarily for Navy unrestricted line officers.

NON-RESIDENT PROGRAMS OF STUDY:

The Systems Engineering Department also supports three non-resident programs of study:

- Curriculum 311, the Master of Science in Systems Engineering via Distance Learning (MSSE DL), is an eight-quarter, distance-learning degree program intended primarily for federal government civilian scientists and engineers at Navy field activities.
- Curriculum 721, the Master of Science in Systems Engineering Management (MSSEM), is a distance-learning program intended for qualified military officers, senior enlisted, federal government civilians, and defense contractor civilians.
- The Systems Engineering Certificate Program provides the fundamentals of systems engineering to engineering duty officers and other officer communities without requiring the student to enroll in an NPS degree program.

RESEARCH THRUSTS:

Our research seeks to understand: 1) engineering methods and their application to problem solving, and 2) the spectrums of systems engineering – lifecycle, analyses, and integration of systems – balancing resources to ensure timely completion through hands-on research with Navy sponsors. Our mission is to:

- Prepare graduates to ensure national security by providing technical education in designing, building, operating, maintaining, and improving reliable, capable, effective, affordable, complex systems-of-systems that meet the user’s needs when the user needs them.
- Perform research to improve and develop new systems engineering techniques and methods.
- Apply systems engineering techniques and methods to develop cost-effective, timely solutions to urgent national-security problems.

Systems engineering research at NPS can be categorized into four specialization areas: systems engineering...
SYSTEMS ENGINEERING

methodology, systems engineering applications, system simulation and modeling, and system suitability assessment.

• Systems engineering methodology involves the investigation of or development of tools and techniques for conceptualizing, designing, and developing systems. Study areas include discovery of fundamental principles of systems theory, elucidating the use of these principles through systems engineering tools and techniques, analyzing the conditions of employing the tools and techniques, and determining the efficacy of those tools and techniques. Specific methodology areas include system requirements generation, requirements allocation, system architecture, system dynamics and control, and risk engineering.

• Systems engineering applications involves the application of systems engineering processes to the solution of specific complex problems. This can include conceptual design of systems, investigation of issues associated with integration of system components into system segments, investigation of issues associated with integration of system segments into systems, and the analysis of case studies of successful and/or unsuccessful systems engineering applied to military acquisition programs. Specific application areas include combat systems integration, ship systems engineering, and enterprise systems engineering.

• System simulation and modeling involves the development of simulations and models of military systems, evaluation of the efficacy of these simulations and models in providing the information to accomplish systems engineering functions (especially system design requirements and comparison of alternative solutions), and investigation of the characteristics of simulations and models that lead to outputs that are useful in the systems engineering process.

• System suitability assessment involves the study of tools, techniques, and disciplines that permit the assessment of the suitability of systems in meeting requirements. Requirements can include performance, availability, operability, and cost. Specific suitability assessment areas include reliability engineering, system survivability, and system cost estimation and control.

RESEARCH CHAIR:

• Command, Control, Communications, Computers, and Intelligence (C4I) Chair
• Chair of Expeditionary and Mine Warfare
• Naval Chair of Systems Engineering

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Department of Systems Engineering is provided below:

Size of Program: $1.7M
<table>
<thead>
<tr>
<th>Name</th>
<th>Title and Position</th>
<th>Phone Number</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robert Harney</td>
<td>Associate Chairman for Research &amp;</td>
<td>831-656-2685</td>
<td><a href="mailto:cawhitco@nps.edu">cawhitco@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td>Associate Professor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eugene Paulo</td>
<td>Associate Chairman for Instruction &amp;</td>
<td>831-656-3452</td>
<td><a href="mailto:epaulo@nps.edu">epaulo@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td>Associate Professor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matt Boensel</td>
<td>Senior Lecturer</td>
<td>831-656-3489</td>
<td><a href="mailto:mboensel@nps.edu">mboensel@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charles N. Calvano</td>
<td>Professor of Practice</td>
<td>831-656-2334</td>
<td><a href="mailto:calvano@nps.edu">calvano@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ronald Carlson</td>
<td>Professor of Practice</td>
<td>831-656-9743</td>
<td><a href="mailto:rcarlso@nps.edu">rcarlso@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tim Chung</td>
<td>Assistant Professor</td>
<td>831-656-7858</td>
<td><a href="mailto:thchung@nps.edu">thchung@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kristin Giammarco</td>
<td>Lecturer</td>
<td>931-240-0761</td>
<td><a href="mailto:kmgiamma@nps.edu">kmgiamma@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rachel E. Goshorn</td>
<td>Assistant Professor &amp; C4I Chair</td>
<td>831-656-3835</td>
<td><a href="mailto:goshorn@nps.edu">goshorn@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>John M. Green</td>
<td>Senior Lecturer</td>
<td>831-656-1084</td>
<td><a href="mailto:jmgreen@nps.edu">jmgreen@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>David A. Hart</td>
<td>Professor of Practice</td>
<td>831-656-3839</td>
<td><a href="mailto:daharti@nps.edu">daharti@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thomas V. Huynh</td>
<td>Associate Professor</td>
<td>831-656-7568</td>
<td><a href="mailto:thuynh@nps.edu">thuynh@nps.edu</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ravi Vaidyanahan  
Research Assistant Professor  
831-656-2960  
rvaidyan@nps.edu

Mary Vizzini  
Lecturer  
831-747-4399  
mhvizzin@nps.edu

Richard Williams  
RADM, USN (Ret.)  
Chair of Expeditionary and Mine Warfare  
831-656-7702  
rwillia@nps.edu

Oleg Yakimenko  
Professor  
831-656-2826  
oayakime@nps.edu
OBJECTIVE: Provide Principal Academic Investigator scientific and technical support to investigate the hardware and software architecture for a Next Generation MSS processing display and visualization capability. Provide scientific input at working groups and program review as part of the Next-Gen Working Group. Propose functional allocations and methods for evaluating new concepts and resources.

N8F CHAIR OF SYSTEMS ENGINEERING ANALYSIS
Charles N. Calvano, Professor
Department of Systems Engineering
Sponsor: Chief of Naval Operations

OBJECTIVE: Pursuant to agreements reached at the initial curriculum review by the sponsor (OPNAV N8F) of the Systems Engineering Analysis curriculum in June of 2008, an MOA has been agreed to by N8F and NPS. Among other things, the MOA commits the parties to the promotion of high quality faculty and graduate student research in Analysis and in Systems Engineering, and the promotion of faculty and student-performed capstone projects which address problems of Navy and DoD concern. The MOA also calls for the initiation of additional research projects that support faculty or SEA student work or which address issues of interest to Navy Program Offices, OPNAV or other DoD entities and calls for minor support activities such as the invitation of speakers who can augment the research of SEA students and enrich their education. The PI of this funded research proposal will provide the leadership and oversight of the activities. The MOA identifies the PI as incumbent of the N8F Chair of Systems Engineering Analysis.

DETERMINATION OF ADVANCED LEADING INDICATORS OF PROGRAM TECHNICAL ISSUES
Ronald R. Carlson, Professor of Practice
Department of Systems Engineering
Sponsor: Naval Air Systems Command (NAVAIR)

OBJECTIVE: The objective of this proposal is to identify advanced leading indicators of acquisition program technical issues so that they can be identified early and corrective actions put in place to ensure successful program completion.

SUMMARY: Work started on this research late in 2009 and NAVAIR has continued to fund it now into FY11. The work performed during 2009 was to determine what data would be most useful in determining program health and then to determine if that data was readily available. It was determined that continuous data for almost any problem area was not readily available and the task turned to evaluating available data and searching archives for missing and additional information. In 2010, data collection and analysis was conducted for aircraft weight, program manning, software and operational test. The results of this was a predictive tool that could be utilized to forecast where the trends of an aircraft programs weight would take it compared to other like programs that completed before it. Late in the year the emphasis was re-directed toward identifying areas that System Engineering could affect Total Ownership Cost (TOC).

PRESENTATIONS:
OTHER:


N8F CHAIR OF SYSTEMS ENGINEERING ANALYSIS
James N. Eagle, Professor (Department of Operations Research)
Department of Systems Engineering
Sponsor: Chief of Naval Operations

OBJECTIVE: Pursuant to agreements reached at the initial curriculum review by the sponsor (OPNAV N8F) of the Systems Engineering Analysis curriculum in June of 2008, an MOA has been agreed to by N8F and NPS. Among other things, the MOA commits the parties to the promotion of high quality faculty and student research in Systems Engineering Analysis and the promotion of faculty and student-performed capstone projects which address problems of DoN and DoD concern. The MOA also calls for the initiation of additional research projects which support faculty or SEA student work or which address issues of interest to Navy Program Offices, OPNAV or other DoD entities. The PI of this research proposal will provide the leadership and oversight of the activities. The MOA identifies the PI as incumbent of the N8F Chair of Systems Engineering Analysis.

MODELING AND ASSESSMENT OF THE C4ISR & NETWORK MODERNIZATION EVENT 10 ARCHITECTURE
Kristin Giammarco, Lecturer
Department of Systems Engineering
Sponsor: U. S. Army Research, Development, and Engineering Command

OBJECTIVE: To conduct and apply research in architecture formalization using C4ISR architecture data provided to C4ISR & Network Modernization by key Army stakeholders, and support C4ISR & NM Event 10 (E10) execution and analysis by leading the development and evolution of the Event Integrated Architecture.

SUMMARY: This research applied formal methods to the assessment of interoperability of a design using the E10 Architecture Model. The design goal assessed was “100% of the modeled architecture elements conform to all required technological Standards.” Two case studies (Orders Development and Dissemination, and Conduct of Operations) were developed for C4ISR & Network Modernization’s E10 Integrated Architecture model, and used to demonstrate a new technique for assessing an architecture model for possession of certain necessary conditions for design interoperability, given a pair of Performers and their related Performer Activities, connecting Connectors, exchanged Interaction Items, and governing technology Standards. Both case studies were ultimately shown to meet the design goal through the new interoperability assessment technique, after some redesign on the latter example prompted by the assessment results. The logical statements that were created in structured natural language show promise for a more automated capability to support the reduction of downtime during the tightly scheduled and resourced experiments during Integrated Capability Events.

PUBLICATIONS:
OBJECTIVE: To provide subject matter expertise and guidance to CERDEC Space & Terrestrial Communications Directorate with respect to formal methods as they apply to architecture modeling.

SUMMARY: Formal measurement of system-wide architecture attributes has long been a challenge for system architects and decision makers. The introduction of the idea to use formal methods in the architecture modeling process early in the lifecycle has brought a new perspective to using logic statements to help quantify ambiguous, nonfunctional qualities and help designers reason about system behavior in achieving the desired qualities at the highest levels of abstraction. The expertise provided in this area builds on previous work in CY09, and in particular focuses on assessing a specific quality of interest in user demand-based systems: interoperability. This paper describes and demonstrates a new method for assessing technological interoperability of a modeled architecture using seven necessary conditions. The proposed set of conditions is scalable across the lifecycle of a design, and extensible to assess a complete operational or technical thread. The method can be used early in a system’s design to help architects/designers identify and correct oversights in their designs that can potentially affect actual interoperability in a real system or System of Systems (SoS), predicting issues well before deployment.

PUBLICATIONS:


SOFTWARE PRODUCT LINE APPROACH TO OPEN ARCHITECTURE AND NAVY WEAPONS SYSTEM ACQUISITION
John M. Green, Senior Lecturer
Gregory Miller, Lecturer
Department of Systems Engineering
Sponsor: NPS Acquisition Research Program

OBJECTIVE: The overall objective is to show the viability of software product lines in developing warfare domain specific systems that are built from components that allow software reuse across multiple, diverse platforms (e.g., submarines and destroyers). While the basic approach has been demonstrated by others, the intended research will address two new issues. First, we will look at the role of simulation and its ability to support development of both operational and system architectures. Second, we will evaluate methods by which we can capture and incorporate legacy system elements with the as yet undefined CG(X) system.

SUMMARY: This is an on going project that continued into 2010. Two student–based efforts were completed in March 2009. One was a 30 person MSSE capstone project that evaluated methodologies related to the implementation of a combat system architecture based on software product lines. The second effort was a PD-21 thesis that looked at the relationship of the DoD Architecture Framework’s relationship to capturing the outcome of the requirements process. Green and Miller extended the concepts discussed in Green’s original paper, the results of which were presented at the NDIA Systems Engineering Conference. Green also presented a paper at the NPS 2009 acquisition symposium. The final report has been delayed by illness of the principal investigator (Green), however, it is anticipated that the final report will be completed during the spring quarter 2011.
PUBLICATIONS:


PRESENTATIONS:


THESES DIRECTED:


SHARE TRANSITION SUPPORT AND REPOSITORY TOOL DESIGN

Jean M. Johnson, Lecturer

Department of Systems Engineering

Sponsor: Program Executive Office Integrated Warfare Systems (PEO IWS)

OBJECTIVE: In 2007, Program Executive Office Integrated Warfare Systems (PEO IWS) approved funding for research in the area of software reuse. The objective is to develop a framework for the Software, Hardware Asset Reuse Enterprise (SHARE) repository, which was established to promote reuse of Navy surface combat systems as part of the Naval Open Architecture strategy. In 2008, the creation of this framework was completed which included updated metadata specifications incorporating solutions for describing software behavior. Ontologies were developed based on relevant domain information for providing context to repository items.

Favorable review of these deliverables resulted in the funding of follow on work to develop preliminary designs for repository tools that allow for guided navigation of artifacts in software repositories. The tools are based on the framework developed during the previous years’ efforts. In CY10 a draft feature list for the repository tools in addition to detailed use cases demonstrating a significant portion of the tool functionality. The activities culminated in a presentation of these new products at the 2010 Acquisition Research Symposium for the project sponsors and other members of the community of interest.

PRESENTATIONS:

Proposition Objectif: Pursuant to the 22 August 2008 MOA between ASN (RD&A) CHESNG, PEO (IWS) and the NPS President, NPS proposes to promote high quality graduate systems engineering education that supports both the ASN (RD&A) CHSENG and PEO IWS missions, to conduct current research in topics related to ASN (RD&A) CHSENG, NAVSEA and PEO IWS and to stimulate and support research by NPS faculty and students.

SUMMARY: These two research projects are essentially one project with two sponsors. The funds provided by the sponsors were focused on supporting the growth and enhancement of SE education in response to and aligned closely with the needs of the Navy and the sponsors. This involved applying funds to the most critical needs of Curricula 580 and 311, to include the support and enhancement of an evolving resident and nonresident SE faculty, the support and enhancement of the educational experiences of SE students, and assisting with the development of the infrastructure essential for success.

More specifically, funds were allocated to student travel related to theses and the enhancement of their educational experiences, faculty travel aligned their research and professional development, and upgrading equipment and facilities related to sustaining both resident and nonresident systems engineering programs, and preparation for the ABET visit in 2010. The focus and allocation of funds were also in accord with the guidance in the 22 August 2008 MOA signed by both PEO IWS and ASN RDA CHSENG who sponsor and fund the Naval Chair.

Related to the above, an important role of the Naval Chair is to serve as the Executive Secretary of the Systems Engineering Oversight Council (SEOC). This was particularly true in 2010 as the Navy continued its efforts to enhance systems engineering competencies in the work force. The SEOC consists of the Navy’s senior systems engineering leaders and is chaired by ASN RDA CHSENG, and includes the sponsor of Curriculum 580 PEO IWS (now Director, SSP) and all Navy SYSCOM Chief Systems Engineers. In short, the SEOC is the interface between the DoN systems engineering community and its source of graduate systems engineering education, NPS. The focus of the SEOC is an additional influence on how funds are allocated.

The Naval Chair of Systems Engineering is responsible for assuring timely and responsive SEOC meetings and communications to assure that NPS responds to Navy needs with high quality systems engineering education. The SEOC meeting agendas are consistent with and are derived from the purposes and focus of the SEOC. For example, the meeting in 2010 focused on the following:

a. Review of FY10 nonresident programs and projections for FY11 with emphasis on the following:
   i. Return on investment to date
   ii. Enrollment / budget issues
b. Present a preview of the ABET visit in 2010.
   i. The ABET visit, process, and the role and importance of the external stakeholders of the SE program
   ii. The objectives and outcomes of the SE Program
      1. The need for formal endorsement by the external stakeholders
      2. Feedback on how objectives and outcomes are being met
      3. Examples of student successes
   iii. Objectives and outcomes of the SEM program (“PD21”) 
   iv. Summary of emerging key points of the ABET self-study
   v. Discuss the need for and nature of a one-day SEOC meeting at NPS in August 2010
   vi. Review of FY10 nonresident programs and projections for FY11
   vii. Student thesis presentations to SEOC members
   viii. Video-record sponsor statements for ABET visit in Fall, 2010
   ix. Summary of self-study and feedback from program evaluator to date

c. Provide information and feedback to SEOC members on NPS plans to address the DoN systems engineering educational requirements as laid out in the SEOC Core Expectations including:
i. Responsiveness to the systems engineering competency (i.e. graduate SE education) requirements of the Naval Acquisition Community (NAC)

ii. Responsiveness to fulfilling the graduate SE education component of the systems engineering competency requirements of the Naval Acquisition Community (NAC).

d. Provide strategic feedback and advice to the President and the Provost, NPS, on matters related to:

i. NPS support for strategic goals for DoN systems engineering

ii. Progress in achieving the DoN strategic goals for systems engineering

iii. Adjustments to the systems engineering curriculum at NPS to enhance NPS support for the DoN strategic goals for systems engineering

e. Provide operational feedback and advice to the President and the Provost, NPS, on matters related to the effectiveness and continuous improvements of systems engineering education provided by NPS to the DoN work force.

OVERCOMING ARCHITECTURE AND OPERATIONAL PROBLEMS WITH UAVS
Gary O. Langford, Senior Lecturer
Department of Systems Engineering
Sponsor: National University of Singapore

OBJECTIVE: The two main objectives of the Unmanned Aerial Vehicles UAV architecture research project were to formulate and evaluate a framework from which to (1) identify key variables and their measures that define mega-multi-UAV operations (massive force and operations in a massively cluttered UAV environment); and (2) determine architectural sensitivities to these key variables in an environment, so defined in (1).

SUMMARY: Managing operations of large numbers of Unmanned Aerial Vehicles (UAVs) within an infrastructure and supporting resources must be consistent with the architectural constraints and battlefield environments. The aim was to design a command and control system that deals with hundreds or thousands of targets in real-time.

Often the UAV management optimizes coverage versus data communication, while other times there are operational trade-offs of flying UAV configurations and upcoming missions. There are also newly inserted collection and mission requirements that mandates a considerable planning and scheduling effort. While many of these problems are not new, the anticipated, dramatic increase in autonomous or controlled UAVs exacerbates this architecture and planning problem. Ultimately, the objective is to get the correct information in the right hands in a timely fashion.

The grant will proceed through three phases of work, each with a deliverable that is inclusive of the totality of the work and complete in its implementation.

• Phase 1 will be to outline the area of research, develop the principles, and summarize the reference materials to facilitate communications with potential graduate students.

• Phase II will be to extend the area of research with specific instances of supplementary work that will broaden the purview of student’s participation. This will include architecture views, underlying theory, and an analysis framework.

• Phase III will be to advise students, working with them to investigate concepts to sufficient breadth and depth to achieve both the scholarship requirements and the project goals. The primary project goal is to formulate and evaluate an architectural framework that facilitates decision making.

Completion of the work is planned for 30 December 2011 with delivery of Master’s theses from the next two groups of MDTS students (expected to begin their work in January 2010 and September 2011).

PUBLICATIONS:


TUNNEL DETECTION RESEARCH
Gary O. Langford, Senior Lecturer
Department of Systems Engineering
Sponsor: TRAC – Monterey and U.S. Customs and Border Protection

OBJECTIVE: The two main objectives of the Tunnel Detection Research were to (1) support U.S. Customs and Border Protection in selecting a system of systems for detecting tunnels, and (2) update the 2009 report based on the findings of the field investigations in Douglas, Arizona.

SUMMARY: Substantial progress was made in characterizing the trafficking threats to the U.S. – Mexican border. The tasks include providing a supply and value chain model that reflects the interests of the traffickers.

PUBLICATIONS:

PRESENTATIONS:

THESES DIRECTED:

SOFTWARE COST ESTIMATION METRICS
Raymond Madachy, Associate Professor
Department of Systems Engineering
Sponsor: U. S. Air Force Cost Analysis Agency

OBJECTIVE: The research objective is to establish a robust and cost effective software metrics collection process and knowledge base that supports the legitimate data needs of the DoD, while imposing minimal burdens on the Acquisition Workforce, and its industry partners. Further objectives are to enhance the utility of the collected data to oversight and management entities, and to academic and commercial research into improved cost estimation of future DoD software-intensive systems, as well as to the DoD cost community. See supplemental proposal for details.

SUMMARY: We furthered 2009 research with new cost analyses, improved drafts of the cost estimation manual, and importantly had an impact on the DoD data collection process. We successfully recommended changes to the Software Resources Data Report Form (SRDR) based on our 2009 research and they will be implemented. This work also resulted in several conference presentations, workshops and papers in-progress in addition to the manual itself.

We updated our recommended changes to the SRDR to reflect future needs for data and for obtaining more definitive productivity analyses. Had a meeting with AFCAA and the DoD DCARC personnel on the proposed changes to the data form. We supported the meeting results by elaborating the definitions of revised SRDR data element definitions,
and began propagating the results into the AFCAA metrics guidebook contents. Explored possibilities of analyzing combinations of the COCOMO II database in the context of the SRDR database categories and began some initial analyses. An initial result showed significant differences in productivity calibrations between new and upgrade projects.

We prepared for reviews and updates of the metrics guidebook contents to be presented in working group meetings at GSAW and PSM, including the experimental criticality/complexity rating scales for future improvements in SRDR project productivity estimation. We presented:


The DCARC decided to incorporate our recommended revisions into the next version of the SRDR data collection forms and guidance, with the exception of the criticality/complexity rating scales.

We will continue to analyze the SRDR and COCOMO databases to test the new experimental rating scales. Analyses have found some non-monotonic relationships between the COCOMO II cost driver ratings and productivity for some cost drivers, particularly for upgrade projects. This may be due to the effects of other variables.

Based on the preparation for and results at the PSM, we worked with our sponsor on a revised organization and outline for the manual. We then conducted a workshop at the COCOMO Forum with our sponsor that provided additional community feedback on SRDR changes and draft metrics guidebook:


The workshop review comments are being incorporated, and draft being prepared for additional external peer reviews in 2011.

**PRESENTATIONS:**


OBJECTIVE: The general objective of this reimbursable research (R77R2: 20% WY) is the development of technologies enabling enhanced weapon system health management. Two specific objectives that are addressed by the proposed research are:

a. robust sensors for application in extreme environments exposed to high temperature, pressure, vibration and shock.
b. open system instrumentation/sensor systems reducing the cost & time for weapon system development & qualification test.

SUMMARY: Prior to joining NPS, Dr. Millar was working with the NAVAIR SBIR Office, AIR 4.4, and Joint Strike Fighter Joint Program Office [JSFJPO] as Technical Point of Contact [TPOC] guiding SBIR project implementation. JSF JPO requested that Dr. Millar continue his efforts in the role of TPOC for up to five impending SBIR contracts, plus assisting in the program reviews, proposal evaluations and planning for these projects. The specifics of the individual SBIR projects are tabulated below:

Funding of $55,000 for the continuation of these efforts, with the addition of sixth SBIR contract, with Luna Innovations (on optical sensor networking), was awarded October 2009, covering through November 2010.

The successful technologies developed under this research effort are expected to be incorporated into the broader effort described in Dr. Millar’s NIFR project summary. This funding paid for a visit to University of Rhode Island in August for coordination with Wireless Sensor Technologies Inc.

NAVAL AVIATION SYSTEMS ENGINEERING CHALLENGES

OBJECTIVE: The CY 2010 work scope of this research project (BSEZS: 60,000, 20% WY) focused on several Naval Aviation systems engineering challenges:

A. Develop enhanced systems engineering based approaches to defining and validating improved weapon system and sub-system health management and maintenance processes and tools.

B. Develop and employ systems engineering approaches to define requirements for, and identify effective approaches to, instrumentation and sensor systems and adaptive model based control that address significant naval aviation capability gaps.

SUMMARY: In the first year of this RIP it became apparent that application of systems engineering to challenges and opportunities at the sub-system level, and to sustainment processes and related systems of systems, had more immediate promise of attracting reimbursable funding in the NAVAIR environment.

Thus, in the 2nd year, two areas within this broad category became the focus of this research:

i. Integrated and effective weapon system and sub-system health management and maintenance tools, and processes providing more effective TLCSM (total life cycle systems management),

ii. Open system approaches to instrumentation and sensor systems used in T&E, control systems and equipment health management,

The sustainment and sub-system architecture challenges were addressed by application of systems engineering (e.g. CBM+) based on Naval Aviation weapon system capability gaps common to many programs and overarching TLCSM imperatives.
This research agenda was addressed in concert with NAVAIR and key industry players including small business, major sub-system suppliers and prime contractors. This effort further identified opportunities for expanded long term research and demonstration projects under ONR sponsorship, resulting in two reimbursable projects described in the following research summaries. As a result of this successful outcome, about one third of the funding for this RIP was returned to NPS prior to its expiry.

Under this funding Dr. Millar participated in IEEE RAMS 2010 (January), served as session chair at the IEEE Aerospace Conference (March) and presented at the 2010 P-SAR Conference (October, 50/50 share w/ ONR).

This research effort related to participation in several university, industry and government Science and Technology forums:

a. Propulsion Instrumentation Working Group (PIWG)
   With its relevance to anticipated sensor systems research, I participated in several leadership teleconferences and attended the PIWG Fall meeting October 5-6. (ONR Funded)

b. SAE E-32 Engine Health Management Committee
   I attended committee meetings in the fall (Canandaigua). (ONR funded)

d. Aeronautic Sensors Working Group (ASWG)
   I am a member of this working group and participate in their monthly teleconferences.

e. Distributed Engine Controls Working Group (DEWG)
   I participated in the September meeting of this team, which has an interest in advanced sensor systems, in conjunction with the Turbine Engine Technology Symposium. (ONR funded)

PUBLICATIONS:


Millar, R.C. and David H. Olwell, “Parametric Models for Aircraft Engine Removals Resulting from Foreign Object Damage”, accepted for publication in the Naval Engineer’s Journal (Expected June, 2011.)

PRESENTATIONS:

Millar, R.C., “A Different Approach to Implementing PHM Based RCM”, (Presented at the P-SAR Conference, Jacksonville FL, March 16-18, 2010) Proceedings distributed to attendees as a CD ROM

PROPULSION-SAFETY AND AFFORDABLE READINESS SENSOR SYSTEMS
Richard C. Millar, Associate Professor
Department of Systems Engineering
Sponsor: Office of Naval Research (ONR)

OBJECTIVE: Most science and technology [S&T] efforts related to sensors for aerospace system test and evaluation [T&E], health management and control focus on sensing specific parameters in extreme environments, with some consideration of the issues related to the integration of the sensor into the equipment. The purpose of this research is to undertake a higher level Systems Engineering analysis of requirements and functionality for the integrated sensor systems needed to support the imperative of propulsion safety, affordability and readiness [PSAR] within the overall goals of total life cycle systems management [TLCSM].
**SYSTEMS ENGINEERING**

Funding from ONR was received 17 November 2009. This project (R771X: 20% WY) has a total budget of $120,000 which, after a 3 month extension, expires 31 March 2011.

**SUMMARY:** This project encompasses needs for more cost effective and suitable sensor systems in three categories of sensor application: test & evaluation instrumentation, health management, and system control. Systems engineering study has identified requirements that are common to all three applications, but with varying impact and priority. Sensor precision, repeatability, durability and compatibility with the environment and components to which it is applied are usually addressed in sensor S&T. However, this research focuses on overall sensor system issues: total instrumentation/sensor system acquisition and life cycle cost, suitability to the T&E process and in-service operation including sustainment, faster and less costly change to address unanticipated instrumentation/sensor requirements, and the desire for open-system interfaces to facilitate timely and cost effective incorporation of sensor technology advances.

This effort refined and formalized this systems engineering assessment in consultation with the US Navy and industry propulsion community to define requirements with quantitative measures, uses these to identify and assess high potential technological approaches, sets out a proposed IISS taxonomy and suggests functional architectures for selected sensor system options.

The deliverables from this project are expected to provide direction and assist justification for follow-on research into, & development of, integrated instrumentation/sensor systems for propulsion development, test & health management and control. In 2010 reports were submitted to ONR and a journal paper manuscript was submitted to IEEE Sensors Journal, and is now in revision. An abstract was accepted for AIAA Infotech@Aerospace (March 2011).

In pursuing this research Dr. Millar has attended the following conferences and meetings: P-SAR 2010 (Jacksonville FL, March, 50%), ASME 2010 IDETC/CIE Conference (Montreal PQ, August, 100%), Turbine Engine Technology Symposium (Dayton OH, September, 100%), the Propulsion Instrumentation Working Group (Newport News VA, October, 50%) and the SAE E-32 Committee meeting (Canandaigua NY, November, 50%). This project also paid for travel to NPS in December for a coordination meeting.

**PROPULSION TURBO-MACHINERY MONITORING**

Richard C. Millar, Associate Professor
Department of Systems Engineering
Sponsor: Office of Naval Research (ONR)

**OBJECTIVE:** The objective of this research project (R7220; $50,000: 20% WY) is to define requirements for propulsion turbo-machinery monitoring, beyond vibration monitoring, in the context of Condition Based Maintenance – Plus [CBM+] and the Propulsion Safety, Affordable Readiness [P-SAR] initiative.

**SUMMARY:** Funding arrived 17 November 2009 and expires 31 March 2011, after a 3 month extension.

Existing work on advanced turbo-machinery monitoring focuses on R&D applications and failure mode specific sensors. Little work has been performed looking at the overall problem of propulsion turbo-machinery monitoring while considering the full sustainment needs and constraints in the demanding environment of Naval Aviation.

Much S&T effort is being expended on tools to sense the state and usage of individual components, particularly the critical turbo-machinery and typically focused on specific failure modes, as the main line of defense against escalating maintenance costs. A more coordinated and comprehensive systems engineering approach to the problem of turbo-machinery monitoring appears to be needed, to yield a simpler, robust CBM+ system with flexibility to deal effectively with unanticipated failure modes.

This project encompasses a systems analysis and functional requirements synthesis focused on total life-cycle systems management [TLCSM], giving full weight to sustainment priorities to yield an integrated CBM+ system architecture for turbo-machinery monitoring that is robust, adaptive and cost-effective, i.e., suitable for the intended use.
In pursuing this research Dr. Millar has attended the following conferences and meetings: P-SAR 2010 (Jacksonville, FL, March, 50%), the Propulsion Instrumentation Working Group [PIWG] (Newport News, VA, October, 50%) and the SAE E-32 Committee meeting (Canandaigua, NY, November, 50%). He also participates in related government/industry working groups (PIWG, SAE E-32, Advanced Sensor WG, and Propulsion Control WG).

Periodic status presentations have been submitted to ONR and a presentation to the P-SAR Conference in March 2011 has been arranged. An abstract for a paper at the ASME/IGTI Turbo-Expo was accepted (June 2011).

ADVANCED OPERATIONAL CONCEPT DEVELOPMENT CRADA
Gregory A. Miller, Senior Lecturer
David H. Olwell, Professor
Department of Systems Engineering

Sponsor: Northrop Grumman Systems Corporation, Electronic Systems Sector

OBJECTIVE: Provide technical expertise and support in developing Concepts of Operations (CONOPS) related to Navy Sea Shield, Sea Strike and Expeditionary Warfare.

SUMMARY: A Cooperative Research and Development Agreement between NPS and Northrop-Grumman in which the partners work to develop and analyze advanced concepts of operations in several different Navy mission areas. Student study and faculty research were completed in:

- Submarine use of UAVs was examined in terms of specific mission accomplishment. The potential operational impact was quantified and compared to life-cycle cost estimates for several different alternatives.
- The impact of deploying UUVs on submarines was examined in terms of manpower and maintenance requirements. Recommendations for sustainable operational deployment were made.
- An innovative approach to sustaining USV’s in support of naval forces in remote locations was developed.
- The impact of threat anti-ship cruise missiles doctrine was evaluated and a model developed to assess the impact of doctrine on electronic warfare system design.
- Integrating electronic warfare into the ship’s combat system was also evaluated with a special focus on the role of automation in layered defense.

Reports Exchanged:

The following student theses were exchanged:

- “Mission-Based Assessment of Submarine-Launched Unmanned Aerial Vehicle Requirements” by LT Bruce Layne, MS Thesis
- “Manning and Maintainability of a Submarine Unmanned Undersea Vehicle (UUV) Program: A Systems Engineering Case Study” by LT Troy Vandenberg, MS Thesis
- “Using Kill Chain Analysis to Develop Surface Ship CONOPS to Defend Against Antiship Missiles” by Roy Smith, MS Thesis
- The following student capstone reports were exchanged:
  - “Integrated Electronic Warfare Systems aboard the United States Navy 21st Century Warship” (report #NPS-SE-09-016) by cohort 311-082
  - “Augmenting Naval Capabilities in Remote Locations” (report #NPS-SE-10-001) by cohort 311-082

Funding: $50,000 in FY09 and $50,000 in FY10

THESES DIRECTED:


**SYSTEMS ENGINEERING APPLIED LEADING INDICATORS AND CONTROL OF TOTAL OWNERSHIP COSTS OF DOD ACQUISITION DEVELOPMENT PROGRAMS THROUGH INTEGRATED SYSTEMS ENGINEERING PROCESSES AND METRICS**

Paul Montgomery, Associate Professor
Department of Systems Engineering

Sponsors: NPS Acquisition Research Program and NAVAL

OBJECTIVE: This research investigates what SE metrics and methods can be derived during the development process to generate leading indicators to provide alerts to program cost growth and acquisition health as well as predicting and controlling total ownership cost of a system throughout its life-cycle.

SUMMARY: This research proposes to leverage previous research into Systems Engineering (SE) Applied Leading Indicators and extend that work to investigate what key SE metrics and indicators can be defined to provide direct insight into Weapons System Acquisition and Reform Act (WSARA) goals. Specifically, which SE metrics provide greatest insight into technical cost estimation confidence, technical measures of system development health, and technical predictors into total ownership cost projections. The goal is to develop an integrated Management-Systems Engineering approach to developing SE metrics into high fidelity, unambiguous technical measures that integrate with current and emerging program management and analysis methods. This research will be conducted in close coordination with the Naval Air Systems Command at NAS, Patuxent River, MD.

**BODY OF KNOWLEDGE AND CURRICULUM TO ADVANCE SYSTEMS ENGINEERING**

David H. Olwell, Professor
Department of Systems Engineering
Sponsor: DoD DDRE

OBJECTIVE: To write the definitive body of knowledge for systems engineering. Use that body of knowledge to build a widely accepted standard graduate curriculum for systems engineering.

SUMMARY: A multinational team of volunteers (45 contributors and 200+ reviewers world-wide authored a preliminary draft of a systems engineering body of knowledge. That body of knowledge was used to craft a graduate curriculum for systems engineering. Work is continuing on refining both products.

PUBLICATIONS:


SUPPORT OF RED TEAM EFFORTS FOR BASE PROTECTION
David H. Olwell, Professor
Department of Systems Engineering
Sponsor: SOCOM

OBJECTIVE: To support experimentation on base protection at Camp Roberts by providing a red team and systems perspective on vulnerabilities

SUMMARY: Experimentation on base protection to be conducted at Camp Roberts was supported by providing a red team with a systems perspective to define potential vulnerabilities.

GENERATING A SYSTEMS ARCHITECTURE ADDRESSING THE CAPABILITIES, REQUIREMENTS, AND TPPS FOR THE TRANSFORMABLE CRAFT (T-CRAFT)
Eugene P. Paulo, Associate Professor
Department of Systems Engineering
Sponsor: Office of Naval Research

OBJECTIVE: In years three and four (FY11/FY12) of this project’s continued effort, the principle investigator (PI) will team with ONR, other DoD organizations, appropriate industry representatives, and faculty and student-officers at NPS to support the comprehensive systems engineering effort. The primary effort for FY2011-FY2012 is to perform a Systems Engineering Analysis based off of the robust modeling and simulation (M&S) work completed in FY10-FY11 which examined the various T-Craft operational and performance requirements; the SE Analysis will also combine the “fleet” architecture of T-Craft mixed with other transport platforms research results and utilize the results of the in-depth life-cycle cost analysis of the T-Craft.

MASTER OF SCIENCE IN SPACE SYSTEMS OPERATIONS DISTANCE LEARNING PROGRAM
Mark M. Rhoades, Senior Lecturer
Department of Systems Engineering
Sponsor: U. S. Air Force Space Command

OBJECTIVE: To provide distance learning education for Air Force Space Professionals yielding a Master of Science degree. This curriculum is delivered over two years.

SUMMARY: This program delivered eight of the fifteen courses as part of the Masters of Science in Space Systems Operations degree.

THESES DIRECTED:

SYSTEMS ENGINEERING

AUTONOMOUS AMPHIBIOUS ROBOTS FOR SURF ZONE OPERATIONS
Ravi Vaidyanahan, Research Assistant Professor
Richard Harkins, Senior Lecturer (Physics)
Department of Systems Engineering
Sponsor: National University of Singapore

OBJECTIVE: The project is a joint effort between NUS and NPS. The Autonomous Systems and Robotics Laboratory at NPS and NUS Scientists will conduct a two-year study to develop a prototype autonomous amphibious robot for maritime surf-zone operations. Under this collaborative effort, the researchers will design and fabricate a second generation amphibious robot prototype and complete the first ever implementation of an autonomous control system on such a vehicle. The proposed vehicle will leverage state-of-the-art technologies biologically inspired mobile robotics to provide a robot capable of mobility in both terrestrial and aquatic environments. Specifically, the device will be capable of receiving a mission plan, deploying from an aquatic environment, and autonomously maneuvering within the critical transitional region shoreline (e.g. the surf zone).

ADVANCED POWER SYSTEM MODEL-BASED ARCHITECTURE AND DESIGN METHODS
Clifford Whitcomb, Professor
Department of Systems Engineering
Sponsor: U. S. Navy Office of Naval Research (ONR)

OBJECTIVE: The goal of this research is to develop a functionally integrated architecture and design simulation environment to implement automated methods for exploring different electrical distribution system tradeoffs in a total ship context in order to find optimum ship designs in terms of operational effectiveness metrics.

SUMMARY: This work was combined with the other ONR funded project on Power System Architectures. The work focused on the integration of electric weapons and advanced combat systems into all electric ship architectures. The development of the TESLA ship for the TSSE project from 2009 contains the ship design result. A thesis by Justin Hlavin focused on the modifications of that destroyer design to accommodate the advanced electric propulsion system. A notional warfighting scenario was developed in the Phoenix tool being developed with Prof. Auguston in the NPS CS department. The results of this preliminary investigation led to a publication at the 2010 ICCRTS conference in Santa Monica, CA.

PRESENTATIONS:

THESES DIRECTED:

DESIGN OF ADVANCED POWER SYSTEMS FOR WAR-FIGHTING EFFECTIVENESS
Clifford Whitcomb, Professor
Department of Systems Engineering
Sponsor: U. S. Navy Office of Naval Research (ONR)

OBJECTIVE: The goal of this research is to develop a functionally integrated architecture and design simulation environment to implement methods for exploring different electrical distribution system tradeoffs in a total ship context in order to find optimum ship designs in terms of operational effectiveness metrics.
SYSTEMS ENGINEERING

SUMMARY: This work was combined with the other ONR funded project on Power System Architectures. The work focused on the integration of electric weapons and advanced combat systems into all electric ship architectures. The development of the TESLA ship for the TSSE project from 2009 contains the ship design result. A thesis by Justin Hlavin focused on the modifications of that destroyer design to accommodate the advanced electric propulsion system. A notional warfighting scenario was developed in the Phoenix tool being developed with Prof. Auguston in the NPS CS department. The results of this preliminary investigation led to publications at the ICCRTS conference in Santa Monica, CA, and the INCOSE-IEEE MBSE Conference, George Mason University, Fairfax, VA.

PUBLICATIONS:


PRESENTATIONS:


THESES DIRECTED:


MODEL-BASED SYSTEMS ENGINEERING FOR THE UNMANNED VEHICLE SENTRY ARCHITECTURE DEVELOPMENT

Clifford Whitcomb, Professor
Department of Systems Engineering
Sponsor: Office of Naval Research

OBJECTIVE: The objective of the proposed work is to continue the creation and demonstration of an effective methodology and tool set to enable design, development, and assessment of alternative system architectures for the UV Sentry. The final prototype is expected to be used in future UV Sentry program developments, to configuration manage the architecture structure, as well as providing consistent quantitative evaluation of program requirement suitability, effectiveness, technology maturation, risk, and cost before and during program execution.

UV SENTRY SOS ARCHITECTURE SUPPORT AND DEVELOPMENT

Clifford Whitcomb, Professor
Department of Systems Engineering
Sponsor: U. S. Navy Office of Naval Research (ONR)

OBJECTIVE: Study of UV sentry SoS architecting process and architecture framework that implements various surface, sub-surface, and airborne UV to accomplish the desired UV sentry capabilities. Attend meetings in support of the Unmanned Vehicle (UV) Sentry Systems Architecture Study.
SYSTMS ENGINEERING

SUMMARY: Developed various portions of architecture models in CORE. Developing a network modeling capability to determine UV network communications performance and effectiveness in warfighting scenarios.

PRESENTATIONS: Presented to UV Sentry project review meetings.

THESES DIRECTED:

**SYSTEMS ENGINEERING**

**JOURNALS**


**INTERVIEWS**


**BOOKS**


**CONTRIBUTIONS TO BOOKS**


**BOOK REVIEWS**


**CONFERENCE PUBLICATIONS & PROCEEDINGS**


CONFERENCE PRESENTATIONS


Roberts, B. and Owen, W., “Administering Distance Education Programs: Current Challenges and Solutions”, 26th Annual Conference on Distance Teaching & Learning, University of Wisconsin, Madison, WI, August 3-5, 2010.


TECHNICAL REPORTS


Bostwick, S., Buenviaje, B., Fotouhi, A., Perez-Luna, C., Pilling, K., Umeres, J.C. “Augmenting Naval Capabilities
SYSTEMS ENGINEERING


SPACE SYSTEMS ACADEMIC GROUP

OVERVIEW:
The Space Systems Academic Group (SSAG), along with ten academic departments, is an integral part of the Graduate School of Engineering and Applied Sciences. As an interdisciplinary association of professors, the SSAG provides direction and guidance for two curricula: Space Systems Engineering and Space Systems Operations. Officer students in the Space Systems curricula fulfill degree requirements for a Master of Science in the department of their choice or in a specialized engineering science. A space-oriented thesis is mandatory, as is coursework to fulfill the requirements of a space billet. Officer graduates are prepared to manage the technical aspects of a space-system lifecycle, including design, development, installation, and maintenance of spacecraft, space payloads, supporting ground stations, terminals, and C3 connectivity. The SSAG serves as the focal point for all space-related research performed at the Naval Postgraduate School (NPS). A major goal is to couple NPS space-research efforts with the graduate education of military officers. This is typically accomplished through space-related thesis research in several areas and includes small satellite projects created specifically as an educational tool for officer students. The SSAG oversees classified and unclassified student involvement in research activities and helps facilitate their placement in follow-on tours.

CURRICULA SERVED:
- Space Systems Operations
- Space Systems Engineering

DEGREES GRANTED:
- Master of Science in Space Systems Operations
- Master of Science in Aerospace Engineering
- Master of Science in Electrical Engineering
- Master of Science in Mechanical and Aerospace Engineering
- Master of Science in Applied Physics

RESEARCH THRUSTS:
- Military Applications for Space
- Space Reconnaissance and Remote Sensing
- Radiation Hardened Electronics for Space
- Design, Construction, and Launching of Small Satellites
- Classified (SCI Level) Research
- Satellite Communications Systems
- Military Space Systems and Architectures

RESEARCH CHAIRS:
- Measurement and Signature Intelligence (MASINT) Chair
- Michael J. Smith and William C. McCool Chair for Space Systems
- National Reconnaissance Office Chair
- Naval Space Systems Engineering and Acquisition Chair
- Navy Space Technology Program Chair
- Space Systems Chair

RESEARCH CENTERS:
- Spacecraft Research and Design Center
- Center for Reconnaissance Research
- Center for Radiation Hardened Electronics
- Center for Cryptologic Research
RESEARCH FACILITIES:

- Open Site EMI/EMC Facility
- Satellite Ground Station Facility
- FLTSATCOM Satellite Operations
- Spacecraft Attitude Dynamics and Control Laboratory
- Spacecraft Environmental Simulation and Test Laboratory
- Radiation Effects Laboratory
- Solar Simulation Facility
- NPS-AFRL Optical Relay Spacecraft Laboratory
- Flash X-Ray Facility
- Small Satellite Test and Development Laboratory
- Smart Structures Laboratory

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Space Systems Academic Group is provided below:

Size of Program: $1.4M
SPACE SYSTEMS ACADEMIC GROUP

Rudolf Panholzer
Chairman & Professor
831-656-2154
rpanholzer@nps.edu

Brij Agrawal
Distinguished Professor
Department of Mechanical and Aerospace Engineering
831-656-3338
agrawal@nps.edu

William B. Colson
Distinguished Professor
Department of Physics
831-656-2765
colson@nps.edu

Sherif N. Michael
Professor
Department of Electrical and Computer Engineering
831-656-2252
michael@nps.edu

Terry Alfriend
Visiting Professor
831-656-3929
ktalfrie@nps.edu

Donald A. Danielson
Professor
Department of Applied Mathematics
831-656-2622
dad@nps.edu

James C. Moltz
Associate Professor
Department of National Security Affairs
jmoltz@nps.edu

Tom Betterton
RAHM, USN (Ret.)
Naval Space Technology Program Chair
tcbetter@nps.edu

Philip A. Durkee
Professor & Chairman
Department of Meteorology
831-656-2516
durkee@nps.edu

Jim Mueller
Navy TENCAP Research Coordinator
831-656-3549
jwmuelle@nps.edu

Daniel C. Boger
Chairman
Department of Information Sciences
831-656-3671
dboger@nps.edu

Douglas J. Fouts
Professor & Associate Dean of Research
Department of Electrical and Computer Engineering
831-656-2852
fouts@nps.edu

Beny Neta
Professor
Department of Applied Mathematics
831-656-2235
bneta@nps.edu

Alexander Bordetsky
Associate Professor
Department of Information Sciences
831-656-2287
abordetsky@nps.edu

Mathias N. Kolsch
Assistant Professor
Department of Computer Science
831-656-3402
kolsch@nps.edu

James H. Newman
Professor
831-656-2487
jhnewman@nps.edu

Christopher M. Brophy
Associate Professor
Department of Mechanical & Aerospace Engineering
831-656-2327
cmbrophy@nps.edu

Barry S. Leonard
Visiting Assistant Professor
Department of Mechanical and Aerospace Engineering
bleonard@nps.edu

Richard C. Olsen
Professor
Department of Physics
831-656-2019
olsen@nps.edu

Nancy Ann Budden
Department of Defense Analysis
831-656-3332
nbudden@nps.edu

Herschel H. Loomis
Professor
Department of Electrical and Computer Engineering
831-656-3214
loomis@nps.edu

John Phillips
Research Professor & Michael J. Smith and William C. McCool Chair for Space Systems
831-656-7844
jphilhill@nps.edu

Daniel W. Bursch
CAPT, USN (Ret.)
Professor & National Reconnaissance Office Chair
831-656-2764
dwbursch@nps.edu

Randall “Ty” Pollak
MAJ, USAF
Assistant Professor
831-656-1144
randall.pollak@us.af.mil
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Department</th>
<th>Phone Number</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charles M. Racoosin</td>
<td>Visiting Assistant Professor &amp; Naval</td>
<td>Space Systems Academic Chair</td>
<td>831-656-2231</td>
<td><a href="mailto:cmracoos@nps.edu">cmracoos@nps.edu</a></td>
</tr>
<tr>
<td>Mark M. Rhoades</td>
<td>Lecturer</td>
<td>Department of Systems Engineering</td>
<td>831-277-9153</td>
<td><a href="mailto:mmrhoad@nps.edu">mmrhoad@nps.edu</a></td>
</tr>
<tr>
<td>Marcello Romano</td>
<td>Research Assistant Professor</td>
<td>Department of Mechanical and Aerospace Engineering</td>
<td>831-656-2885</td>
<td><a href="mailto:mromano@nps.edu">mromano@nps.edu</a></td>
</tr>
<tr>
<td>Alan A. Ross</td>
<td>Professor of Practice</td>
<td>Department of Electrical and Computer Engineering</td>
<td>831-656-3769</td>
<td><a href="mailto:aross@nps.edu">aross@nps.edu</a></td>
</tr>
<tr>
<td>I. Michael Ross</td>
<td>Professor</td>
<td>Department of Mechanical and Aerospace Engineering</td>
<td>831-656-2074</td>
<td><a href="mailto:imross@nps.edu">imross@nps.edu</a></td>
</tr>
<tr>
<td>Alan D. Scott</td>
<td>Senior Lecturer &amp; Naval Space</td>
<td>Systems Engineering and Acquisition Chair</td>
<td>831-656-2453</td>
<td><a href="mailto:adscott@nps.edu">adscott@nps.edu</a></td>
</tr>
<tr>
<td>Stephen Tackett</td>
<td>LCDR, USN, Retired</td>
<td>Lecturer and Program Officer</td>
<td>831-656-2944</td>
<td><a href="mailto:shtacket@nps.edu">shtacket@nps.edu</a></td>
</tr>
<tr>
<td>David Trask</td>
<td>MASINT Chair &amp; Professor</td>
<td>Department of Physics</td>
<td>831-656-2219</td>
<td><a href="mailto:dmttrask@nps.edu">dmttrask@nps.edu</a></td>
</tr>
<tr>
<td>Donald van Zelm Wadsworth</td>
<td>Senior Lecturer</td>
<td>Department of Electrical and Computer Engineering</td>
<td>831-656-3456</td>
<td><a href="mailto:dwadsworth@nps.edu">dwadsworth@nps.edu</a></td>
</tr>
<tr>
<td>Donald L. Walters</td>
<td>Professor</td>
<td>Department of Physics</td>
<td>831-656-2267</td>
<td><a href="mailto:walters@nps.edu">walters@nps.edu</a></td>
</tr>
<tr>
<td>Todd Weatherford</td>
<td>Associate Professor</td>
<td>Department of Electrical and Computer Engineering</td>
<td>831-656-3044</td>
<td><a href="mailto:trweathe@nps.edu">trweathe@nps.edu</a></td>
</tr>
<tr>
<td>William J. Welch</td>
<td>Lecturer</td>
<td>Department of Information Sciences</td>
<td>831-656-3212</td>
<td><a href="mailto:wwelch@nps.edu">wwelch@nps.edu</a></td>
</tr>
<tr>
<td>Todd Weatherford</td>
<td>Associate Professor</td>
<td>Department of Electrical and Computer Engineering</td>
<td>831-656-3044</td>
<td><a href="mailto:trweathe@nps.edu">trweathe@nps.edu</a></td>
</tr>
<tr>
<td>William J. Welch</td>
<td>Lecturer</td>
<td>Department of Information Sciences</td>
<td>831-656-3212</td>
<td><a href="mailto:wwelch@nps.edu">wwelch@nps.edu</a></td>
</tr>
</tbody>
</table>
OBJECTIVE: This project is concerned with the application of fault-tolerant techniques to reconfigurable space-based digital processors, with computer algorithms to specific military space projects, the development of specialized computer architectures for military Space applications, and the infusion of the research into the Space Systems Curricula.

SUMMARY:

During 2010 the following contributions have been made:
1. The development of a fault-tolerant Software-Defined Radio (SDR) for eventual incorporation on an existing DoD spacecraft-deployed FPGA.
2. Support of the LPI communications committee and LPI research.
3. Development of Geolocation algorithms and techniques. We have identified a geolocation algorithm for implementation on the NRO-funded MAESTRO Rad-hard multi-core chip.
4. Supported the inclusion of relevant research into Space Systems Courses, SS3001 and SS4051.

PUBLICATIONS:

Report of the SS4051 Capstone Architecture Class, NPS Technical Report NPS-SP-10-001, July 2010

THESES DIRECTED:

Culnen, James J., “Assessing the effects of Low Probability of Intercept (LPI) Radar on the ability of the United States Intelligence Community (IC) to maintain Maritime Domain Awareness (MDA),” MS Operations Research, September 2010 (C)

Gavros, Athanasios, “Use of the Reduced Precision Redundancy (RPR) Method in a Radix-4 FFT Implementation,” MS in Electrical Engineering, September 2010 (C)

Graewert, Eric and Smith, Troy, “Feasibility of Using a Tactical Precision Geo-Location System in a GPS-Denied Environment,” MS in Information Warfare Systems Engineering, September 2010 (C) (Joint Thesis)

Jarvis, “Geolocation of LTE Subscriber Stations Based on the Timing Advance Ranging Parameter,” MS in Electrical Engineering, September 2010 (C)
OBJECTIVE: This is a continuation of the research efforts for the design and optimization of state-of-the-art space-based solar cells. A new method for developing a realistic model of any type of solar cell using the SILVACO/ATLAS Virtual Wafer Fabrication software was developed at the Naval Postgraduate School (NPS). Taking into account the high cost of research and experimentation involved with the development of advanced cells, this novel methodology was developed. In our opinion, the introduction of this modeling technique to the Photovoltaic community will prove to be of great importance in aiding in the design and development of advanced solar cells. A multi-junction InGaP/GaAs/Ge solar cell was successfully modeled and was fully simulated. The simulation results were comparable to published experimental data of similar cells. Further research for the development of more accurate model that can be used for the design and optimization of advanced multi-junction cells is proposed. A major goal of this research is also to bridge the gap between current state of the art manufactured cells at 30% efficiency, and the theoretical limit of more than 40%. Further research in optimizing solar cells output power for high temperature and/or radiation environment realistic space operations is proposed.

MOBILE CUBESAT COMMAND AND CONTROL (MC3) SUPPORT
James H. Newman, Professor
Space Systems Academic Group
Sponsor: National Reconnaissance Office (CubeSat Project Office)

OBJECTIVE: The objective of this project is to develop the capability to provide network command and control capability in support of the QbX (CubeSat Project Office) Colony II CubeSat Program.

SUMMARY: The Mobile CubeSat Command and Control (MC3) project is sponsored by the NRO’s QbX office and is the ground segment complementing the Colony II Bus (C2B) program. As the C2B satellites are developed and launched, starting in June 2012, the ground stations need to be ready to communicate with the orbiting CubeSats. The MC3 uses the NRL’s Common Ground Architecture (CGA) software, scrubbed to be unclassified, operate on a laptop, and be deployable to the various field locations with UHF and S-band yagi antennas. Master’s thesis students LT Bobby Griffith and LT Greg Morrison are currently working this project, includes the procurement and replication of the MC3 hardware developed at the NRL. The challenges include networking of these stations for satellite command and control, including receiving data and transmitting it to the appropriate end user.

NPSCUL-LITE FLIGHT UNIT FOR ADAMAAT / ADAMSAT: NPSCUL-LITE STRUCTURES, FLIGHT DOCUMENTATION, AND INTEGRATION ACTIVITIES
James H. Newman, Professor
Space Systems Academic Group
Sponsors: National Science Foundation / National Reconnaissance Office, Advanced Systems and Technology CubeSat Office

OBJECTIVE: The objective of this project is to substantially increase the number of CubeSat launch opportunities for US Government, industry, and academic CubeSat developers on US launch vehicles.

SUMMARY: Although the CubeSat was originally developed as a satellite standard in the US, until recently most CubeSats have been launched overseas due to the difficulty of getting secondary payloads onto domestic launches.
The NPSCuL (NPS CubeSat Launcher) project utilizes the ESPA (EELV Secondary Payload Adaptor) ring interface standard to accommodate eight Cal Poly P-PODs in a single structure.

OSL (Office of Space Launch) has sponsored the development of the ABC (Aft Bulkhead Carrier) by ULA (United Launch Alliance) to provide auxiliary payload accommodation on the aft end of the Centaur upper stage, also utilizing the ESPA ring standard. In CY09 the NRO AS&T QbX office sponsored the ADaMSat (AS&T Development and maturation Satellite for launch in late 2010. ADaMSat was cancelled in December 2009 due to payload schedule issues. In CY10 OSL decided to sponsor OUTSat (Operationally Unique Technologies Satellite) as the first payload on the ABC. OUTSat is currently scheduled for integration with the CubeSat payloads in December 2011 for the NRO L-36 launch in June 2012.

The CY10 effort continued the development of NPSCuL as originally envisioned for the NRO QbX ADaMSat effort. The OUTSat project is in collaboration with NPS and the Auxiliary Payload Integrating Contractor, SRI International and Cal Poly. The NRO QbX office and NASA are furnishing the CubeSats for OUTSat. The CY10 work focused on finishing the qualification of the flight design in preparation for construction and test of a flight unit.

In CY10, work on the NPS CubeSat Launcher (NPSCuL) has been funded by the continuation of grants from the NRO (National Reconnaissance Office) and the NFS (National Science Foundation).

NPSCuL in the OUTSat configuration is shown to the right. It packages eight Cal Poly CubeSat Deployers, called P-PODs, short for the Poly Picosatellite On-orbit Deployer, for launch on any compatible secondary payload mounting fixture. To date these fixtures are available on the ABC and the ESPA (EELV Secondary Payload Adaptor) ring. The Space Test Program and NASA have indicated the possibility of flying the NPSCuL on future ABC missions and on an upcoming flight of the ESPA ring.

Currently civilian Master’s student Vidur Kaushish and PhD student Wenschel Lan, are working on the project, assisted part-time by Master’s student Madison Studholme.

PRESENTATIONS:


THESES DIRECTED:


PHASE III: FINAL INTEGRATION AND TESTING OF A FLIGHT NANO SATELLITE SOLAR CELL ARRAY TEST

James H. Newman, Professor
Space Systems Academic Group

Sponsor: National Reconnaissance Office, Advanced Systems and Technology-Outreach Program

OBJECTIVE: The objective of this project is to investigate the use of very small satellites to accomplish focused research of national interest. To support this objective, this project is producing NPS’s first satellite using the CubeSat form factor, thereby gaining experience in all phases of CubeSat payload development, systems integration and testing, and flight operations. The use of the CubeSat form factor is expected to enhance our capability to perform certain research of national interest that is also accessible and interesting to the NPS student body. This CubeSat characterizes the performance of various solar cells in the space environment. The results are of general interest and
demonstrate the capability of the CubeSat as a technology demonstration satellite, as well as a potential platform for more sophisticated experiments.

**SUMMARY:** This project continues the work done under the Phase I and Phase II, with the expectation of producing a flight-ready CubeSat, NPS-SCAT. This work seeks to demonstrate the capability in the SSAG to produce payloads using the CubeSat form factor to enable focused research objectives of national interest. The Space Test Program (STP) is seeking a launch opportunity, including perhaps a ride in late 2011 to the International Space Station (ISS) for deployment from the Japanese exposed facility in mid-2012. Naval Postgraduate School’s first CubeSat takes one experiment, the solar cell IV curve tester, from NPSAT1 and repackages it to fit in the CubeSat form factor. This work is a continuation of research done by an increasing number of students. The student team has come together to finish testing the SCAT systems and payload.

**PRESENTATIONS:**


**THESES DIRECTED:**


**OTHER:**

This project was successfully presented to the DoN and the DoD Space Experiment and Review Board and ranked for an eventual launch opportunity.

**STUDENT RIDESHARE PAYLOAD MODEL**

James H. Newman, Professor
Space Systems Academic Group
Sponsor: California Space Education Workforce Institute

**OBJECTIVE:** The Naval Postgraduate School has robust Space Systems Engineering and Operations research and education programs. The operations education/research focuses on design, development and acquisition management of space communications, navigation, surveillance, electronic warfare and environmental sensing systems. The engineering education/research encompasses the operations, tasking and employment of spaces surveillance, communications, navigation and atmospheric, oceanographic, environmental sensing systems as well as payload design and integration - specifically for the exploitation of Space and Information products.
The California Space Education and Workforce Institute is a non-profit organization whose mission includes space-related education and concentrated programs to advance space science, engineering and technology.

NPS and CSEWI will collaborate to produce and qualify a student payload launcher and update requirements and process information to improve student access to launch opportunities.

**SPACE SITUATIONAL AWARENESS: CUBESAT BUS, ATTITUDE CONTROL, AND UTILIZATION**

James H. Newman, Professor  
Marcello Romano, Associate Professor (Mechanical & Aerospace Engineering)  
Alan Scott, Senior Lecturer (Mechanical & Aerospace Engineering)  
Sponsor: Lawrence Livermore National Laboratory (DOE)

**OBJECTIVE:** To integrate a test the LLNL optical payload with the Boeing Colony II Bus (C2B) in preparation for launch.

**SUMMARY:** Space situational awareness (SSA) is important for avoiding collisions between satellites and other objects in space and for observing unanticipated satellite maneuvering. LLNL’s SSA activities include maintaining computer codes (TESSA, Test Environment for SSA) that predict conjunctions. To improve conjunction analysis and to reduce the number of false positive conjunctions, LLNL is interested in fielding two 3U CubeSats with an optical payload to validate its capability to improve the state vectors of certain satellites. The optical payload is a telescope that can capture satellites; reflected light as streaks against a star background. Using GPS for time and position information, analysis of the streaks should improve the knowledge of the tracked object’s state vector or ephemeris.

LLNL has partnered with NPS and TAMU (Texas A&M University) to produce 3U CubeSats that can assist in satellite ephemeris improvement in support of Space Situational Awareness. This project, STARE or Space Telescope for the Active Refinement of Ephemeris, includes development of a sophisticated, compact telescope by LLNL. NPS and TAMU will each participate in integration and test of a telescope and the Colony II Bus (C2B). The C2B is an advanced 3U bus being developed by the Boeing Company under contract by the NRO CubeSat Development Office (QbX). With two star trackers for attitude determination, four reaction wheels for attitude control, about 1.5U for a payload, about 20W continuous power available, and significant download capability, the C2B should provide a powerful platform for rapid payload development and launch.

Shown conceptually to the right, with a telescope at one end, each of the two STARE satellites is scheduled to launch as part of the OUTSat mission. The delivery date of December 2011 is followed by integration into a P-POD and subsequently into OUTSat. The project is of national interest and exposes students to a number of interesting concepts and a valuable hands-on satellite project.

**THESES DIRECTED:**


**NAVAL SPACE SYSTEMS ACADEMIC CHAIR**  
Rudolf Panholzer, Professor  
Space Systems Academic Group  
Sponsor: Naval Network Warfare Command

**OBJECTIVE:** Incumbents of the Naval Space Systems Academic Chair will engage in instruction and research and act as a consultant in the area of specialization to students and faculty of the Naval Postgraduate School.

**SUMMARY:** The instructional, research, and advisory program carried out by the Naval Space Systems Academic
Chair was comprised of various activities including: stimulating and participating in appropriate faculty research as well as coordinating and supervising student research. The chair supported and guided ongoing curriculum and laboratory development at the Naval Postgraduate School. The chair also presented/coordinate seminars as mutually agreed upon with SSAG chairman in areas of common interest and taught courses as appropriate.

The chair also acted as a conduit between Naval Network war Command and Naval Postgraduate School on the latest developments in Space Systems and their impact on future Naval Operations and resources.

**NPS NPSSAT1 SATELLITE SUPPORT**

*Rudolf Panholzer, Professor*

*Space Systems Academic Group*

*Sponsor: SAF ST*

**OBJECTIVE:** The objective of this proposal is to fund instructional thesis research related to the NPSAT1 micro-satellite, and the development of the space vehicle. NPSAT1 is part of the Small Satellite Design Program under the NPS Space Systems Academic Group.

**SUMMARY:** This program provided a mechanism for research and instruction in satellite design technology and its applications. NPSAT1 is a low-cost, three-axis stabilized, small satellite hosting a number of experiments for technology demonstration. NPS is currently working through the Department of Defense Space Test Program (STP) to manifest NPSAT1 on a launch opportunity. Earliest launch opportunities are in the CY12 time frame. NPSAT1 was ranked 43rd out of 60 experiments briefed to the November 2009 DoD STP Space Experiments review Board.

**SPACE SYSTEMS ENGINEERING EXPERIENCE TOUR AND SPACE SYSTEMS ENGINEERING SUPPORT**

*Rudolf Panholzer, Professor*

*Space Systems Academic Group*

*Sponsor: National Reconnaissance Office*

**OBJECTIVE:** To fund the Space Systems Academic Group Space Systems, engineering support, engineering student thesis research, related travel, and Experience Tour travel.

**SUMMARY:** This research is one of the main sources of funding for the Space System Academic Group. The bulk of the money supported the engineer’s labor used to assist the graduate students as they worked on the research related to their thesis projects. The students participated in many hands-on research involving on-going projects giving them valuable experience in design, development, installation, system integration, and maintenance of spacecraft and payloads.

Another significant segment of the funds were used to financially support the travel needed to work on DoD, NASA, other government sites, and commercial installations as a group to gain exposure to different facilities and their functions.

**SPACE SYSTEMS OPERATIONS THESIS RESEARCH/EXPERIENCE TOUR**

*Rudolf Panholzer, Professor*

*Space Systems Academic Group*

*Sponsor: Naval Network Warfare Command*

**OBJECTIVE:** The objective of this research was to fund Space Systems Academic Group (SSAG) Space Systems Operations student thesis research related travel and Experience Tour Travel.

**SUMMARY:** This research allowed student to conduct on-site research and learning in support of thesis development.
It also provided students an opportunity to participate in Experience Tour travel. The Experience Tour encompassed two weeks off-site visiting DoD, NASA, other government sites, and commercial installations as a group to gain exposure to different facilities and their functions.

**NAVAL SPACE SYSTEMS ENGINEERING AND ACQUISITION CHAIR**

Alan D. Scott, Senior Lecturer  
Space Systems Academic Group  
**Sponsor:** Program Executive Office for Space Systems

**OBJECTIVE:** The objective of the Naval Space Systems Engineering and Acquisition (SSEA) Chair is to promote and guide a focused instructional program in space systems engineering and acquisition at the Naval Postgraduate School (NPS) which will support naval space systems. The roles and responsibilities governing the Naval SSEA Chair are defined in a Memorandum of Agreement (MOA) signed by the President, Naval Postgraduate School and the Program Executive Officer for Space Systems.

The intent of this proposal is to define tasks to be executed by the Naval SSEA Chair during Fiscal Year 2011 to support the NPS Space Systems Program and the Program Executive Office for Space Systems (PEO SS) and encourage further collaboration between the two organizations.
SPACE SYSTEMS
ACADEMIC GROUP

2010
Faculty Publications
and Presentations
Crane, W., Romano, M., and Newman, J., “Characterization of a Shape Memory Alloy Interference Joint”, Smart Materials and Structures (target journal), in preparation


D. Sakoda. Presentation to the DOD Space Experiments Review Board (SERB) on the NPSAT1 Small Satellite, Experiment Number: NPS-0001, November 2010.

D. Sakoda. Presentation to the Navy Space Experiments Review Board (SERB) on the NPSAT1 Small Satellite, Experiment Number: NPS-0001; NPSCL (CubeSat Launcher), Experiment NPS-0701; and NPS-SCAT (Solar Cell Array Tester), Experiment Number NPS-0801, June 2010.

Report of the SS4051 Capstone Architecture Class, NPS Technical Report NPS-SP-10-001, July 2010

PATENTS

GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY

WILLIAM GATES
DEAN
GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY

OVERVIEW:

The Graduate School of Business and Public Policy offers a unique, residential, defense-focused MBA program, plus Master’s degrees in five other Department of Defense-relevant areas. Faculty research is an important component of the school and strives to support military decision making, problem solving, and policy setting; improve administrative processes and organizational effectiveness; contribute knowledge to academic disciplines; and advance the mission of graduate education. The research program is integrated to the greatest possible extent with the educational process. Students are encouraged to participate in faculty projects, and faculty research results are typically incorporated in classroom instruction. Topics and issues can be grouped into five broad functional areas: acquisition and contracting; budgeting and financial management; logistics and transportation; manpower-systems analysis; and policy formulation, analysis, and management.

RESEARCH CHAIRS:

- Chair of Acquisition Management
- Chair of Innovation
- Conrad Chair of Financial Management
- RADM George F. Wagner Chair in Public Management

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Graduate School of Business and Public Policy is provided below:

Size of Program: $6.7M
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aruna Apte</td>
<td>Assistant Professor</td>
<td><a href="mailto:aupte@nps.edu">aupte@nps.edu</a></td>
</tr>
<tr>
<td>Uday Apte</td>
<td>Professor</td>
<td><a href="mailto:umapte@nps.edu">umapte@nps.edu</a></td>
</tr>
<tr>
<td>Jeremy Arkes</td>
<td>Associate Professor</td>
<td><a href="mailto:jaarkes@nps.edu">jaarkes@nps.edu</a></td>
</tr>
<tr>
<td>Kathryn Aten</td>
<td>Assistant Professor</td>
<td><a href="mailto:kjaten@nps.edu">kjaten@nps.edu</a></td>
</tr>
<tr>
<td>Frank J. Barrett</td>
<td>Professor</td>
<td><a href="mailto:FBarrett@nps.edu">FBarrett@nps.edu</a></td>
</tr>
<tr>
<td>Michael W. Boudreau</td>
<td>Senior Lecturer</td>
<td><a href="mailto:mboudreau@nps.edu">mboudreau@nps.edu</a></td>
</tr>
<tr>
<td>Douglas E. Brinkley</td>
<td>Senior Lecturer</td>
<td><a href="mailto:brinkley@nps.edu">brinkley@nps.edu</a></td>
</tr>
<tr>
<td>Douglas A. Brook</td>
<td>Professor &amp; Director, Center for Defense Management Research</td>
<td><a href="mailto:dabrook@nps.edu">dabrook@nps.edu</a></td>
</tr>
<tr>
<td>Philip J. Candreva</td>
<td>Senior Lecturer</td>
<td><a href="mailto:pcandre@nps.edu">pcandre@nps.edu</a></td>
</tr>
<tr>
<td>Aruna Apte</td>
<td>Patricia Cook</td>
<td>Patricia Cook</td>
</tr>
<tr>
<td>Uday Apte</td>
<td>Peter Coughlan</td>
<td>Peter Coughlan</td>
</tr>
<tr>
<td>Jeremy Arkes</td>
<td>Alice M. Crawford</td>
<td><a href="mailto:acrawford@nps.edu">acrawford@nps.edu</a></td>
</tr>
<tr>
<td>Kathryn Aten</td>
<td>Jesse Cunha</td>
<td><a href="mailto:jcunha@nps.edu">jcunha@nps.edu</a></td>
</tr>
<tr>
<td>Frank J. Barrett</td>
<td>Robert Davis</td>
<td><a href="mailto:rwdavis@nps.edu">rwdavis@nps.edu</a></td>
</tr>
<tr>
<td>Michael W. Boudreau</td>
<td>Nicholas Dew</td>
<td><a href="mailto:ndew@nps.edu">ndew@nps.edu</a></td>
</tr>
<tr>
<td>Douglas E. Brinkley</td>
<td>John T. Dillard</td>
<td><a href="mailto:jtdillard@nps.edu">jtdillard@nps.edu</a></td>
</tr>
<tr>
<td>Douglas A. Brook</td>
<td>Marco DiRenzo</td>
<td><a href="mailto:msdirenz@nps.edu">msdirenz@nps.edu</a></td>
</tr>
<tr>
<td>Philip J. Candreva</td>
<td>Kenneth H. Doerr</td>
<td><a href="mailto:khdoerr@nps.edu">khdoerr@nps.edu</a></td>
</tr>
<tr>
<td>Aruna Apte</td>
<td>Richard B. Doyle</td>
<td><a href="mailto:rdoyle@nps.edu">rdoyle@nps.edu</a></td>
</tr>
<tr>
<td>Uday Apte</td>
<td>Mark J. Eitelberg</td>
<td><a href="mailto:meitelberg@nps.edu">meitelberg@nps.edu</a></td>
</tr>
<tr>
<td>Jeremy Arkes</td>
<td>Kenneth J. Euske</td>
<td><a href="mailto:kjeuske@nps.edu">kjeuske@nps.edu</a></td>
</tr>
<tr>
<td>Kathryn Aten</td>
<td>Geraldo Ferrer</td>
<td><a href="mailto:gferrer@nps.edu">gferrer@nps.edu</a></td>
</tr>
<tr>
<td>Frank J. Barrett</td>
<td>Patrick Flanagan</td>
<td><a href="mailto:piflanag@nps.edu">piflanag@nps.edu</a></td>
</tr>
<tr>
<td>Michael W. Boudreau</td>
<td>Raymond E. Franck</td>
<td><a href="mailto:refranck@nps.edu">refranck@nps.edu</a></td>
</tr>
<tr>
<td>Douglas E. Brinkley</td>
<td>Deborah E. Gibbons</td>
<td><a href="mailto:degibbon@nps.edu">degibbon@nps.edu</a></td>
</tr>
<tr>
<td>Douglas A. Brook</td>
<td>James B. Greene</td>
<td><a href="mailto:jbgreene@nps.edu">jbgreene@nps.edu</a></td>
</tr>
<tr>
<td>Philip J. Candreva</td>
<td>William D. Hatch II</td>
<td><a href="mailto:wdhatch@nps.edu">wdhatch@nps.edu</a></td>
</tr>
<tr>
<td>Name</td>
<td>Title and Affiliation</td>
<td>Phone Number</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Timothy G. Hawkins</td>
<td>Assistant Professor, MAJ, USAF</td>
<td>831-656-7647</td>
</tr>
<tr>
<td>Susan K. Heath</td>
<td>Assistant Professor, Associate Professor</td>
<td>831-656-2093</td>
</tr>
<tr>
<td>David R. Henderson</td>
<td>Associate Professor, Assistant Professor</td>
<td>831-656-2524</td>
</tr>
<tr>
<td>Susan P. Hocevar</td>
<td>Associate Professor, Assistant Professor</td>
<td>831-656-2249</td>
</tr>
<tr>
<td>Bryan J. Hudgens</td>
<td>Lecturer, Assistant Professor, Air Force Acquisition</td>
<td>831-656-2039</td>
</tr>
<tr>
<td>Becky Jones</td>
<td>Lecturer, Assistant Professor</td>
<td>831-656-2755</td>
</tr>
<tr>
<td>Lawrence R. Jones</td>
<td>Professor &amp; RADM George F. Wagner Chair in Public</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Management</td>
<td>831-656-2482</td>
</tr>
<tr>
<td>Keebom Kang</td>
<td>Associate Professor, Assistant Professor</td>
<td>831-656-3106</td>
</tr>
<tr>
<td>Christina Kelton</td>
<td>Visiting Professor, Assistant Professor</td>
<td>831-656-2644</td>
</tr>
<tr>
<td>John Khawam</td>
<td>Research Assistant Professor, Associate Professor</td>
<td>831-656-2470</td>
</tr>
<tr>
<td>Maxim Kidalov</td>
<td>Assistant Professor, Assistant Professor</td>
<td></td>
</tr>
<tr>
<td>Cynthia King</td>
<td>Assistant Professor, Assistant Professor</td>
<td>831-656-3228</td>
</tr>
<tr>
<td>David Lamm</td>
<td>Visiting Research Associate Professor, Assistant Professor</td>
<td></td>
</tr>
<tr>
<td>Steven Landry</td>
<td>Visiting Professor, Assistant Professor</td>
<td>831-656-7768</td>
</tr>
<tr>
<td>Ira A. Lewis</td>
<td>Associate Professor, Assistant Professor</td>
<td>831-656-2464</td>
</tr>
<tr>
<td>Lisa Lindsey</td>
<td>Associate Professor, Assistant Professor</td>
<td>916-873-2922</td>
</tr>
<tr>
<td>Janie Lynn Maddox</td>
<td>Lecturer, Assistant Professor</td>
<td>831-656-7646</td>
</tr>
<tr>
<td>Danny Matthews</td>
<td>Senior Lecturer, Assistant Professor</td>
<td>831-656-7962</td>
</tr>
<tr>
<td>David F. Matthews</td>
<td>Senior Lecturer, Assistant Professor</td>
<td>831-656-2360</td>
</tr>
<tr>
<td>Douglas Moses</td>
<td>Vice Provost for Academic Affairs, Assistant Professor</td>
<td>831-656-3218</td>
</tr>
<tr>
<td>Brian Murphy</td>
<td>CDR, Lecturer, Assistant Professor</td>
<td>831-656-2471</td>
</tr>
<tr>
<td>John E. Mutty</td>
<td>Senior Lecturer, Assistant Professor</td>
<td>831-656-2205</td>
</tr>
<tr>
<td>Noah Myung</td>
<td>Assistant Professor, Assistant Professor</td>
<td>831-656-2811</td>
</tr>
<tr>
<td>Brad Naegle</td>
<td>Senior Lecturer, Assistant Professor</td>
<td>831-656-3620</td>
</tr>
<tr>
<td>Robert Osterhoudt</td>
<td>Senior Lecturer, Assistant Professor</td>
<td>831-656-2884</td>
</tr>
<tr>
<td>Walter E. Owen</td>
<td>Senior Lecturer, Assistant Professor</td>
<td>831-656-2048</td>
</tr>
<tr>
<td>Elda Pema</td>
<td>Assistant Professor, Assistant Professor</td>
<td>831-656-3631</td>
</tr>
<tr>
<td>Charles Pickar</td>
<td>Senior Lecturer, Assistant Professor</td>
<td>703-589-7544</td>
</tr>
<tr>
<td>Lisa F. Potvin</td>
<td>Lecturer and Program Manager, Assistant Professor</td>
<td>719-357-0679</td>
</tr>
<tr>
<td>Edward H. Powley</td>
<td>Assistant Professor of Management, Assistant Professor</td>
<td>831-656-2768</td>
</tr>
<tr>
<td>Timothy Reed</td>
<td>Visiting Associate Professor, Assistant Professor</td>
<td>703-599-6696</td>
</tr>
<tr>
<td>Juanita M. Rendon</td>
<td>Lecturer, Assistant Professor, Assistant Professor</td>
<td>831-656-2444</td>
</tr>
<tr>
<td>Name</td>
<td>Title</td>
<td>Phone</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Rene G. Rendon</td>
<td>Associate Professor</td>
<td>831-656-3464</td>
</tr>
<tr>
<td>Benjamin Roberts</td>
<td>Senior Lecturer</td>
<td>831-656-2792</td>
</tr>
<tr>
<td>Anita Salem</td>
<td>Lecturer</td>
<td>831-277-6616</td>
</tr>
<tr>
<td>Susan M. Sanchez</td>
<td>Professor</td>
<td>831-656-2780</td>
</tr>
<tr>
<td>Dina Shatnawi</td>
<td>Assistant Professor</td>
<td>831-656-2755</td>
</tr>
<tr>
<td>Yu-Chu Shen</td>
<td>Associate Professor</td>
<td>831-656-2951</td>
</tr>
<tr>
<td>Cary A. Simon</td>
<td>Lecturer</td>
<td>831-656-2439</td>
</tr>
<tr>
<td>Keith F. Snider</td>
<td>Associate Professor</td>
<td>831-656-3621</td>
</tr>
<tr>
<td>William Stoddart</td>
<td>Lecturer</td>
<td></td>
</tr>
<tr>
<td>James E. Suchan</td>
<td>Professor &amp; Associate Dean for</td>
<td>831-656-2905</td>
</tr>
<tr>
<td>Donald E. Summers</td>
<td>Senior Lecturer</td>
<td>831-656-3632</td>
</tr>
<tr>
<td>Katsuaki Terasawa</td>
<td>Lecturer</td>
<td>831-656-3628</td>
</tr>
<tr>
<td>Gail Fann Thomas</td>
<td>Associate Professor</td>
<td>831-656-2763</td>
</tr>
<tr>
<td>Bernad Udis</td>
<td>Visiting Research Professor</td>
<td>831-656-2471</td>
</tr>
<tr>
<td>Chong Wang</td>
<td>Assistant Professor</td>
<td>831-656-2665</td>
</tr>
<tr>
<td>Frank Wood</td>
<td>Senior Lecturer</td>
<td></td>
</tr>
<tr>
<td>Joseph Yakovac</td>
<td>Senior Lecturer</td>
<td>703-455-6381</td>
</tr>
<tr>
<td>Elliott Cory Yoder</td>
<td>Senior Lecturer &amp; Academic Associate</td>
<td></td>
</tr>
<tr>
<td>Keenan D. Yoho</td>
<td>Assistant Professor</td>
<td>831-656-2029</td>
</tr>
<tr>
<td>Donald E. Summers</td>
<td>Senior Lecturer</td>
<td>831-656-3619</td>
</tr>
</tbody>
</table>

531
GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY

A STUDY OF BUDGET FORMULATION AND EXECUTION IN DEFENSE MANPOWER DATA CENTER (DMDC)

Douglas A. Brook, Professor
Graduate School of Business and Public Policy
Sponsor: Defense Manpower Data Center

OBJECTIVE: Based on preliminary discussions with senior leaders and managers at Defense Manpower Data Center, the Center for Defense Management Research (CDMR) recommends a study that examines the budget formulation and execution professes at DMDC. The purposes of this study are: first, to examine the policies, practices and cultural influences in DMDC budget formulation and execution; secondly, to develop models of budget formulation and execution and a change management strategy that could serve DMDC’s need for budgetary efficiency, stewardship, accountability and strategic alignment; and third, to develop recommendations and change management strategies based on the findings of this study.

DON CHIEF MANAGEMENT OFFICER: A WORKSHOP TO EXPLORE FOUNDATIONS FOR THE CMO/DCMO IN THE DEPARTMENT OF THE NAVY

Douglas A. Brook, Professor
Graduate School of Business and Public Policy
Sponsor: Deputy Under Secretary of the Navy

OBJECTIVE: Based on preliminary discussions with the Under Secretary of the Navy and the Deputy Under Secretary of the Navy for Business Enterprise Operations and Transformation, this proposal is submitted to assist Navy leadership in further developing the concept and operations of the office of MO for the Department of the Navy. CDMR has previously been engaged in applied research for the DoD Business Transformation Agency and some of its researchers have previous experience working in DoN business transformation.

THE ENTERPRISE CONCEPT FOR BUSINESS TRANSFORMATION IN THE NAVY: AN ANALYTICAL HISTORY

Douglas A. Brook, Professor
Graduate School of Business and Public Policy
Sponsor: Naval Supply Systems Command

OBJECTIVE: We propose to conduct research and prepare an analytical history of the enterprise concept in the Navy with a focus on business management transformation, changes in business processes, and financial impacts. We will perform a literature review that addresses the theory and practice behind the enterprise concept and we will examine the original goals of Admirals Clark and Massenberg for Sea Enterprise and Naval Aviation Enterprise. We will trace the evolution of enterprise management and assess its impact on business operations and financial results. Our report will highlight aspects of Navy Enterprise that are particularly relevant for the future of Navy business transformation.

IMPLEMENTATION OF NSPS AND DHS PERSONNEL SYSTEMS

Douglas A. Brook, Professor
Graduate School of Business and Public Policy
Sponsor: Program Executive Office, National Security Personnel System

OBJECTIVE: For this study, we will investigate how DoD implemented NSPS in the period between enactment and the publication of regulations in the Federal Register on 16 January 2009. This research will be conducted by:

• Examining documents in the public record
• Examining documents provided by the PEO and the DoD historian
• Reviewing data and files provided by the program office and other sources
GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY

- Coding data from transcripts of interviews by DoD and component historians
- Interviewing key players in NSPS implementation.

The primary researchers for this project will be Dr. Douglas Brook and Dr. Cynthia King. Additionally, they will work with two assistants on the project: a current NPS graduate student, as well as a former NPS military student who was one of the student authors on one of the earlier personnel management studies.

BARRIERS TO IMPLEMENTING LED LIGHTING INNOVATIONS IN THE NAVY
Nicholas Dew, Assistant Professor
Graduate School of Business and Public Policy
Sponsor: Office of Naval Research

OBJECTIVE: The focus of this work is on identifying what are the barriers that make innovation implementation difficult in the Navy. As directed, we will study LED lighting as a specific case in point, though our ultimate goal is to generate insights into the wider lessons that might be learned from this case for innovation implementation in general in the Navy.

The final deliverable report is expected to have three elements:
1. a financial analysis - to identify, “what’s the opportunity we’re missing?” with LED lighting?, i.e. what’s the opportunity cost of not implementing this innovation?
2. a barriers to implementation analysis - to identify “why we are missing this opportunity?”, i.e. what aspects of our organizational structures, processes, culture, institutions make it difficult for us to implement this?
3. a case write-up that designed for use in the Navy’s executive education programs, or NPS MBA programs, that prompts discussants to analyze “what are the wider lessons learned?” from this particular case.

COST OF ATTRITION
John Enns, Senior Lecturer
Graduate School of Business and Public Policy
Sponsor: OSD Personnel and Readiness

OBJECTIVE: The purpose of the research is to estimate how much first term attrition costs the Army and Navy by examining attrition rates and replacement costs across several personnel categories and separation points, Estimation of current attrition rates and associated costs will help the Services to make a cost-effective selection of personnel: this is the primary benefit to be realized from this research.

SUPPORT TO COMMANDER NAVAL SURFACE FORCES
Kenneth J. Euske, Professor
Graduate School of Business and Public Policy
Sponsor: Commander Naval Surface Forces

OBJECTIVE: To provide support to Commander Naval Surface Forces to address issues regarding costing, process analysis, internal control, and training.
SUPPORT TO THE NAVAL SUPPLY SYSTEMS COMMAND
Kenneth J. Euske, Professor
Graduate School of Business and Public Policy
Sponsor: Naval Supply Systems Command

OBJECTIVE: To provide support to Commander Naval Supply Systems Command to address issues regarding costing, process analysis, internal control, and training.

APPLYING UID/RFID TO TRACK MAINTENANCE ASSETS IN THE US DEPARTMENT OF DEFENSE
Geraldo Ferrer, Associate Professor
Graduate School of Business and Public Policy
Sponsor: Office of the Commander FISCs 00W1

OBJECTIVE: COMFISCS WNY desires to have faculty and students of the Naval Postgraduate School (NPS) to engage in supply chain management research involving topics that are of importance of the Program Executive Office, the Department of the Navy and the Department of Defense. In furthering this objective, funding is requested in the amount of $53K to the Naval Postgraduate School in support of research about the use of UID for tracking maintenance assets in the Naval supply chain, and for the development of educational material to disseminate the respective knowledge among NPS students and members of the DoD community. NPS faculty and students will undertake specific research projects within the scope of GSBPP expertise in Supply Chain Management. The Principal Investigator will apply discretion determining the use of funds towards relevant research and studies in Supply Chain Management. The deliverables will be in the form of one or more student thesis. This study is being executed as part of the partnership initiated in FY2008 between COMFISCS UID Project Manager and the Graduate School of Business and Public Policy of the Naval Postgraduate School.

INNOVATION RESEARCH
CAPT Barbara Ford, USN, Military Associate Dean
Graduate School of Business and Public Policy
Sponsor: Office of Naval Research

OBJECTIVE: Objective is to train and critical mass of Naval (and other) leaders in order to effect a state change in the effectiveness and strategic value of their innovation efforts. And to create an Innovation Initiative located at Naval Postgraduate School that will aggregate resources and best practices so that it becomes a hub for innovation “know-how” and “know-what”. Program will involve multi-disciplinary approach, and will be incorporated into several curriculums/areas of NPS, and across Department of the Navy. Costs to cover labor expense of contracted Innovation Chair and supporting travel/administrative expenses.

APPLYING SOCIAL CONTROL THEORY TO MODELING AND ASSESSMENTS
Deborah E. Gibbons, Associate Professor
Graduate School of Business and Public Policy
Sponsor: U.S. Center for Army Analysis

OBJECTIVE: The overarching objective of this work is the development of feasible methods and empirically grounded metrics for assessing and modeling dynamic attitudes and intentions of civilians in irregular warfare and counterinsurgency environments. This work includes three components:

Identify personal, social and cultural factors that are likely to affect civilians’ attitudes, intentions, and behaviors in COIN/IW situations
GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY

Develop metrics for the most likely precursors to attitudes and behaviors in COIN/IW environments, and help the US CAA incorporate them into reliable and valid surveying methods for use in COIN/IW situations.

Translate the key personal, social, and cultural factors into parameters and processes that can be incorporated into practical simulations for wargaming and decision support.

**IRREGULAR WARFARE (IW) METHODS, MODELS, AND TOOLS (MMT)**

**INFRASTRUCTURE & ESSENTIAL SERVICES ONTOLOGY**

Deborah E. Gibbons, Associate Professor
Graduate School of Business and Public Policy

Sponsor: Training and Doctrine Command Analysis Center

**OBJECTIVE:** Document socio-culture factors and their influence on the need, use, and response to infrastructure & essential services based on a social psychology background.

**CAPACITY MODELING OF FLEET READINESS CENTER SOUTHWEST, PHASE 1**

Susan K. Heath, Assistant Professor
Graduate School of Business and Public Policy

Sponsor: Fleet Readiness Center Southwest

**OBJECTIVE:** This project will consist of construction of a capacity simulation model of Fleet Readiness Center Southwest (FRCSW). All major aircraft platforms, major types of maintenance, repair, and overhaul (MRO), and major phases of MRO will be modeled. This includes the consolidation of existing process and flow data which will be provided by FRCSW. The data will then be used to construct a discrete-event simulation model. The model will be designed to allow for experimentation to test a variety of questions about future capacity use.

The scope of this Phase 1 project includes modeling at the level of detail of the aircraft platforms and types and phases of MRO. It will cover work that is performed on the aircraft at the North Island location of FRCSW. Part-level detail, back-shop detail, and specific detailed level of work may be considered under a subsequent project. Any changes to this project plan will be made by mutual agreement of the Commanding Officer Fleet Readiness Center Southwest and Professor Susan Heath.

**ANALYSIS OF FLIGHT HOUR PROGRAM MANAGEMENT, BUDGET EXECUTION, COST-AVOIDANCE AND FINANCIAL MANAGEMENT INITIATIVES IN CNAF**

Lawrence R. Jones, Professor
Graduate School of Business and Public Policy

Sponsor: Naval Air Command and Naval Air Command Pacific (CNAF/CNAP)

**OBJECTIVE:** The purpose of this research is to provide analytical assistance to the Office of the Comptroller, CNAF in the comptroller function and in analysis of budget execution and other initiative for improving command management and management control, achieving cost-reduction and avoidance in the Flight Hour Program (FHP) and accommodating budget reduction in the period of FY10, FY11 and beyond. In addition, the project includes analysis of improvements in management systems and systems support to provide better data to enable management of the command in conformance with sounds business management principals and practices.
ANALYSIS OF FLIGHT HOUR PROGRAM MANAGEMENT, BUDGET EXECUTION, COST-AVOIDANCE AND FINANCIAL MANAGEMENT INITIATIVES IN CNAP

Lawrence R. Jones, Professor
Graduate School of Business and Public Policy
Sponsor: Naval Air Command and Naval Air Command Pacific (CNAF/CNAP)

OBJECTIVE: The purpose of this research is to provide analytical assistance to the Office of the Comptroller, CNAP in the comptroller function and in analysis of budget execution and other initiative for improving command management and management control, achieving cost-reduction and avoidance in the Flight Hour Program (FHP) and accommodating budget reduction in the period of FY09, FY10 and beyond. In addition, the project includes analysis of improvements in management systems and systems support to provide better data to enable management of the command in conformance with sounds business management principals and practices.

ANALYSIS OF BUDGETARY, FINANCIAL MANAGEMENT AND RELATED INITIATIVE IN NAVSOC

Lawrence R. Jones, Professor
Graduate School of Business and Public Policy
Sponsor: Naval Special Warfare Command

OBJECTIVE: The purpose of this research is to provide analytical assistance to the Office of the Comptroller, NAVSOC USSOCOM in the areas of budgeting, financial management and cost analysis and related activities. Related issue areas include budget formulation, justification, execution and various initiatives for improving command and Navy management and management control, and achieving cost-reduction and avoidance in the Command in accommodating budget changes and possible reductions in the period of FY10, FY11 and beyond. In addition, the project includes analysis of potential improvements in management systems and systems support to provide better data to enable management of the command in conformance with sound business management principles and practices.

RADM GEORGE F.A. WAGNER CHAIR

Lawrence R. Jones, Professor
Graduate School of Business and Public Policy
Sponsor: Space and Naval Warfare Systems Command

OBJECTIVE: The objective of continuing the sponsorship of this Chair Professorship is to further develop and enhance the relationship between Naval Postgraduate School (NPS) and the Space and Naval Warfare Command (SPAWARSYSCOM) in the area of management of Command, Control, Communications, Computers, Intelligence (C4I), and Enterprise Information Systems within the Naval Enterprise structure, and related areas of management including cost analysis, financial management including all phases of Programming, Budgeting, and Execution System (PPBES), systems acquisition and other relevant areas of management including computer and systems engineering management. The Chair shall act as a coordinator across the NPS faculty and students to provide research, analytical and other services devoted to addressing and resolving SPAWAR management of Information Systems (writ-large) issues in the areas noted above.
GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY

ASSESSMENT OF INTER-ORGANIZATIONAL COLLABORATIVE CAPACITY (ICC)
- STUDY ONE

Cynthia King, Assistant Professor
Graduate School of Business and Public Policy
Sponsor: Business Transformation Agency

OBJECTIVE: The focus of Study I will be to assess the capacities of BTA to collaborate “generically” i.e., with the spectrum of external stakeholder groups. The results of this survey-based assessment will provide data to BTA about how organizational members view the various dimensions of ICC including strategic alignment, resourcing, reward systems, personnel capabilities, and lateral mechanisms (technical and social). Research findings will be delivered in a workshop with BTA staff to identify action implications. Additional phases of research can include: Assessing the Inter-organizational Collaborative Capacity (ICC) of BTA along with key organizations who are engaged in a specific business transformation initiative; Survey of ICC for participating organizations; and/or Case study of collaboration factors within the task force or work group for a specifically identified initiative.

BUSINESS TRANSFORMATION AGENCY: MANAGING THE TRANSITION
2009/2010

Cynthia King, Assistant Professor
Graduate School of Business and Public Policy
Sponsor: Business Transformation Agency

OBJECTIVE: The Defense Business Transformation Agency (BTA) will, like other federal agencies, face new challenges in light of the changes introduced by a new presidential administration. Following on CDMR’s research into BTA’s value proposition, perceptions within OSD, and preliminary perspectives on business transformation by President Elect Obama, we will provide additional research to assist BTA in applying its strengths and opportunities to achieve its goals within the Department of Defense. CDMR will provide research assistance to BTA in various areas including strategic communication, performance management, interagency collaboration, and organizational behavior assessment. Drawing on a combination of both quantitative and qualitative research approaches, as well as our understanding of BTA and its mission within DoD, we will work with BTA leadership to identify key projects of interest throughout the period of research engagement.

DCAA STRATEGIC COMMUNICATION ASSESSMENT

Cynthia King, Assistant Professor
Graduate School of Business and Public Policy
Sponsor: Defense Contract Audit Agency

OBJECTIVE: In conjunction with the Director of DCAA in their efforts to assess and transform DCAA’s organizational culture, CDMR will undertake an assessment of DCAA’s internal and external strategic communication environment. Over the past year, CDMR has gained tremendous insight into DCAA’s challenges, particularly regarding communication and management issues. Specifically, DCAA has identified strategic communication efforts as critical to understanding and responding to the organizational challenges DCAA faces. CDMR proposed that it assess DCAA’s strategic communication efforts, identify and pilot additional communication activities, and conduct a baseline and follow up assessment of employee reception to these new efforts.
DCAA STRATEGIC COMMUNICATION PLAN-PHASE 2
Cynthia King, Assistant Professor
Graduate School of Business and Public Policy
Sponsor: Defense Contract Audit Agency

OBJECTIVE: In conjunction with the Director of DCAA in their efforts to assess and transform DCAA’s organizational culture, CDMR will create a strategic communication plan. Building from activities undertaken in a previous strategic communication assessment, CDMR will identify key communication activities, engage in qualitative stakeholder research, and work with the DCAA leadership team to develop a 12-24 month communication plan.

DCAA STRATEGIC COMMUNICATION ASSESSMENT: PHASE 3
Cynthia King, Assistant Professor
Graduate School of Business and Public Policy
Sponsor: Defense Contract Audit Agency

OBJECTIVE: In conjunction with the Director of DCAA in their efforts to assess and transform DCAA’s organizational culture, CDMR will create a strategic communication plan. Building from activities undertaken in a previous strategic communication assessment, CDMR will identify key communication activities, engage in qualitative stakeholder research, and work with the DCAA leadership team to develop a 12-24 month communication plan.

EXECUTIVE COMMUNICATION RECEPTION STUDY
Cynthia King, Assistant Professor
Graduate School of Business and Public Policy
Sponsor: Defense Contract Audit Agency

OBJECTIVE: DCAA seeks to assess their agency to identify key issues for improving and transforming their organizational culture, particularly for ensuring shared understanding and commitment to strategic objectives. There is much literature that links the quality of leadership to the quality of leader communication (e.g. Mayfield, Mayfield and Knopf, 1998; Mayfield & Mayfield, 2002; Michael, Harris, Giles, and Field, 2005; Riggio, Salinas, Riggio, Cole, 2003; Young, and Post, 1993). Additionally, our previous research has shown that leader communication was critical to change initiatives in the US auto industry and US Naval Aviation (King, 2006). However, very little research has been done that focuses on the relationship issued by the director of DCAA and its reception by employees throughout all layers of the organization. This study seeks not only issues of comprehension of policy content, but how employees make sense of the communication against a backdrop of one of the biggest organizational changes in DCAA’s history.

KEY FACTORS OF ORGANIZATIONAL RESILIENCE
Edward H. Powley, Assistant Professor
Graduate School of Business and Public Policy
Sponsor: BUMED M00WII

OBJECTIVE: Resilience is a critical capacity in a world where serious challenges threaten to immobilize and disrupt individuals and organizations. In particular, military units at home or deployed abroad face a multitude of stressors and risks which require strength and fortitude to remain intact. One of the key elements in Navy marine Corps Combat and Operations Stress control (OSC) has been the concept of individual resilience. Individual resilience speaks to the psychological and emotional strength to bounce back from difficult circumstances.

An emerging key interest though, is how resilience can be developed and built over time to help organizations thrive. Simultaneous to building individual resilience, organizations ought to be able to develop and foster resilience in groups, departments, teams, and organizational units. During a meeting chaired by the OSC Coordinator in May 2010,
a group of over 20 Navy researchers identified organizational resilience as vitally important in any stress-related initiatives.

The proposed work aims to outline key factors of organizational resilience specifically applied to Navy and Marine Corps military organizational units. The research would provide a review of existing organizational measures and their applicability to Navy from which programmatic assessments could be developed.

EFFECTS OF FUNDING GENEROSITY ON EMERGENCY DEPARTMENT ACCESS AND THE CONSEQUENCES ON PATIENT OUTCOMES
Yu-Chu Shen, Assistant Professor
Graduate School of Business and Public Policy
Sponsor: Robert Wood Johnson Foundation

OBJECTIVE: The ability of public health systems to respond to emergencies, large-scale disasters, and epidemics depends critically on local emergency services capacity. It is well documented that the US experiences decreased access to emergency departments (ED). However there is little empirical evidence on its consequences in population health. The principal objectives of our research are twofold:
1. we explore how variation in public funding sources influence access to ED; and
2. we examine whether decreased ED access (measured by ED closures and ED diversion time) results in adverse patient outcomes or changes in other health indicators.

ACQUISITION RESEARCH THROUGH THE ACQUISITION CHAIR AND RESEARCH PROGRAM
Keith F. Snider, Associate Professor
Graduate School of Business and Public Policy
Sponsor: Program Executive Officer (PEO) SHIPS

OBJECTIVE: NPS proposes to perform studies and analyses in acquisition topics as well as to stimulate and supervise studies and analyses conducted by faculty and graduate students.

ACQUISITION RESEARCH THROUGH THE ACQUISITION CHAIR AND RESEARCH PROGRAM
Keith F. Snider, Associate Professor
Graduate School of Business and Public Policy
Sponsor: U.S. Army Material Command

OBJECTIVE: NPS proposes to perform studies and analyses in acquisition topics as well as to stimulate and supervise studies and analyses conducted by faculty and graduate students.

AMF JTRS - CHAIR OF ACQUISITION AND ACQUISITION RESEARCH PROGRAM
Keith F. Snider, Associate Professor
Graduate School of Business and Public Policy
Sponsor: Airborne, Maritime and Fixed Station, Joint Tactical Radio System

OBJECTIVE: AMF JTRS desires to have faculty and students at NPS engaged in acquisition research involving topics that are of importance to the Program Executive Office and DOD. In furtherance of this objective, AMF JTRS wishes to sponsor research under the Chair of Acquisition Management positioned in the Graduate School of Business and Public Policy (GSBPP) at the Naval Postgraduate School.
OBJECTIVE: The Acquisition Chair is responsible for, among other things, managing acquisition research for AMF JTRS and NPS, including: coordinating research opportunities for NPS faculty, stimulating research projects by selected graduate students, traveling as necessary to support research objectives, providing seminars and symposiums. GSBPP faculty and students will undertake specific research projects identified by AMF JTRS, however, if specific projects are not delineated, the Acquisition Chair will apply discretion in determining the appropriate scope and depth of research work to be performed. In consultation with AMF JTRS, the Acquisition Chair will continuously develop a list of potential research projects for accomplishment by NPS faculty and students.

OBJECTIVE: To establish accounts and procedures for the development, delivery and maintenance of the Annual Acquisition Research Symposium of the Naval Postgraduate School to support Revenues and Expenses described below;

Revenues. Sources of revenue/funding include: registration fee; reimbursable research funds from the Acquisition Chair; donations from private firms such as Seimens Corporation and the NPSFI. Funds received fall into two categories: appropriated and non-appropriated. The timing of revenue flow is expected to be as follows: Industry funding is anticipated to be received around 1 March each year. Registration fees will start to flow in January. Reimbursable Research funds will be available as needed.

Expenses. Categories include: conference planning and execution, conference facilities and support, conference catering, conference materials, conference advertising (hard copy and web related). While expenses start to be incurred well in advance of the event (advertisement and deposits for facilities.), the major portion of the bill paying occurs close to the event. In effect what this means is that as we wrap up one event we are already in the execution phase for the next event. The “Maintenance” aspect is a very important part of the overall execution strategy.

OBJECTIVE: Pursuant to the MOA between the Director, DBSAE and the NPS President, currently being staffed, NPS proposed to perform studies an analyses in acquisition topics of immediate concern to the DBSAE as well as to stimulate and supervise studies and analyses conducted by NPS faculty and students.
OBJECTIVE: Pursuant to the MOUS between PEO SHIPS and the NPS President, renewed 14 NOV 2008, NPS proposed to perform studies and analyses in acquisition topics of immediate concern to the PEO as well as to stimulate and supervise studies and analyses conducted by NPS faculty and students.

DASN (A&LM) - CHAIR OF ACQUISITION AND ACQUISITION RESEARCH PROGRAM
Keith F. Snider, Associate Professor
Graduate School of Business and Public Policy
Sponsor: Deputy Assistant Secretary of the Navy Acquisition and Logistics Management DASN (A&LM)

OBJECTIVE: Acquisition and Logistics are closely related. Thus, the acquisition topics envisioned by DASN (A&LM) are consistent with broad acquisition-related topics already being investigated by the Acquisition chair and the Acquisition Research Program.

The Acquisition Chair is responsible for, among other things, managing acquisition and logistics research for DASN (A&LM) and NPS, including: coordinating research opportunities for NPS faculty, stimulating research projects by selecting graduate students, traveling as necessary to support research objectives, and providing quarterly reports regarding research progress and accomplishments. GSBPP faculty and students will undertake specific research projects identified by DASN (A&LM) however, if specific projects are not delineated, the Acquisition Chair will apply discretion in determining the appropriate scope and depth of research work to be performed. In consultation with DASN (A&LM), the Acquisition Chair will continuously develop a list of potential research projects for accomplishment by NPS faculty and students.

DDACM (ARMY) - U.S. ARMY ACQUISITION STUDENT SUPPORT
Keith F. Snider, Associate Professor
Graduate School of Business and Public Policy
Sponsor: Office of the Assistant Secretary of the Army

OBJECTIVE: Funding provided on a Project Order Basis for US ARMY ACQN Students to support: travel, field trips, guest speakers ITOs, DAU Equivalencies, equipment, materials and administration.

The DDACM represents the sponsor of the Systems Acquisition Management (816) curriculum, and the Master of Science in Program Management (836) curriculum. These curricula provide officers and Government civilians an advanced education in the fundamental concepts, methodologies, and analytical techniques necessary for successful acquisition and management of major defense systems.
OBJECTIVE: This Memorandum of Agreement (MOA) documents agreement between the Director, Acquisition Resources and Analysis (ARA), Office of the Under Secretary of Defense (Acquisition, Technology and Logistics) (OUSD(AT&L)) and the President of the Naval Postgraduate School (NPS) to establish and support a program in Acquisition Research at the NPS, with support from collaborating research entities.

GRANTS-OSD SPONSORED ACQUISITION RESEARCH PROGRAM AT THE NAVAL POSTGRADUATE SCHOOL

OBJECTIVE: Pursuant to the MOU between the Director of Acquisition Resources and Analysis, Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (USD AT&L) and the President of the Naval Postgraduate School (NPS), NPS proposed to perform acquisition research in support of an OSD sponsored Acquisition Research Program domiciled at the Naval Postgraduate School.

NAVSEA - CHAIR OF ACQUISITION AND ACQUISITION RESEARCH PROGRAM

OBJECTIVE: Pursuant to the 28 FEB 2008 MOUS between the Commander, NAVSEA and the NPS President, NPS proposes to perform studies and analyses in acquisition topics of immediate concern to the Commander as well as to stimulate and studies and analyses conducted by faculty and graduate students. Proposed topics will be agreed upon by the Sponsor and the Acquisition Research Chair.

OPAM - ANALYSIS OF DOE'S COST PROPOSAL REQUIREMENT FOR COMPETITIVE ENVIRONMENTAL OPERATING AND CAPITAL PROJECTS

OBJECTIVE: Pursuant to the MOA between Director of OPAM, DOE and the President, NPS signed 21 JULY 2010, NPS proposed to perform studies and analyses in acquisition topics of immediate concern to the OPAM as well as to stimulate and supervise studies and analyses conducted by NPS faculty and students.
GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY

PEO IWS 7.0 - CHAIR OF ACQUISITION MANAGEMENT AND ACQUISITION RESEARCH PROGRAM
Keith F. Snider, Associate Professor
Graduate School of Business and Public Policy
Sponsor: Program Executive Officer (PEO) IWS

OBJECTIVE: Pursuant to the 10 OCT 07 MOU between PEO (IWS) and the NPS President, NPS proposes to perform studies and analyses in acquisition topics of immediate concern to the PEO as well as to stimulate and supervise studies and analyses conducted by NPS faculty and student.

SSP - CHAIR OF ACQUISITION AND ACQUISITION RESEARCH PROGRAM
Keith F. Snider, Associate Professor
Graduate School of Business and Public Policy
Sponsor: Office of the Direct Reporting Program Manager Strategic Systems Program

OBJECTIVE: The Acquisition Chair is responsible for, among other things, managing acquisition research for SSP and NPS, including: coordinating research opportunities for NPS faculty, simulating research projects by selecting graduate students, traveling as necessary to support research objectives, providing seminars and symposiums. GSBPP faculty and students will undertake specific research projects identified by SSP, however, if specific projects are not delineated, the Acquisition Chair will apply discretion in determining the appropriate scope and depth of research work to be performed. In consultation with SSP, the Acquisition Chair will continuously develop a list of potential research projects for accomplishment by NPS faculty and students.

SUPPORT GRADUATE STUDENT AND ACQUISITION RESEARCH AT NPS
Keith F. Snider, Associate Professor
Graduate School of Business and Public Policy
Sponsor: Office of the Assistant Secretary of the Army

OBJECTIVE: This proposal is to support graduate student and Acquisition Research at NPS.

The DDACM represents the sponsor of the Systems Acquisition Management (816) curriculum, and the Master of Science in Program Management (836) curriculum. These curricula provide officers and Government civilians an advanced education in the fundamental concepts, methodologies, and analytical techniques necessary for successful acquisition and management of major defense systems.

BUILDING STRATEGIC COMMUNICATION CAPABILITIES
Gail Fann Thomas, Associate Professor
Graduate School of Business and Public Policy
Sponsor: J9 USJFCOM

OBJECTIVE: To support J9’s goals, Naval Postgraduate School will assist J9 in aligning communication products with the strategic goals of stakeholders. The purpose of the work is to build an internal capability for turning technical documents into products that are easily accessible to a variety of key stakeholders. This project is follow-on work to J9’s Strategic Communication Internal Assessment and Workshop A.
GRADUATE SCHOOL
OF BUSINESS AND
PUBLIC POLICY

2010
Faculty Publications
and Presentations
GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY

JOURNALS


EDITORIALS


BOOKS


BOOK REVIEWS


CONFERENCE PUBLICATIONS & PROCEEDINGS


B. Roberts and W. Owen. “Administering Distance Education Programs: Current Challenges and Solutions,” In Proceedings of the 26th Annual Conference on Distance Teaching & Learning, August, 2010, The University of Wisconsin, Madison.


CONFERENCE PRESENTATIONS


TECHNICAL REPORTS


Hocevar, S.P. Interorganizational Collaborative Capacity: Development of a Database to Refine Instrumentation and Explore Patterns. NPS-GSBPP-10-022, September 2010.


RESEARCH REPORTS


WORKING PAPER

INSTITUTES, CENTERS AND OTHER

CEBROWSKI INSTITUTE

WAYNE E. MEYER INSTITUTE OF SYSTEMS ENGINEERING

MOVES INSTITUTE (MODELING, VIRTUAL ENVIRONMENTS, AND SIMULATION)

CENTER FOR INTERDISCIPLINARY REMOTELY PILOTED AIRCRAFT STUDIES

FIELD EXPERIMENTATION PROGRAM- USSOCOM

NATIONAL SECURITY INSTITUTE

CENTER FOR ASYMMETRIC WARFARE

GLOBAL PUBLIC POLICY ACADEMIC GROUP
CEBROWSKI INSTITUTE

PETER J. DENNING
DIRECTOR
CEBROWSKI INSTITUTE

OVERVIEW:

The Cebrowski Institute for Innovation and Information Superiority sponsors cross-discipline investigations into ways that information processes and technologies, organizational development, and personal skills can strengthen stability, transition operations, crisis response, warfighting, and defense in support of national and global security. Areas of focus include hastily formed networks, indicators of impending crisis, globalization, architectures for network centric operations, World Wide Consortium for the Grid (W2COG), maritime domain awareness, mobile devices and communications, information operations, counterterrorism and irregular warfare, energy and sustainability, information assurance and security, and innovation process.

RESEARCH CHAIR:

- Inman Intelligence Chair

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Cebrowski Institute is provided below:

Size of Program: $6.7M
CEBROWSKI INSTITUTE

Peter J. Denning
Director & Professor
Department of Computer Science
831-656-3603
pjd@nps.edu

David Alderson
Assistant Professor
Department of Operations Research
831-656-1814
dlalders@nps.edu

Karen Guttieri
Assistant Professor
Global Public Policy Academic Group
831-656-2294
guttieri@nps.edu

Andy Singer
Intelligence Chair
831-656-3528
amsinger@nps.edu

John Arquilla
Professor
Department of Defense Analysis
831-656-3450
jarquilla@nps.edu

Rick Hayes-Roth
Professor
Department of Information Sciences
831-656-3983
fahayesr@nps.edu

Gurminder Singh
Professor
Department of Computer Science
831-656-3041
gsingh@nps.edu

Frank Barrett
Professor
Graduate School of Business and Public Policy
831-656-2328
fbarrett@nps.edu

Susan Higgins
Deputy Director & Lecturer
Department of Information Sciences
831-656-3596
slhiggin@nps.edu

Brian Steckler
Lecturer
Department of Information Science
831-656-3837
steckler@nps.edu

Dan C. Boger
Chairman
Department of Information Sciences
831-656-3671
dboger@nps.edu

Jeffrey Knorr
Professor
Department of Electrical and Computer Engineering
831-656-2815
jknorr@nps.edu

David Tucker
Associate Professor
Department of Defense Analysis
831-656-3754
dctucker@nps.edu

Anne Clunan
Associate Professor
Department of National Security Affairs
831-656-2904
aclunan@nps.edu

Craig Martell
Associate Professor
Department of Computer Science
831-656-2110
cmartell@nps.edu

Mitzi Wertheim
Professor of Practice
831-656-2466
mitizi.wertheim@gmail.com

Nicholas Dew
Assistant Professor
Graduate School of Business and Public Policy
831-656-3622
ndew@nps.edu

Nancy C. Roberts
Professor
Department of Defense Analysis
831-656-2742
nroberts@nps.edu

Dennis M. Volpano
Associate Professor
831-656-3091
volpano@nps.edu

Rachel Goshorn
Assistant Professor
Department of Systems Engineering
831-656-3835
goshorn@nps.edu

Glenn Robinson
Associate Professor
Department of Defense Analysis
831-656-2710
grobinson@nps.edu

Geoffrey G. Xie
Professor
Department of Computer Science
831-656-2693
xie@nps.edu
CEBROWSKI INSTITUTE

CHALLENGES IN TECHNOLOGY TRANSITION
Peter J. Denning, Professor
Department of Computer Science/Cebrowski Institute
Sponsor: DARPA

OBJECTIVE: This project supports a seedling Center for Shipping Science and Technology for the DARPA Adaptive Execution Office (AEO).

COLLABORATIVE RESEARCH II: A FIELD GUIDE FOR THE SCIENCE OF COMPUTATION
Peter J. Denning, Professor
Department of Computer Science/Cebrowski Institute
Sponsor: National Science Foundation

OBJECTIVE: Our plan is to develop a body of content that presents the deep insights of scientific theories of computing, attuned by field testing to a broad range of students, from middle school through graduate school. We will structure this content as a service, the Field Guide to the Science of Computation, which organizes the scientific theories in a framework of seven categories - computation, communication, coordination, recollection, automation, evaluation, and design.

CPATH CDEF: RESPARKING INNOVATION IN COMPUTING EDUCATION
Peter J. Denning, Professor
Department of Computer Science/Cebrowski Institute
Sponsor: National Science Foundation

OBJECTIVE: Unavailable.

MILITARY WIRELESS COMMUNICATIONS
Joshua Dixon, Student
Cebrowski Institute
Sponsor: TRADOC

OBJECTIVE: The NPS Military Wireless Communications (MWC) research group, a Cebrowski Institute project, is hosting a two day workshop to explore various commercial cellular technologies with possible suitability for military applications. Three programs of record with separately present different technology approaches to help inform the research.

AUTOMATED MEDIA EXPLOITATION RESEARCH P&R
Simson L. Garfinkel, Associate Professor
Department of Computer Science/Cebrowski Institute
Sponsor: Defense Intelligence Agency

OBJECTIVE: To develop new techniques and automated tools for analyzing captured data containing devices.

SUMMARY: This project, started in 2005, seeks to develop new algorithms, techniques and eventually tools for automatically processing information from hard drives, USB memory sticks, cell phones, and other data carrying devices.

The thrust of this research covers three main areas:
1. Developing open source tools for working with electronic evidence.
2. Developing an unclassified Real Data Corpus (RDC) consisting of “real data from real people” that can be used to develop new algorithms, quantify results, and test automated tools.
3. Developing new algorithms and approaches for working in a “data-rich environment” such as a large collection of hard drives that have been seized during the course of law enforcement or military operations.

Key work accomplished in 2010 includes:
• Significantly increasing the size of the Real Data Corpus.
• Development and fielding of bulk_extractor tool for rapid media exploitation.

PUBLICATIONS:


THESES DIRECTED:

Kristian P. Kearton, Visualization Framework for Temporal Analysis of Social Networks, March 2010

ESTABLISH AN EXPERIMENTATION CAPABILITY FOR MILITARY WIRELESS COMMUNICATIONS

John H. Gibson, Lecturer
Geoffrey Xie, Professor and Co-PI
Department of Computer Science/Cebrowski Institute
Sponsor: Marine Corps Systems Command, Program Group 11

OBJECTIVE: This research identifies a collection of wireless and cellular systems sufficient to support multiple research activities focusing on the exploitation of existing and emerging commercial cellular and wireless technologies to enhance and extend the communications and computational capabilities of dismounted or remotely dispersed Marines.

SUMMARY: Funding for this project was received the end of June 2010 and was available for execution mid-July. The purpose of the funding was to establish several stand-alone suites of systems that could support multiple, independent research and experimentation activities to promote exploration of commercial-off-the-shelf technologies as a means to rapidly develop and deploy enhanced tactical data and voice networking capabilities to forward deployed Marines. The systems acquired under this effort represent current global cellular infrastructure capabilities across all generations of the technologies, thereby providing a means to explore the use of both advanced, emerging systems and those typically found in disadvantaged, third-world nations. Further, these capabilities are available to researchers across departments, as a means to stimulate further study and collaboration between researchers, as well as a basis for cost sharing on future proposals.
CEBROWSKI INSTITUTE

NETCENTRIC CERTIFICATION OFFICE
Chris Gunderson, Research Associate Professor
Sue Higgins, Lecturer
Department of Information Science/Cebrowski Institute
Sponsor: Joint Interoperability Test Command

OBJECTIVE: Establish a U.S. Government Netcentric Certification Office for performing embedded test, evaluation, certification, accreditation, and validation and verification of network services per attached statement of work.

CANES SOA BASED SECURITY ARCHITECTURE
Chris Gunderson, Research Associate Professor
Department of Information Science/Cebrowski Institute
Sponsor: SPAWAR PMW 160

OBJECTIVE: Service-oriented architecture (SOA) is a flexible set of design principles used during the phases of systems development and integration. A deployed SOA-based architecture will provide a loosely integrated suite of services that can be used within multiple domains.

RECOGNIZING PATTERNS OF ANOMIE THAT SET THE CONDITIONS FOR INSURGENCY
Karen Guttieri, Assistant Professor
Global Public Policy Academic Group/Cebrowski Institute
Sponsor: Office of Naval Research

OBJECTIVE: The goal of this project is to better understand and depict how social unrest leads to insurgencies in order to develop better decision making options. This work will better prepare civilian and military decision-making for future insurgencies in places of unrest by compiling scientific evidence for cause-targeted interventions aimed at anticipating and migrating societal disorder. If instability-related patterns and risks of societal disorder are to be detected and reversed in time. It is crucial to perform an in-depth assessment of invisible but measurable attitudes that precede subsequently observable patterns of behavior. We seek to detect relevant correlations and interactions between social change and societal disorder at an early stage, as well as to identify the potential for sustainable operational interventions.

RECOGNIZING PATTERNS OF ANOMIE THAT SET THE CONDITIONS FOR INSURGENCY
Karen Guttieri, Assistant Professor
Global Public Policy Academic Group/Cebrowski Institute
Sponsor: Office of Naval Research

OBJECTIVE: The objective of this proposed research by the Naval Postgraduate School Principal Investigator is to provide research panel support for the Milcord LLC development of a semantic and structured wiki service that will serve the information and knowledge management needs of the Complex Operations community responsible for mission training, planning and operations. The HYKNOCO Project by Milcord LLC, of which this proposal is a part, seeks to research, design, and develop a hybrid answers engine prototype. This proposal responds to the BAA objectives for an ‘effects and open source reliability scoring capability, integrating fact and opinion-based knowledge sources’. The overall project goal is to build our application using open source semantic wiki tools (e.g. Semantic MediaWiki for knowledge representation, open source structured wiki tools (e.g. TikiWiki) for structured content representation, and our Knowledge Management (CKM) framework for fact discovery and management. We propose to use open source knowledge and data sources (e.g. doctrine manual, encyclopedic knowledge, historical databases...
RAPID PROTOTYPING VALUABLE INFORMATION AT THE RIGHT TIME
(RAPID PRO VIRT)

Rick Hayes-Roth, Professor
Department of Information Science/Cebrowski Institute
Sponsor: MARCORSYSCOM (PM Intelligence Systems)

OBJECTIVE: NPS will support the Rapid Prototyping Team (RPT) at MARCORSYSCOM Intelligence Systems. Their objective is to develop and maintain an agile, scalable sub-organization capable of dynamically responding to emergent requirements that balance intelligence “ownership” vs. “stewardship.” Specifically, they should seek material and non-material solutions that serve a traditional [doctrinal] intelligence cycle while simultaneously delivering valuable information at the right time to achieve the right ‘effects’ in order to enable our warfighters with “knowledge at the point of action.” RPT requires a disciplined systems architecture, i.e. repeatable best practices and resultant structures, to support this mission. The “Valued Information, Right Time” (VIRT) body of work envisions such architecture. This project will provide the architecture and technology transition process to support the RPT aims.

SUMMARY: Rapid changes in environment, missions, and technology make current systems obsolete and render slow narrowly-focused programs mostly irrelevant. We need to implement an adaptive evolutionary management of the capability portfolio. Specifically, we want to make most of our capabilities modular and composable while continually combining them in opportunistic ways that address new opportunities and allow us to reinforce valuable components. In short, we want to implement IT applications as if they were a population assembled from a tested and selected pool of “genetic” components. While we have a small population, a limited set of “genes” to work with, and a small number of generations to control, we want to exploit and improve the basic strategy of natural selection applied to our IT components. The high rate of change in the environment, missions, and available IT components make an adaptive approach both desirable and necessary. The technical means of accomplishing this adaptive approach include: (1) an architecture for composing capabilities; (2) a set of evolving components; (3) an environment for testing and employing candidate systems; (4) a fitness function that assesses how well the candidates perform in the environment and that guides feedback; and (5) a feedback function that assures investment flows into successful components and promising new candidates. Because so much of information processing focuses on improving decisions that ultimately yield better outcomes, the fitness function must shape our systems to increase utilization of high-value information and reduce low-productivity activities that produce or consume low-value bits. This, of course, is what our VIRT concepts address: how to assure that significant bits flow to and affect decision-makers while they have time and processing resources to exploit them. Our idea is to create an on-going research program that implements these ideas, supports them with best methods and techniques, and applies them to important defense and government problems. We believe that other groups in the Marine Corps, others in the DoD and throughout government, could also benefit from NPS capabilities and research efforts in this line of work. Therefore, we aim to support PM Intel MCSC as an initial means of validating our value and, over time, we plan to seek other partners to improve and grow these capabilities. Specifically, we aim to implement a successful program in service of PM Intel USMC over a 3-year period and, during that period, to seek one or two more additional customers who have overlapping needs where we could deliver high value efficiently.

STRATEGIC COMMUNICATIONS
Susan Higgins, Lecturer
Department of Information Science/Cebrowski Institute
Sponsor: Office of Naval Research

OBJECTIVE: ONR seeks to apply a strategic engagement with its sponsors, stakeholders, partners, employees, customers, and the general public based upon the Human Behavioral Science approach to communication outlined by the Center for Fisk Communication’s nearly 40 years of research. To achieve this goal, ONR requires Strategic
CEBROWSKI INSTITUTE

Change Communication expertise and research to provide strategic and tactical planning support, analysis, research and implementation. ONR requires an experienced, senior level Research Associate from the Naval Postgraduate School to provide this expertise to the strategic engagement approach being implemented by the ONR Office of Corporate Strategic Communication.

WEB 2.0 INFORMATION SHARING
Susan Higgins, Lecturer
Department of Information Science/Cebrowski Institute
Sponsor: Office of Naval Research

OBJECTIVE: Task will include developing a framework for an inter-agency energy-climate wiki. This will include identifying the right personnel across government to help create a collaborative team, for a bottom, up government only, Google searchable wiki, to identify who is doing what on energy and climate in both programs and research. The purpose is to learn from others so we can speed up the process and avoid siloed duplication.

DISRUPTIVE TECHNOLOGY EXPLORATION
Susan Higgins, Lecturer
Department of Information Science/Cebrowski Institute
Sponsor: Office of Naval Research

OBJECTIVE: Identify, evaluate and provide recommendations on how emerging/disruptive business technologies and alternate business models can be leveraged to innovate business operations and support improved time-to-value realization of capabilities to the enterprise.

TRANSFORMATIONAL C2 SERVICES FOR UNDERSTANDING THE IMPACT OF GLOBALIZATION ON STABILITY AND SECURITY
Susan Higgins, Lecturer
Department of Information Science/Cebrowski Institute
Sponsor: SPAWAR Systems Center, Charleston

OBJECTIVE: To establish a Collaboration Laboratory (Co-Lab) focused on Open Technology Development initiatives and their potential impact on issues of globalization, stability and security. Co-Lab will provide a venue to explore best practices across disciplines regarding open source community engagement and technology development between DoD and non-traditional partners.

ON INTEGRATION OF CELLULAR TECHNOLOGY WITH U.S. MILITARY COMMUNICATION NETWORKS
Frank E. Kragh, Assistant Professor
Department of Electrical and Computer Engineering/Cebrowski Institute
Sponsor: Joint Program Executive Office

OBJECTIVE: Explore all technical issues associated with expanding the reach of military tactical networks to more warriors by altering the military tactical network and/or altering inexpensive commercial mobile phones to allow voice and data communications between the two independent of traditional cellular infrastructure.
ON-PHONE TOPIC AND AUTHOR ANALYSIS OF SMS/EMAIL TRAFFIC
Craig H. Martell, Associate Professor
Department of Computer Science/Cebrowski Institute
Sponsor: National Reconnaissance Office

OBJECTIVE: State-of-the-art techniques in topic detection and authorship detection are becoming powerful enough to help with problems of interest to the NRO/IAO. In particular, the natural-language processing community has made large strides in being able to reliably detect the topic and author of Twitter messages, SMS, chat posts, and blogs. We are also able to correlate the content of these data with other openly available signals, such as YouTube videos. Despite these recent advances, the state of the art still requires large-scale computational infrastructure. We propose to build topic and authorship detection software that can be run solely on a constrained device of interest, for example, a smartphone. Further, we propose to study methods for on-demand transfer, balance, and coordination of the computational analysis as mandated by current device conditions (e.g. an overly taxed cellular phone).

IDENTITY AND DATABASE CHALLENGES FOR FORCE PROTECTION
Cynthia Irvine, Professor
Craig H. Martell, Associate Professor
Department of Computer Science/Cebrowski Institute
Sponsor: Defense Manpower Data Center

OBJECTIVE: The Defense Manpower Data Center (DMDC) maintains records on Department of Defense personnel in dozens of databases containing over 40 million records. Threats to DMDC data are external and internal, some intentional, and some inadvertent. This research, under the auspices of Team Monterey Phase II, at NPS will focus on three primary areas: the identification of threats to selected subgroups of individuals for whom records are maintained in the DMDC databases, analysis of the costs of data and transitive population exposure, and threat mitigation through a combination of technical and procedural countermeasures.

ASN RDA CHSENG NR-KP IMPLEMENTATION
Scott Miller, Research Associate
Sue Higgins, Lecturer
Cebrowski Institute
Sponsor: OASN

OBJECTIVE: Participate in NR-KPP policy working groups, while coordinating with Research, Development, and Acquisition Chief Engineering Office, other DON organizations to establish DON position on NR-KPP policy. Project includes identifying guidance conflict with other policies and pushing for resolutions in the working groups. This will include a widespread discussion of the incorporation of the Chief Engineering Office profess into process.

ASSESSMENT FEDERATION SUPPORT
Scott Miller, Research Associate
Sue Higgins, Lecturer
Cebrowski Institute
Sponsor: SPAWAR

OBJECTIVE: Warfighting assessment in support of current readiness and long-term investment strategies.
CEBROWSKI INSTITUTE

HASTILY FORMED NETWORKS IN SUPPORT OF HUMANITARIAN ASSISTANCE/ DISASTER RELIEF (HA/DR) AND STABILITY, SECURITY, TRANSITION AND RECONSTRUCTION (SSTR) OPERATIONS

Brian Steckler, Lecturer
Sue Higgins, Lecturer

Department of Information Science/Cebrowski Institute
Sponsor: Office of the Assistant Secretary of Defense for Networks and Information Integration (OASD-NII)

OBJECTIVE: OASD-NII (ISS) desires to continue sponsoring NPS studies focused on the full range of Hastily Formed Networks (HFN) activities from the earliest stages (finding ways to bring the participating parties into a mode of cooperation and trust quickly a mature/functional HFN in the field, NPS students will deliver Masters Thesis projects to meet the goals of these studies, NPS faculty and student teams will deliver After Action Reports and/or Case Studies as appropriate, NPS faculty and students will consider issues such as preparatory training, overcoming organizational biases and conditioned tendencies, technologies to facilitate information sharing, agreements on decision-making and coordination, and involvement of citizens, industry and civilian and military entities, The topic areas to be covered by these studies will be agreed upon in discussions between the Principal Investigator and the OASD-NII (IIS) Point of Contact.

INTEGRATING CELL PHONE TECHNOLOGY WITH MARINE CORPS TACTICAL NETWORKS
Geoffrey C. Xie, Professor

Department of Computer Science/Cebrowski Institute
Sponsor: Marine Corps Systems Command

OBJECTIVE: The research idea is motivated from the current lack of communication capabilities observed by Marines while in a tactical/field environment. A cell phone has the capability in send and receive real time voice communications, voice messaging, text messaging, email, capture videos/pictures, in addition to a long list of other features. However, the cost of this technology in a field environment traditionally is too heavily weighted toward permanent infrastructure or other non-cost efficient solutions.

This research will explore the idea of wirelessly connecting smart phones to a Marines Corps tactical radio network. The purpose of the research will be to explore the possible solutions and illustrate each option with associated costs.

COMMAND AND CONTROL RAPID PROTOTYPE Capability (C2RPC) SERVICE ORIENTED ARCHITECTURE (SOA) - BASED CONCEPT OF OPERATIONS (CONOPS)
Warren Yu, Research Associate
Sue Higgins, Lecturer

Cebrowski Institute
Sponsor: Space and Naval Warfare Systems Command Center Pacific

OBJECTIVE: PEO C4I seeks to provide systems and security engineering, integration testing, and support for all Navy information telecommunication, and network systems. It aims to serve as the Navy’s technical lead for Information Assurance (IA) and IA-related products and services used within ship, aircraft, and shore IT systems, including Navy Marine Corps Intranet and ONE-net. PEO C41 is asking NPS to provide security engineering services to develop progressive, new approaches to protecting critical IT assets and telecommunications infrastructures while leveraging the latest in handheld and cloud-computing technologies. Purpose includes beginning work on the Enterprise wide tactical data exchange effort to develop interface specifications and related research to facilitate the
movement and synchronization of tactical combat system information with the broader C2 information.

DECISION SUPERIORITY IN CYBERSPACE
Warren Yu, Research Associate
Sue Higgins, Lecturer
Cebrowski Institute
Sponsor: Space and Naval Warfare Systems Command Center Pacific

OBJECTIVE: Establish the ability to bring together Flag and Senior Executive Service (SES) personnel to provide Information Technology (IT), War Fighter, and Business Leader leadership a forum for development of understanding of Cyber, IT capabilities, and security and Information Assurance (IA) processes and responsibilities. This forum would also serve as a means to further enhance Departmental transition activities and functional and technical requirements interaction.

CONFERENCE PRESENTATIONS


OVERVIEW:

The Wayne E. Meyer Institute of Systems Engineering was first established as the Institute of Defense Systems Engineering and Analysis in 2001. In May 2002, the Institute was renamed the Wayne E. Meyer Institute of Systems Engineering after RADM Wayne E. Meyer, USN (Ret.), the founding Program Manager of the Aegis Combat System, the first large Navy Surface Warfare acquisition program in which a total systems approach was used in system development and design.

The Meyer Institute’s mission is to apply NPS expertise in systems science and engineering to improve Navy and DoD warfare capability and operations. Towards this end, it works closely with the Systems Engineering Department.

FUNCTIONS:

In meeting the priority needs of our national security stakeholders, the Meyer Institute currently has the following functions:

- Support and enable assigned research faculty and Chair Professors to carry out their academic responsibilities.
- Foster and encourage NPS faculty and students to apply their talents to answering the high-priority questions in defense systems science and engineering.
- Publicize and share the results of NPS defense systems science and engineering research.

RESEARCH:

Recent research conducted:

- Undersea Warfare.
- Expeditionary and Mine Warfare
- Sixteen Systems Engineering and Analysis student capstone, interdisciplinary research projects over the last nine years in such areas as Littoral Undersea Warfare, Port Security, and Ship-Based ABM
- Bi-Dimensional Empirical Model Decomposition for Mine Detection and Change Detection
- Underwater Bomb Trajectory Prediction for JABS from VSW to SW/DW
- Carbon Nanotube - Enhanced Fluid Technology Characterization
- Demonstration of Aerosol Duct Sealing Technology at Department of the Navy Facilities
- Critical Experiments in Condensed Matter Nuclear Science Phases 2b/2c: Standard Heat Experiment Modeling and Analysis
- Reducing the Barriers-to-Research into the Fleischmann-Pons Effect (FPE): Phase 2, Produce, Test, and Characterize the System for a Peer Reviewed, Publishable Instrumentation Paper
- Shipboard Electric System Modeling
- Defense METOC Enterprise Architecture (DMEA) Development
- Reduction in Total Ownership Cost (RTOC)

RESEARCH CHAIR:

- Chair of Undersea Warfare
- Chair of Expeditionary and Mine Warfare

RESEARCH FACILITIES:

The research facilities that support faculty and students include:

- Faculty offices
- Three integrated student design labs
- Workspace for Collaborative, Distributive Projects
Wayne E. Meyer Institute

- Research and study space for 44 students

Research Program-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Meyer Institute of Systems Engineering is provided below:

Size of Program: $1.4M
WAYNE E. MEYER INSTITUTE

Paul V. Shebalin
Director & Professor of the Practice of Systems Engineering
Department of Systems Engineering
831-656-1047
pshebalin@nps.edu

Barbara Berlitz
Research Associate
831-656-3324
biberlit@nps.edu

Peter C. Chu
Professor
Department of Oceanography
831-656-3688
pcchu@nps.edu

Winford G. (Jerry) Ellis
RADM, USN (Ret.)
Senior Lecturer & Chair of Undersea Warfare
831-656-2488
wgeilis@nps.edu

Rodney W. Johnson
Visiting Professor
831-656-7959
rwjohnso@nps.edu

Raymond Jones
Senior Lecturer
831-656-2488
rgjones@nps.edu

Fernand D. Marquis
Research Professor
831-656-3721
fdmarqu@nps.edu

Michael E. Melich
Research Professor
831-656-1776
mmelich@nps.edu

David H. Olwell
Professor
Department of Systems Engineering
831-656-3583
dholwell@nps.edu

Gary Parker
Research Associate
831-656-7845
gwparker@nps.edu

William D. (Will) Rodriguez
Deputy Director
831-656-2371
wdrodrig@nps.edu

William A. Solitario
Professor of Practice
831-656-2546
wasolita@nps.edu

Richard (Rick) Williams
Chair of Mine Warfare
831-656-7702
rdwillia@nps.edu

Christopher Wolfgeher
Research Assistant
623-925-2812
cwolfg@nps.edu
**OBJECTIVE:** A fast and accurate detection and classification system is essential for the side-scan sonar system. In this proposal, we will use the EMD method to establish such a system. This system will expedite mine clearing operations and many automate tasks such as identification and neutralization in the future.

**SUMMARY:** Automatic detection of sea mines in coastal regions is a difficult task due to the highly variable sea bottom conditions present in the underwater environment. Detection systems must be able to discriminate objects which vary in size, shape, and orientation from naturally occurring and man-made clutter. Additionally, these automated systems must be computationally efficient to be incorporated into Unmanned Underwater Vehicle (UUV) sensor systems characterized by high sensor data rates and limited processing abilities. Using empirical mode decomposition analysis, a fast, robust sea mine detection and change detection systems can be created. These decompositions project key image features, geometrically defined structures with orientations, and localized information into distinct orthogonal components or feature subspaces of the image. The performance of the new detection system is compared against the performance of an independent detection system in terms of probability of detection (Pd) and probability of false alarm (Pfa).

**JOURNAL PAPERS/ARTICLES:**


**THESES DIRECTED:**


**UNDERWATER BOMB TRAJECTORY PREDICTION FOR JABS FROM VSW TO SW/ DW**

**OBJECTIVE:** The Joint Direct Attack Munition (JDAM) Assault Breaching System (JABS) have proven effective to clear mines and light obstacles on beach and surf zones as well as in very shallow water (VSW, depth up to 40 ft) through the Stand-off Assault Breaching Weapon Fuse Improvement (SOABWFI) program. The Navy and Marine Corps need the capability to rapidly clear mines in shallow water (SW, depth: 40-200 ft) and deep water (DW, depth over 200 ft) zones to permit rapid, effective, transition from the sea to land. This project is to support the extension of SOABWFI from VSW to SWIDW through development of 3D prediction model for underwater bomb trajectory such that the final denotation position relative to target position can be predicted.
WAYNE E. MEYER INSTITUTE

NPS CHAIR OF UNDERSEA WARFARE PROGRAM
Winford G. Ellis, Senior Lecturer
Wayne E. Meyer Institute of Systems Engineering
Sponsor:  NAVSEA

OBJECTIVE: The Chair of UnderSea Warfare was established with a MOU between the President of the Naval Postgraduate School (NPS) and the Newport Undersea Warfare Center (NUWC) Commander. The Chair program is intended to enhance the academic and research content in several curricula with Undersea Warfare related material and to establish NPS as a major center for instruction, research, and analysis in undersea warfare subjects. To that end, the Chair serves as the Director, NPS Undersea Warfare Research Center. The function is under the NPS Wayne Meyer Institute of Systems Engineering. Parties to the Chair of UnderSea Warfare MOU agreed that the position be established on a continuing basis to support undersea warfare acquisition and life cycle management. This proposal supports the continuing employment agreement for RADM Winford Ellis, USN (ret), and the travel expenses required by the Chair USW position.

UNDERSEA WARFARE RESEARCH SUPPORT
Winford G. Ellis, Senior Lecturer
Wayne E. Meyer Institute of Systems Engineering
Sponsor:  NAVSEA & CNO

OBJECTIVE: The objective of this proposal is to increase the research opportunities that result in improving the quality of the USW related courses at NPS.

CARBON NANOTUBE - ENHANCED FLUID TECHNOLOGY CHARACTERIZATION
Young W. Kwon, Professor
Department of Mechanical and Aerospace Engineering & Wayne E. Meyer Institute of Systems Engineering
Sponsor:  Northrop Grumman

OBJECTIVE: The main objective of this collaboration is to develop and assess advanced technologies and concepts of operations in the areas of naval and marine systems to improve future war fighting missions. Initial focus areas will include a) Ship Shipboard Electric Systems Modeling Engineering for the feasibility assessment of hybrid electric drive systems focused on reduced operational fuel consumption and b) Carbon Nanotube-enhanced Fluid Technology Characterization for high power electric system cooling fluid for speed of light engagement.

DEMONSTRATION OF AEROSOL DUCT SEALING TECHNOLOGY AT DEPARTMENT OF THE NAVY FACILITIES
Fernand D.S. Marquis, Research Professor
Wayne E. Meyer Institute of Systems Engineering
Sponsor:  Naval Facilities Engineering Services Center

OBJECTIVE: The objective of this project is to prove that duct sealant technology, if applied to air duct applications within the Navy energy program, can save energy without any maintenance or operations issues and with a simple payback within the expected lifetime of the technology. An additional objective is to develop a tool to use the accurate predict energy saving ahead of time. This tool will be primarily used by ESCOs and energy managers to propose that this technology be used in Energy Savings Performance Contracts where savings are required to be guaranteed by the ESCO.
OBJECTIVE: This continues work begun in 2006. That the condensed matter state affects the state of nuclei has been established in a continuing series of experiments begun over 20 years ago. It has become clear that the release of energy in these chemical systems depends on subtle correlation effects within the condensed matter state, particularly where hydrogen is loaded into metals. A workshop in 2006 at NRL reviewed the experimental evidence and identified areas of fruitful research; subsequently, DTRA identified the Fleischmann-Pons Effect (FPE) i.e. heat-producing experiments, as a focus.

Phase 2b. An objective of this work is to use formal inference methods (in particular Bayesian networks) to characterize sources of error in experiments and to suggest areas for improvement and further experimentation. Phase 2c. Experiments using the “E-Cat” reactor of Andrea Rossi (Leonardo Corp.) hold forth the promise of a new technology for generating heat from light hydrogen in a nickel system. The work of Chernov, Lipson, et al. on production of energetic protons and alpha particles from deuterated metal systems needs to be extended. It is a further objective of this project to apply Bayesian inference to these two classes of experiments.

SUMMARY: Investigators continued work on the Bayesian network for assessing a selection of published reports on the FPE. An exact analytic solution for the network was found, removing computational restrictions on the number of such reports that could be considered. Results pointed up the need to provide a quantitative treatment of the question of publication bias, and another network was formulated for that purpose. A presentation of the results was prepared for the then forthcoming ICCF-16 conference. A revised version of the investigators’ ICCF-14 presentation (“Weight of Evidence …” below) was prepared for a special issue of the Journal of Condensed-Matter Nuclear Science. Four of the investigators’ ICCF-14 presentation finally saw publication in the Proceedings of that conference.

Progress of Rossi’s experiments was monitored, including participation in NRL efforts to substantiate his heat-production claims by independent measurement.

PUBLICATIONS:


OBJECTIVE: This is Phase 2 of work begun in December 2007. Phase 1. Experimentally verify the heat producing performance of several experiments in which electrolytically co-deposited deuterium and palladium produce excess heat. Select and qualify the preferred co-deposition experiment. Phase 2. Produce, test, refine, and characterize the selected experiment as a basis for a peer-reviewed paper for publication in a major scientific instrumentation journal.

SUMMARY: Energy and power densities observed by numerous experimenters on the Fleischmann-Pons Effect (FPE) over the last 20 years are persuasive evidence of a real physical effect in deuterium-palladium (D-Pd) systems. However, the multi-week time requirements and metallurgical difficulties of preparing a suitable system have been a formidable barrier to scientists interested in investigating the effect. Experiments with simultaneous co-deposition of D and Pd on a substrate suggested that, that approach may avoid these problems and may reduce the startup time from weeks or months to hours or weeks. An informal workshop was held in 2007 at SPAWAR Systems Center to plan development of a “standard experiment” that could lower the barriers to research on the FPE. Three co-deposition experiments were selected as possible bases for development. The first experimental protocol was reported by Szpak et al. in 1991. The second was developed by Miles in Japan at New Hydrogen Energy Project (NHE) in 1997-98. The third, using the Szpak chemistry but with a gold cathode, was developed by Dennis Letts. Later, DTRA added gas loading as a research topic.

Dennis Cravens performed the experiment as described by Szpak et al. in 1991 and did not see any anomalous heat production. NRL ran the Miles NHE chemistry and did extensive chemical analyses; they believe that “shuttle reactions” (chemical) may be responsible for Miles’s observations. Miles has redone his experiments and continues to see heat for which he does not have a chemical explanation. He does not agree that all the heat is due to shuttle reactions. Dennis Letts has an excess heat effect that seems to depend on whether deuterium or ordinary (light) hydrogen is used in the electrolyte. The possible role of a resistance heater in his configuration still requires explanation. NRL has observed anomalous heat in gas-loading experiments from very many materials when loaded with deuterium but not light hydrogen.

PUBLICATIONS:

Presentations at ICCF-14 in August 2008 have been published as papers in the Proceedings volume in December 2010. The following will appear in the proceedings of later ICCF conferences.


WAYNE E. MEYER INSTITUTE

SHIPBOARD ELECTRIC SYSTEM MODELING
Giovanna Oriti, Research Assistant Professor
Department of Electrical and Computer Engineering & Wayne E. Meyer Institute of Systems Engineering
Sponsor: Northrop Grumman

OBJECTIVE: The main objective of this collaboration is to develop and assess advanced technologies and concepts of operations in the areas of naval and marine systems to improve future war fighting missions. Initial focus areas will include a) Ship Shipboard Electric Systems Modeling Engineering for the feasibility assessment of hybrid electric drive systems focused on reduced operational fuel consumption and b) Carbon Nanotube-enhanced Fluid Technology Characterization for high power electric system cooling fluid for speed of light engagement.

EXPEDITIONARY AND MINEWARFARE CHAIR
Paul V. Shebalin, Senior Lecturer
Department of Systems Engineering & Wayne E. Meyer Institute of Systems Engineering
Sponsor: Naval Sea Systems Command

OBJECTIVE: The objective of this agreement is to provide for the sponsorship, funding and administration of the Naval Expeditionary Warfare Chair in the MI.

BUILDING EDUCATION AND WORKFORCE CAPACITY IN SYSTEMS ENGINEERING AMONG THE DEFENSE DEGREE GRANTING INSTITUTIONS
Clifford Whitcomb, Professor
Dave Olwell, Professor
Department of Systems Engineering & Wayne E. Meyer Institute of Systems Engineering
Sponsor: Director, Defense Research and Engineering (DDR&E) and OSD (AT&L)

OBJECTIVE: The overall goal of the project at the Naval Postgraduate School (NPS) is to develop and re-engineer its curriculum to implement a more hands-on pedagogy that directly develops and assesses student achievement of system engineering in the context of a set of externally defined competencies. The objective of the proposed work is to develop means to build educational and workforce capacity in systems engineering for defense departments and the military service schools. The Air Force Institute of Technology (AFIT) and NPS will jointly participate in this task which is being conducted by the OSD and NSA-sponsored Systems Engineering Research Center (SERC) hosted at the Stevens Institute of Technology.

SUMMARY: The first course in the curriculum sequence, SE3100, has been delivered in the new project format, though this was not integrated into the RT-19 project structure per se. This course had an individual project used to teach the students the fundamental concepts associated with systems thinking and basic systems engineering. The last couple of weeks of the SE3100 lab were used to set the stage for the upcoming project. The students organized into potential project categories by project area affinity. The students self-organized into their own proposed categories for project work beginning in the Winter quarter AY11. The NPS research team is currently developing formative and summative assessment instruments related to systems engineering learning, as well as developing a linkage of learning objectives to systems engineering competencies. The RT-19 project is being integrated with an internal SE department initiative to redesign the systems engineering masters curriculum. This initiative was planned for the NPS 2011 academic year (which begins in the Fall quarter of calendar year September 2010). The goals of the RT-19 project aligned very well with the proposed redesign, providing the context for the initially conceived development of a project-based engineering curriculum which uses hand-on projects for external stakeholder to base the context for learning systems engineering. The overall curriculum redesign for the SE masters degree is to be accomplished based on the Conceive, Design, Implement, and Operate (CDIO) Initiative, with specific adjustments made to accommodate the NPS graduate engineering education content.
OBJECTIVE: The objective of the proposed work is to create a DMEA and demonstrate an effective methodology and tool set to accomplish the design, development, and assessment of the DMEA system of systems (SoS). An initial architecture model will be created as a set of architecture products, AV, OV, SV, and CV, as appropriate. A final prototype integrated DMEA model will be created to be used in future METOC program developments, to manage the configuration of the eventual solution architecture structure, as well as providing consistent quantitative evaluation of program requirement suitability, effectiveness, technology maturation, risk, and cost before and during acquisition and program execution.

SUMMARY: The DMEA will be created using a model-based systems engineering (MBSE) method. The primary focus of this first phase of the project is to create the first phase architecture and related products. Later phases of the project will create an executable MBSE model that will enable quantitative modeling and simulation of the system, as well as a series of solution architecture alternatives for ultimate trade-off to select a final DMEA architecture.

OBJECTIVE: The purpose of this project is to develop an initial Defense Meteorological and Oceanographic Enterprise Architecture (DMEA) during fiscal year 2011. The DMEA will be created using a model-based systems engineering (MBSE) method. The primary focus of this phase of the project is to create the first phase architecture and related products. Later phases of the project will create an executable MBSE model that will enable quantitative modeling and simulation of the system, as well as a series of solution architecture alternatives for ultimate trade-off to select a final DMEA architecture.

OBJECTIVE: The Naval Postgraduate School Meyer Institute of Systems Engineering (MISE) will lead and coordinate a multidisciplinary task to support an investigation into reduction in total ownership cost (RTOC). The study will coordinate among human systems integration, acquisition, and engineering disciplines to investigate the application of modeling and simulation tools and systems engineering methods to determine meaningful holistic options to leverage RTOC. The initial effort will be to plan and hold a workshop in the ONR area on the ONR Total Ownership Cost program. This workshop will be an initial effort to bring the appropriate TOC players into discussions and to develop plans and actions for specific follow-up workshops and meetings. The first workshop will be held somewhere within the July - 31 December time period. Participants will be selected by the NPS/ONR team from among the major DoD stakeholders to understand how DOTMLPF aspects impact RTOC in the pre-milestone A activities that can lead to cost reductions throughout the system lifecycle. The anticipated entities involved at NPS include the MISE, MOVES Institute, Systems Engineering department, Operations Research department, and the Graduate School of Business and Public Policy (GSBPP). The expected outcomes are to define what would be meaningful reductions in TOC, the metrics involved, possible analysis methods and tools that can be applied, and a definition of a way forward over the next 2 to 3 years.
WAYNE E. MEYER INSTITUTE OF SYSTEMS ENGINEERING

2010
Faculty Publications and Presentations


Marquis, F.D.S., “Light Weight Materials in the Transportation Industry: Challenges and Opportunities”, to be published

Marquis, F.D.S., “Grain size Effects on the Mechanical Properties of Bulk Structural Materials”, to be published


CONFERENCE PUBLICATIONS & PROCEEDINGS


CONFERENCE PRESENTATIONS


Imam, M. A. et al., “Fabrication, Characterization, and Evaluation of Arata Style Alloys”, 16th Conference on


MOVES INSTITUTE

JOSEPH A. SULLIVAN
DIRECTOR
OVERVIEW:
Our mission is research, application, and education in the grand challenges of modeling, virtual environments, and simulation (MOVES).

The MOVES Institute operates independently and in collaboration with various U.S. Navy and defense modeling and simulation centers to: carry out basic and applied research; analyze continuing modeling, virtual environments, and simulation programs; create advanced prototypes; and develop real technologies and applications for the defense community.

RESEARCH PROGRAM-FY2010:
The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the MOVES Institute is provided below:
MOVES INSTITUTE

Joseph A. Sullivan
Director
CDR, USN, Military Faculty
831-656-7582
jasullivan@nps.edu

Jeffrey Appleget
Senior Lecturer
Department of Operations Research
831-656-7674
jaapleg@nps.edu

Peter C. Chu
Professor
Department of Oceanography
831-656-3688
pcchu@nps.edu

Quinn Kennedy
Lecturer
Department of Operations Research
831-656-2618
mqkenned@nps.edu

Eric R. Bachmann
Research Assistant Professor
Department of Computer Science
831-656-4066
bachmann@nps.edu

Anthony Ciavarelli
Professor
831-656-1073
aciavarelli@nps.edu

Mathias N. Kolsch
Assistant Professor
Department of Computer Science
831-656-3402
kolsch@nps.edu

Wolfgang Baer
Research Associate Professor
Department of Information Science
831-656-2209
baer@nps.edu

Christian J. Darken
Associate Professor
Department of Computer Science
831-656-2095
cjdanken@nps.edu

Moshe Kress
Professor
Department of Operation Research
831-656-2927
mkress@nps.edu

Imre Balogh
Research Associate Professor
ilbalogh@nps.edu

Rudolph P. Darken
Professor
Department of Computer Science
831-656-7588
darken@nps.edu

Theodore G. Lewis
Professor
Department of Computer Science
831-656-2830
tlewis@nps.edu

William J. Becker
Research Associate Professor
831-656-3963
wibecker@nps.edu

John S. Falby
Senior Lecturer
Department of Computer Science
831-656-3390
falby@nps.edu

Thomas W. Lucas
Associate Professor
Department of Operations Research
831-656-3039
twlucas@nps.edu

Gordon H. Bradley
Research Professor
Department of Operations Research
831-656-2359
gbradley@nps.edu

Donald P. Gaver
Research Professor
Department of Operations Research
831-656-2605
dgaver@nps.edu

Michael E. McCauley
Research Professor
Department of Operations Research
831-656-2191
memcauley@nps.edu

Donald P. Brutzman
Associate Professor
Department of Information Science
831-656-2149
brutzman@nps.edu

John Hiles
Research Professor
Department of Computer Science
831-656-2988
jehiles@nps.edu

Eugene Paulo
Associate Professor
Department of Systems Engineering
831-656-3452
epaulo@nps.edu

Arnold H. Buss
Research Associate Professor
831-656-3259
abuss@nps.edu

Patricia A. Jacobs
Professor
Department of Operations Research
831-656-2258
pjacobs@nps.edu

Edward Rockower
Research Professor
ebrockow@nps.edu

Paul R. Chatelier
Research Associate Professor
831-656-2305
prchatel@nps.edu
MOVES INSTITUTE

Neil C. Rowe  
Professor  
Department of Computer Science  
831-656-2462  
ncrowe@nps.edu

Susan M. Sanchez  
Professor  
Department of Operations Research  
831-656-2780  
ssanchez@nps.edu

Robert Wisher  
Research Professor  
703-751-4637  
rawisher@nps.edu

Amela Sadagic  
Research Associate Professor  
831-656-3819  
asadagic@nps.edu

Nita Shattuck  
Associate Professor  
Department of Operations Research  
831-656-2281  
nlmiller@nps.edu

Ji Hyun Yang  
National Research Council Fellow  
831-656-3004  
jyan1@nps.edu

Paul J. Sanchez  
Senior Lecturer  
Department of Operations Research  
831-656-3053  
pjsanche@nps.edu

Gurminder Singh  
Professor  
Department of Computer Science  
831-656-3041  
gsinghi@nps.edu

Xiaoping Yun  
Professor  
Department of Electrical & Computer Engineering  
831-656-2629  
yun@nps.edu
OBJECTIVE: Conduct research and outreach for the HSCB modeling program at NPS. The program will eventually contain four coordinated, mutually supporting lines of operation: Education, Assessment, Performance, and Transition. This year (2010) will focus on Education and Performance.

KEYWORDS: Human, Social, Cultural, Behavioral, Modeling, Irregular Warfare, Counterinsurgency

OBJECTIVE: The NPS MOVES Institute is pleased to submit this proposal in response to MCCDC Statement of Work (SOW) titled “COMBATXXI: MCCDC Behavior Development and Technical Support”. The SOW is provided at the end of this proposal for completeness. The NPS MOVES Institute possesses the unique technical expertise to support and extend MCCDC’s analytic use of COMBATXXI. Such work will also serve to further promote the special relationship between NPS and MCCDC, creating new opportunities for faculty and student research to benefit MCCDC study and development needs.

OBJECTIVE: The DOD is challenged with providing high throughout, realistic, firearm training and performance assessment. Ideally, the setting for training should be variable and include theater realistic terrain: from desert to forest, mountain to valley, and both rural and urban settings. Ideally, targets should simulate the behavior of enemy combatants: working in teams, engaging in evasive maneuvers, and counter-attacks. Recent advances in robotic systems provide unique opportunities for creating intelligent, mobile; interchangeable target platforms to address the armed forces training needs. Rather than taking the soldiers to the training, robotic targets can take the training to the soldiers. Furthermore, the construction of robotic targets provides data acquisition platforms that can be integrated with, and deeply inform, the modeling and simulation activities currently underway to support troop training. Deploying robotic target systems also provides rich opportunities for scientific and technological advances in artificial intelligence, secure communications, autonomous targeting, advanced lightweight armor materials, automated rules of engagement, behavioral studies, and sensor and detectors.
MOVES INSTITUTE

CREATION OF AN OPEN SOURCE VIRTUAL ENVIRONMENT FOR NAVAL HEALTH RESEARCH - PHASE 1
William J. Becker, Research Associate Professor
Perry McDowell, Research Associate
Modeling, Virtual Environments, and Simulation (MOVES) Institute
Sponsor: Navy Health Research Center

OBJECTIVE: Create a system that will provide non-proprietary software to control the hardware making up the CAREN system at the Naval Health Research Center (NHRC) in San Diego. This research is intended to be conversion of the remainder of the system to open software, giving the NHRC better ability to conduct research.

MARINE CORPS SMALL ARMS AND MARKSMANSHIP TRAINING
William J. Becker, Research Associate Professor
Modeling, Virtual Environments, and Simulation (MOVES) Institute
Sponsor: Office of Naval Research & TRAC-Monterey

OBJECTIVE: The purpose of this proposal is to conduct early investigation, risk mitigation, and prototyping on a new Marine Corps initiative in small arms and marksmanship training. While the Marine Corps currently has training capacity for these evolutions, there is a desire to move away from proprietary software and hardware solutions and move towards open platforms, open source, and open APIs so that the Defense training community can bring its expertise and creativity to bear on these critical and enduring problems.

MARINE CORPS WARFIGHTING LABORATORY MOVING TARGETS ENGAGEMENT TRAINER
William J. Becker, Research Associate Professor
Modeling, Virtual Environments, and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

OBJECTIVE: To assemble, test, ship and provide experimental support of four semi-autonomous targetry robots known as the Moving Target Engagement Training robot. Technical support is to be provided during the testing phases, two weeks pre-training and two weeks post training in Quantico, Va.

BATTLESPACE TERRAIN REASONING AND AWARENESS BATTLE COMMAND (BTRA-BC) BATTLE ENGINE VALIDATION
Curtis Blais, Research Associate
Modeling, Virtual Environments, and Simulation (MOVES) Institute
Sponsor: Army Geospatial Center

OBJECTIVE: The BTRA-BC Battle Engine (BBE) is a software tool to assist commanders and staffs to develop and analyze Friendly Courses of Action (FCOAs) in the context of mid-to-high intensity combat operations. It is designed to automate a number of sub-tasks of the Military Decision Making Process (MDMP) that have been previously the exclusive domain of the human planner. Using BBE, commanders and staffs can quickly generate and evaluate an unprecedented number of FCOAs. Through this rapid FCOA generation and evaluation, BBE is intended to increase the speed of tactical decision making without sacrificing any of the quality of those previously manually-developed decisions. To transition the tool to operational use, warfighters need to have confidence in potential courses of action computed by the software. Confidence and credibility are established through measured application of software and combat model validation techniques. The Army Engineer Research and Development Command (ERDC) Topographic Engineering Center (TEC) requested the Naval Postgraduate School (NPS) Modeling, Virtual Environments, and Simulation (MOVES) Institute to conduct a validation of the BBE.
SUMMARY: Mr. Blais led a team of researchers to perform combat model validation, data farming, and operational use validation to develop evidence supporting accreditation of the BBE for use as a planning aid to military decision-makers.

PUBLICATIONS:


PRESENTATIONS:


OBJECTIVE: COMBATXXI is a constructive analytical model under development by the US Army and US Marine Corps at the Army Training and Doctrine Command (TRADOC) Research and Analysis Center, White Sands Missile Range CTRAC-WSMR). As the development and user community begins to grow, collaborative tools are needed to promote communication and coordination across the community. TRAC-WSMR seeks technical support from the Naval Postgraduate School Modeling, Virtual Environments, and Simulation (MOVES) Institute and TRAC-Monterey to establish an initial capability and web presence.

M&S CATALOG METADATA

OBJECTIVE: In accordance with requirements of the DoD modeling and simulation steering committee (M&S SC) and in cooperation with the Air Force Agency for Modeling and Simulation (AFAMS), provide metadata design and development in support of development of a prototype DoD M&S catalog demonstrating the M&S community of interest (COI) metadata standard and interconnectivity search capability. This will include utilizing other ongoing DoD projects that are determining the M&S COI metadata template and those developing online registry/repository capabilities. Any prototype software and metadata content must be in compliance with DoD standards and developing Global Information Grid (GIG) connectivity.

SUMMARY: Mr. Blais provided technical consultation and metadata design and development in support of the DoD Modeling & Simulation Catalog. He participated in design and management meetings for coordination of technical efforts. He developed data mappings from the M&S Community of Interest Discovery Metadata Specification (MSC-DMS) XML format to the Google Search Appliance data feed format and coordinated transfer of 3D graphics models from the MOVES repository to the M&S Catalog.

[Note: This work is continuing in calendar year 2011.]

PUBLICATIONS:

CACHE INSTITUTE

OTHER: XSLT transformation files; SAVAGE repository metadata files

S1000D STUDY
Curtis Blais, Research Associate
Modeling, Virtual Environments, and Simulation (MOVES) Institute
Sponsor: Office of the Under-Secretary of Defense for Acquisition, Technology, and Logistics

OBJECTIVE: S1000D International Specification for Technical Documentation is a defense and aerospace specification for the acquisition and production of technical documentation. Although it was initially developed in the 1980s by the aerospace industry, it has evolved to encompass land, sea, and commercial equipment as well as training. S1000D defines minimal essential requirements like using Extensible Mark-up Language (XML) as a data format to promote interoperability. The Aerospace Industries Association (AIA) has recommended that the Office of the Secretary of Defense for Acquisition, Technology, and Logistics (OSD/AT&L) should adopt S1000D as the preferred specification for all technical documentation by the Department of Defense (DoD). A different opinion has been advanced in an analysis of S1000D for the DoD by Borek and Wilson (2008), who suggest that the potential benefits of adopting S1000D may not be attained without first developing enterprise definitions and determining how S1000D fits within the framework of an overall information management solution for DoD.

The Modeling, Virtual Environments, and Simulation (MOVES) Institute at the Naval Postgraduate School proposes to analyze the benefits and potential problems associated with the adoption of S1000D by the DoD. MOVES faculty, staff, and graduate students will determine current usage patterns of S1000D and the basis for decisions by industry to adopt S1000D or alternative standards or specifications for documentation and technical publications. The MOVES project team will develop a structured interview and, in cooperation with OUSD (AT&L), will identify target organizations and individuals to participate in the interviews. Based on the interview information, key issues will be identified and will become the focus of a questionnaire survey. Quantitative data will be obtained whenever possible. The information obtained from the initial documentation analysis, the structured interviews, and the questionnaire survey will be analyzed and integrated into a set of conclusions and recommendations for OUSD (AT&L) regarding policy guidance for the use of S1000D.

SUMMARY: Mr. Blais performed background research into the S1000D standard and its use in DoD, as well as review of prior studies examining the question of making the standard required across the DoD. Mr. Blais assisted in the development of Institutional Review Board (IRB) materials in preparation for conduct of human subject research, including the recruiting and structured interview scripts and questionnaire. Mr. Blais participated in the conduct of interviews, analysis of information obtained, and preparation of the project final report. Mr. Blais performed management coordination and financial review for the project.

PUBLICATIONS:

PRESENTATIONS:

OTHER: IRB Research Protocol/Application
OBJECTIVE: DoD Directive 3000.05, Military Support to Security, Stability, Transition, and Reconstruction Operations (SSTRO), requires the services to address these areas of warfare on equal footing with combat operations. Traditional modeling approaches that emphasized kinetic aspects of combat are ill-suited for the warfare decision-making needed today. New modeling approaches are required to help determine what forces and force packages the Navy needs to employ now and in the future to provide greatest benefit in the battle for “hearts and minds.”

N81 continues to identify requirements for advanced approaches to modeling and simulation of human social and cultural elements of today’s battlespace. There is considerable interest in being able to understand possible effects of Naval operations on the stability of a nation through shaping operations, including disaster relief and humanitarian assistance. The tasking supported the following activities:

- Faculty and student collection of resources and references on SSTR operations from military and non-military perspectives
- Faculty and student travel and participation in conferences and workshops dealing with SSTR Operations
- Faculty and student participation in related initiatives at NPS; in particular, the Cultural Geography project in TRAC-Monterey
- Outreach to faculty across the school to identify various relevant expertise available to address N81 concerns
- Faculty support to student thesis research
- Planning and conduct of a presentation session on the topic at the 2010 MOVES Research Summit
- Investigation into a number of simulation techniques, tools, and products
- Faculty research into Navy SSTRO M&S requirements

SUMMARY: Mr. Blais prepared a final report on investigations on modeling and simulation (M&S) requirements for modeling social and cultural factors that influence Naval operations, providing information to N81 analysts on modeling efforts occurring in other organizations. This work supported (1) accumulation of reference materials supporting NPS/MOVES instruction on challenges to M&S for Stability Operations; (2) thesis advising in related topics; (3) preparation and conduct of an advanced class in M&S for Stability Operations; and (4) promotion of the topic inside NPS to gather technical expertise across multiple departments; (5) monitoring of developments by TRAC-Monterey with the Cultural Geography model and associated data; (6) continuing evaluation of the Peace Support Operations Model (PSOM) for application to Naval studies; and (6) preparation of proposals and white papers to help develop additional research in this emerging area.

PUBLICATIONS:


THESES DIRECTED:


OTHER: Proposals to ONR HSCB program (NPS HSCB Support project).
OBJECTIVE: Better data integration is needed for communications and information interchange among diverse stovepiped ASW tactical systems, not just with each other but also with complementary modeling and simulation (M&S) systems. NPS has extensive experience in the construction and integration of Extensible Markup Language (XML)'languages for a variety of technical and tactical applications. Much progress has occurred. Current efforts emphasize data interchange and track visualization for validation testing.

In order to support the ASW Community of Interest (COI) program and ASW data-modeling efforts to establish coherent messaging and battlespace-visualization capabilities for network-centric undersea warfare, NPS will participate and provide technical support for the ASW COT Data Management Working Group (originally established as the usw-xml Working Group). Partnered participants from government, industry and academia perform this effort in a close collaboration.

Coordination is expected to occur with multiple related standards organizations as well as other Navy/DoD cars and working groups. Multiple technical projects demonstrate essential near-term and mid-term capabilities. Working group recommendations, exemplars and results will be given broad distribution, properly documented, classified when appropriate, and submitted to Navy and DoD XML registry efforts for long-term ASW Community of Interest (COI) use and improvement.

FINDING THE SWEET SPOT: BRIDGING SIOOOD, X3D, AND SCORM FOR EMBEDDED PERFORMANCE ASSESSMENT

OBJECTIVE: Learning management system (LMS) applications are powerful tools for creating content to help students understand complex technical topics. The Structured Content Object Reference Model (SCORM) by the Advanced Distributed Learning (ADL) Co-Laboratory has special importance for military training. Several important challenges need to be met in order to maximize the capabilities and impact of such tools however. The production of illustrative interactive 3D models is difficult and often blocked from long-term success by proprietary formats. Integrating hyperlinked text, imagery, video and 3D content together within a rich multimedia learning module is further difficult to perform and repeat.

This work will extend the benefits of ISO-approved Extensible 3D (X3D) Graphics standard to SCORM modules through a pilot project. In particular we will focus on the conversion of Computer-Aided Design (CAD) images and models from the SIOOOD specification into animated interactive X3D models that can be linked within a SCORM-based LMS. Partnered work will assess the merit, repeatability and deployability of such solutions that find the “sweet spot” afforded by utilizing these three important specifications in combination.
OBJECTIVE: The Office of Naval Research is sponsoring a pilot project that seeks to extend the genres of Massive Multiplayer Online Gaming and Alternate Reality Games to scenarios of interest to the Navy. ONR has defined objectives, situational scenarios, audience and goal outcomes for the MMOWGLI pilot that are based on social networking technologies realistic tactical simulations and 20/30 modeling. This proposal presents an execution plan to accomplish these ambitious, feasible, potentially high-payoff objectives.

NPS researchers will utilize both existing and emerging standards-based technology capabilities to quickly create a MMOWGLI war game capability that includes social-networking capabilities for rapid user-driven formation of game teams. NPS will use multiple proven low-cost, open-standards, open-source capabilities in concert.

In order to show scalability to potentially large numbers of active participants, social-networking software packages will be utilized to enable flexible professional networking among game teams. The NPS team will support game controllers in measuring and assessing the effectiveness of these new technologies. Easy-to-create wiki pages will document official moves by each of the friendly and hostile teams to ensure long-term archival storage. NPS cluster and supercomputer assets will be further utilized to demonstrate rapid computational power and responsiveness regardless of team demands. Multiple naval-office student theses will also support this unique opportunity to produce a major new capability for large-scale team-play training, tactical alternatives development, war gaming and after-action analysis.

OBJECTIVE: Unavailable.

PROJECT COUNTERPLAY: EVALUATION OF ONLINE GAMING CAPABILITIES
Donald P. Brutzman, Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: MITRE Corporation & JIEDDO

OBJECTIVE: NPS MOVES will help to evaluate a variety of online gaming technologies with respect to team interaction and collaboration capabilities. A handful of test scenarios will be played out within different online gaming environments, using both typical laptops and specialty commercial-hardware interaction devices. Remote players on the East Coast will also participate so that collaboration effectiveness can be evaluated among distant sites. The potential ability to store and replay network streams will be examined in order to consider whether diverse commercial game-play environments can be captured and subsequently re-run as a training tool.
OBJECTIVE: NPS will provide technical support regarding the design, conversion and effective use of data models in order to maximize the long-term interoperability of software systems supporting Mine Warfare (MIW). The MIW Community of Interest (COI) Data Modeling Working Group (DMWG) is the primary forum for these efforts. Modern interoperability includes the ability to convert between different data models with both syntactic and semantic correctness. Lessons learned and interoperability opportunities provided by the Anti-Submarine Warfare (ASW) COI hold particular interest. Numerous technical tasks pertain including data-model design rules, evolving Department of Defense policies, compression, security, conversion correctness, testing, visualization and long-term archivability. Results from this work are further expected to fit under the NAVSEA Open Business Model to ensure that all software and data products remain re-usable, deployable and extendable for the lifetime of military systems.

UNDERSEA WARFARE EXTENSIBLE MARKUP LANGUAGE (USW-XML) WORKING GROUP FOR ANTI-SUBMARINE WARFARE (ASW) COMMUNITY OF INTEREST (COI)
Donald P. Brutzman, Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: NAVSEA IWS-5

OBJECTIVE: Better data integration is needed for communications and information interchange among diverse stovepiped ASW tactical systems, not just with each other and but also with complementary modeling and simulation (M&S) systems. NPS and NUWC have extensive experience in the construction and integration of Extensible Markup Language (XML) languages for a variety of technical and tactical applications.

In order to support the ASW Community of Interest (COI) program and ASW data-modeling efforts to establish coherent messaging and battlespace-visualization capabilities for network-centric undersea warfare, NPS and NUWC will moderate and provide technical support for the already established usw-xml Working Group. Don Brotzman NPS and Mike Grimley NUWC will continue to serve as usw-xml cochairs and coordinate efforts as part of the ASW COI Data Management Working Group. This effort will continue as an open collaboration among partnered participants from government, industry and academia.

Coordination is expected to occur with multiple related standards organizations as well as other Navy/DoD COIs and working groups. Multiple technical projects will demonstrate essential near-term and mid-term capabilities. Working group recommendations, exemplars and results will be given broad distribution, properly documented, classified when appropriate, and submitted to Navy and DoD XML registry efforts for long-term ASW Community of Interest (COI) use and improvement.

Much progress has been achieved and much remains. Our focus is now data conversion, not just data design. Ongoing and new topics include refinement, interoperability and integration of multiple related C4I systems:

- Various DoD C4I data languages for information exchange, including
  - Tactical Assessment Markup Language (TAML) for track interoperability
  - JC3IEDM
  - CNDE/CANES
  - Universal Core (UCore)
  - Comprehensive Maritime Awareness (CMA)
  - Maritime Information Exchange Model (MIEM)
  - Automatic Information System (AIS) for tracking merchant traffic
  - Cursor on Target (CoT)
• Application development to test and demonstrate emerging capabilities
  ▪ A-TAS
  ▪ USW-DSS
  ▪ JC3IEDM Tactical Collaboration (JTC)
  ▪ Offboard control of multiple robots using AUV Workbench
• Cross-cutting technologies
  ▪ Efficient XML Interchange (EXI) binary compression of XML documents, messages
  ▪ Extensible Messaging and Presence Protocol (XMPP) standard for XML-based chat
  ▪ Extensible 3D (X3D) Graphics for X3D-Earth and Interactive Engineering Technical Manuals (IETM)
  ▪ Modeling and simulation using Savage, SavageDefense archives, SavageStudio suite
  ▪ KML markup for geographically positioned map and globe reports
  ▪ Semantic Web languages and tools
  ▪ Navy XML Naming and Design Rules (NOR) specification

ADL RESEARCH AND TECHNICAL SUPPORT
Paul R. Chatelier, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Defense Human Resources Activity

OBJECTIVE: Serve as the focal point at NPS for the ADLI office in Alexandria and Orlando, Florida. Represent the ADLI as requested on appropriate committees and study groups. Participate in NATO/TTCP meetings and committees to assist with the communication and expansion of ADLI within the Alliance, MD, PfP, and other nations wishing to share experiences and technologies. Be responsible for developing initial agreements for review by the ADLI office that will maintain cooperation, prevent redundancy, and reduce the total cost of such ownership of the agreement.

ADVANCED HUMAN SYSTEMS INITIATIVES AT THE NAVAL POSTGRADUATE SCHOOL’S (NPS) MODELING VIRTUAL ENVIRONMENTS AND SIMULATION (MOVES) INSTITUTE
Paul R. Chatelier, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

OBJECTIVE: This effort will focus on providing research and development program support to ONR in the HS(I) domain areas including research and analysis and S&T assessments. Discussions with Code 341 have indicated that they would also like NPS to possibly play a role in identifying new advanced human systems assessment initiatives that might have an impact on their Synthetic Environment for Assessment (SEA) program. Of special interest is investigating what Joint Modeling and Simulation education and research might be able to provide for SEA. This includes determining how NPS Modeling and Simulation current and proposed efforts can be provided to the fleet via networking as well as how M&S technologies might better integrate and improve Navy inter-laboratory human systems assessment capabilities.

FY10 PROGRAM SUPPORT TO ONR CODE 34
Paul R. Chatelier, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

OBJECTIVE: The objectives of this effort are to conduct applied research, business development activities, meeting attendance and representation of SEA and Human Systems efforts where appropriate in terms of advisory services. NPS/MOVES should assist in facilitating SEA and HS business development plans as directed by ONR Code 34, providing advisory services as needed. This may involve attendance at meetings or the hosting of meetings if requested.
It will also involve representing ONR Code 34 interests at meetings worldwide at the sponsor’s request.

- Programmatic liaison with the DDR&E, Department of the Navy, and NATO research and technology organization including the NATO training group (NTG) and The Technology Cooperation Program (TTCP) in the areas of training technology and human systems.
- Specific emphasis should be placed on the tri-service collaboration of technologies that offer high return on investment in Advanced Distributed Learning (ADL), medical education and training, maintenance training and human systems integration. Principle Investigators will provide reports and meeting summaries as requested. Meetings include but are not limited to Department of Navy, Army, Air Force and Department of Defense meetings as well as international NATO meetings.

**FY10 PROGRAM SUPPORT TO ONR CODE 341**
Paul R. Chatelier, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

**OBJECTIVE:** The Naval Postgraduate School (NPS) Modeling Virtual Environments and Simulation (MOVES) Institute will provide program support to ONR Code 341 in areas that encompass all of the domains of Human System Integration (HSI) with specific attention being given to (1) Human Factors Engineering, (2) Manpower (3 Personnel) and (4) Education and Training. Examples of areas that will be covered include strategic and operations planning, providing HSI subject matter expertise, assisting with the planning and conducting of research, analysis assessments that could include performing ONR focused liaison with naval operational commands selected by the ONR PM. Throughout this program NPS (MOVES) will stay abreast of ONR Code 341 program developments assisting with the evaluation of these programs as well as providing assistance of tracking financial status and strategic level communications with ONR designated programs.

- Human Systems Integrations (HSI) with an emphasis on the training, education and design domains;
- Strategic planning related to the development, coordination, and active collaboration of technology innovation and transition with an emphasis on training, learning and design technologies

NPS/MOVES will prepare reports and meeting summaries as requested. Meetings include but are not limited to Department of Navy, Army, Air Force, and Department of Defense meetings as well as international NATO meetings.

**FY10 PROGRAM SUPPORT TO ONR CODE 342**
Paul R. Chatelier, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

**OBJECTIVE:** The Naval Postgraduate School (NPS) Modeling Virtual Environments and Simulation (MOVES) Institute will provide program support to ONR Code 342 for the FY11-15 new start EC, Performance Shaping Functions for Environmental Stressors. Examples of support that will be provided include program planning, providing HSI subject matter expertise, assisting with the planning and conducting of research, analysis, assessments that could include performing ONR focused liaison with naval operational commands selected by the ONR PM. Throughout this program NPS (MOVES) will stay abreast of ONR Code 342 program developments assisting with the evaluation of these programs as well as providing assistance of tracking financial status and strategic level communications with ONR designated programs. Additionally, ONR Code 342 would like NPS to provide support for business plan development activities, meeting attendance and representation of performance shaping functions.

NPS/MOVES will prepare reports and meeting summaries as requested. Meetings include but are not limited to Department of Navy, Army, Air Force, and Department of Defense meetings as well as international NATO meetings.
HEALING HEROS: SUPPORT AND CONSULTATION
Paul R. Chatelier, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: DARPA

OBJECTIVE: The objective of this effort is to provide research and development program support and consultation to DARPA in the areas of Human Systems Integration (HST) and computer security including research and analysis and S&T assessments. NPS will assist DARPA by assisting in monitoring ongoing efforts and research in social networks, gaming, and mobile applications across DoD as well as activities associated with NATO Human Factors and Medical (HFM) Panel and The Technical Cooperation Program (TTCP).

MEDICAL SIMULATION AND TRAINING TECHNOLOGY
Paul R. Chatelier, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Telemedicine and Advanced Technology Research Center

OBJECTIVE: To provide expertise necessary to perform simulation projects and technology investment strategy.

SENIOR RESEARCH SCIENTIST FOR JOINT PROGRAM COMMITTEE (JPC-I)
MEDICAL MODELING SIMULATION AND TRAINING TECHNOLOGY PORTFOLIO
Paul R. Chatelier, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: United States Army Medical Research and Material Command

OBJECTIVE: The United States Army Medical Research and Materiel Command (USAMRMC) and the Telemedicine and Advanced Technology Research Center (TATRC) has requested consultant support in the form of a senior research scientist from the Naval Postgraduate School who can provide guidance to Director TATRC on medical simulation and training policy, standards, and technology investment strategy.

COMMAND AND CONTROL TRAINING SYSTEM RESEARCH AND DEVELOPMENT
Anthony Ciavarelli, Professor
Perry McDowell, Research Associate
Joseph A. Sullivan, Military Faculty
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: EADS North America, Inc.

OBJECTIVE: Asymmetric attacks, natural & man-made disasters and humanitarian assistance operations require new capabilities for Defence & Security forces as well as first responders and others who maintain our Critical National Infrastructure. Furthermore, they require the ability to test, extend and challenge existing doctrines & standard operating procedures that are followed in such emergency situations. Whilst each stakeholder has limited tools to look at their own doctrines in isolation, there is not inter-agency validation testbed for working on the increasing complexity of multi-agent activities, nor a sufficient training environment.

A research and development plan is proposed for this CRADA that would lead to the development of a software framework and visualization platform for doctrine validation and training. The resulting solution will address critical validating existing or proposed Standard Operating Procedures as well as enabling the de-risking or validation of capability insertion. This solution would be used in conjunction with defined scenarios - described by use-cases, of natural and man made disasters, as well as issues regarding asymmetric attack that can be provided in an open,
At the conclusion of the planned research and development program, we will have defined and built an architectural framework, use-case library and further developed the existing MOVES (Modeling, Virtual Environments and Simulation) serious-gaming engine to validate the systems concept and underlying interoperability of the simulation models. Additionally, a joint team from MOVES & EADS-NA will demonstrate an operations prototype at DARPA Tech in August 2010.

**CREATIVE & NOVEL CONTEXT GENERATION FOR SENSE-MAKING USING CONCEPTUAL BLENDING THEORY**

Christian J. Darken, Associate Professor  
Modeling, Virtual Environments and Simulation (MOVES) Institute  
Sponsor: National University of Singapore

**OBJECTIVE:** The project is a joint effort between NUS and NPS in the field of Cognitive Science Theory. Researchers will develop a computational model of Conceptual Blending in order to evaluate its ability to construct novel and creative scenarios in the maritime security domain.

Conceptual Blending is proposed to be a general theory of cognition and has been shown to be the cognitive operator behind human thinking and creative activities (Fauconnier & Turner, 2002). Pereira (2007) has demonstrated creative creature creations with Conceptual Blending on noun-noun combination while Harrell (2007) has demonstrated creative poem generations. The potential applications of conceptual blending could be extended to include creative scenario generation and compression of diffuse knowledge to assist in gaining global insight.

**RUN-TIME COURSE OF ACTION MODIFICATION FOR SIMULATED ENTITIES**

Christian J. Darken, Associate Professor  
Modeling, Virtual Environments and Simulation (MOVES) Institute  
Sponsor: U.S. Army TRADOC Analysis Center

**OBJECTIVE:** Current military simulations do not have adequate support for allowing simulated forces to respond to new information that becomes available during the course of a run. In real operations, it is very normal for very significant information, such as details of terrain or actual positions of enemy forces, to be acquired only during the actual operation. Real Soldier adapt their plans to such circumstances; simulated ones should too. The goal of the proposed work is to significantly improve the state of the art by providing means for simulated forces to dynamically plan routes and otherwise adjust their planned course of action during the course of a simulation run.

**DYNAMIC VIRTUAL ENVIRONMENTS FOR TECHNOLOGY ASSESSMENT AND ADOPTION**

Rudolph P. Darken, Professor  
Modeling, Virtual Environments and Simulation (MOVES) Institute  
Sponsor: DARPA

**OBJECTIVE:** This effort is to determine the feasibility of using highly dynamic virtual environments as a way to build trust, mitigate risk, and consequently accelerate the adoption of DARPA technologies into Department of Defense acquisition programs.
EDUCATIONAL DOMINANCE PROGRAM SUPPORT
Rudolph P. Darken, Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: DARPA

OBJECTIVE: Programmatic and advisory support to the Program Manager for the Educational Dominance DARPA program. Support for the PM directly as well as performers in assisting in experimental design and logistics for experiment execution.

SYNTHETIC ENVIRONMENTS FOR ASSESSMENT: PROTOTYPE INFRASTRUCTURE AND SCENARIO DEVELOPMENT
Rudolph P. Darken, Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

OBJECTIVE: This proposal addresses an ongoing issue with regard to assessment of alternatives in the acquisition and R&D process. We will prototype a new simulation approach that allows for rapid development of simulations for assessing design choices.

BEHAVIOR ANALYSIS AND SYNTHESIS FOR INTELLIGENT TRAINING - BASE-IT
Rudolph P. Darken, Professor
Amela Sadagic, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

OBJECTIVE: A primary objective is to develop a state-of-the-art intelligent training system for pre/in/post evaluation using behavior analysis, review, and behavior synthesis as well as a set of training approaches, aimed to support a wide range of training and operational needs in preparing for and conducting the training in MOUT facilities.

TRAC INFORMATION TECHNOLOGY
Jimmy Liberato, Research Associate
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: TRAC-Monterey

OBJECTIVE: This work will enhance networking technical support for TRAC Monterey.

SOCIAL NETWORK REPRESENTATION AND ANALYSIS
Steve Lieberman, Research Assistant
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: TRAC-Monterey

OBJECTIVE: Steve Lieberman will team with TRAC-Monterey to address the use of social network models and simulations in irregular warfare operations. Deliverables include phased technical reports on theories and methods underlying the quantification of relationships, influence, and persuasion using social network models, and an implementation plan for social network models. Steve Lieberman will work with TRAC-Monterey programmers to develop coded implementations of applicable theories and methods, and the verification of implemented social and behavioral science theories.
WIKI-BASED SOCIAL NETWORKING FOR COMBATING TERRORISM PROFESSIONALS

Steve Lieberman, Research Assistant
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: OSD, Combating Terrorism Fellowship Program

OBJECTIVE: Assist the United States government’s ongoing effort to address the challenges of global security by providing the world’s leading forum for state-of-the-art knowledge about all aspects of combating global terrorism, discussing international best practices and current events in global defense and security, and providing the best social and professional networking tools to international defense and security professionals. This forum will be fully integrated with the Combating Terrorism Fellowship Program (CTFP), and be accessible to defense and security professionals from all over the world, including locations with limited bandwidth and limited computing capabilities.

LANDING SIGNAL OFFICER AUTOMATED PASS AND RECOVERY TRACKING SYSTEM REPLACEMENT
Michael E. McCauley, Research Professor
Modeling, Virtual Environments, and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

OBJECTIVE: Our primary objectives are to reduce LSO workload and to provide the fleet with better carrier-landing performance data. We will reduce LSO workload by automating tasks currently done by hand, and by providing new tools to accomplish LSO tasks more easily such as trend analysis. We will provide better performance data by capturing more data (such as new metrics and video) than APARTS handles currently. Our system will serve as an enhanced training tool for fleet LSOs, and will provide fleet-wide performance data to analysts.

S1000D ANALYSIS
Michael E. McCauley, Research Professor
Modeling, Virtual Environments, and Simulation (MOVES) Institute
Sponsor: Office of the Under-Secretary of Defense for Acquisition, Technology, and Logistics

OBJECTIVE: The objective of this research is to identify the perceived benefits and drawbacks to implementing S1000D. Current and potential users of this guideline will be interviewed to determine the basis for decisions to adopt or reject the S1000D standard. A survey questionnaire will be developed, administered, and the resulting data will be analyzed. Results of all aspects of the analysis will be provided in a final report.

AN INTERACTIVE SIMULATION TO TRAIN SWO DECISION MAKING
Perry McDowell, Research Associate
Modeling, Virtual Environments, and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

OBJECTIVE: Our objective is to create a trainer that will train SWOs in irregular warfare. The system will operate without instructor intervention and will provide feedback to the student on his/her performance. It will also report the student’s performance to a learning management system (LMS), which can display the results for the instructors and proscribe a course of remediation if required. Additionally, it is our hope that it will also serve as the basis for additional training products at SWOS.
CREATING A GAME BASED PORT PROTECTION TRAINER
Perry McDowell, Research Associate
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Federal Law Enforcement Training Center

OBJECTIVE: The goal of this research is to create a trainer for use in the Federal Law Enforcement Training Center’s (FLETC) Maritime Division course Seaport Security Antiterrorism Training Program (SSATP). The game will be used to teach and evaluate students the Seaport Facility Inspection portion of the class. The Seaport Facility Inspection program teaches students how to perform inspections of port facilities and ensure that they are complying with required laws and regulations regarding protection from attack.

DAMAGE CONTROL VISUALIZATION PROTOTYPE
Perry McDowell, Research Associate
Modeling, Virtual Environments, and Simulation (MOVES) Institute
Sponsor: Naval Surface Warfare Center-Carderock Division

OBJECTIVE: The goal of this research is create a prototypical visualization application as part of their Advanced Survivability Assessment Program (ASAP). This visualization component will demonstrate how such a system can assist analysts at NAVSEA Code 665 (Vulnerability Assessment) to better determine the effects of weapons’ impacts and detonations upon Naval vessels.

INVESTIGATIONS INTO USING GAME ENGINES AS THE BASIS OF DEFENSE BASED GAME-BASED TRAINING AND ANALYSIS
Perry McDowell, Research Associate
Modeling, Virtual Environments, and Simulation (MOVES) Institute
Sponsor: Lockheed Martin

OBJECTIVE: Game-based systems are becoming vital to many area becoming vital to so many areas within the Department of Defense, especially training and analysis. Lockheed Martin Simulation, Training and Support currently shares an interest corresponding with building systems using game-based engines. Working together, NPS and LMSTS will investigate how game-based systems can be used for training and analysis, including what modifications need to be done, and examination of different business models and resource requirements.

TRAC-MONTEREY COMPUTATIONAL PLATFORM FOR COMBAT MODELING AND ANALYSIS
Don McGregor, Research Associate
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: TRAC-Monterey

OBJECTIVE: The US Army Training and Doctrine Command (TRADOC) Research and Analysis Center, Monterey (TRAC-Monterey) performs model development and analysis for US Army studies. These studies often require significant computational resources to execute complex models over many replications to gather statistical data for analysis. The Naval Postgraduate School Modeling, Virtual Environments, and Simulation (MOVES) Institute performs systems administration over high-speed, high-capacity computing platforms. TRAC-Monterey seeks to task the MOVES Institute to provide software support to install and make available a variety of models using these high performance computers (HPC).
MOVES INSTITUTE

3D DISPLAY AND CAPTURE OF HUMANS FOR LIVE-VIRTUAL TRAINING
Amela Sadagic, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

OBJECTIVE: We propose research, development, and evaluation of work in 3D display and sensing, initially aimed at Mixed/Augmented Reality-based live-virtual training, but with significant potential for broader impact.

The first segment of this work is to organize and conduct domain analysis of three segments of military training domain: (1) team performances in urban warfighting conditions (USMC), (2) fire drills on ships and submarines (US Navy), (3) tactical cultural awareness training (USMC). The main objective of this activity is to obtain a thorough understanding about the domain, its actors, their specific needs (both current and projected) and environment in which they act; this work will focus on conducting a series of domain and technology related user studies investigating basic human perceptual capabilities, presence and usability of proposed Shader Lamps avatar technology.

BEHAVIOR ANALYSIS AND SYNTHESIS FOR INTELLIGENT TRAINING - BASE-IT
Amela Sadagic, Research Associate Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

OBJECTIVE: A primary objective is to develop a state-of-the-art intelligent training system for pre/in/post evaluation using behavior analysis, review, and behavior synthesis as well as a set of training approaches, aimed to support a wide range of training and operational needs in preparing for and conducting the training in MOUT facilities. The work in FY11 is a continuation of our research efforts we have been engaged in on the same project during the period 10/11/07 - 12/21/10.

TRAC INFORMATION TECHNOLOGY
Joseph A. Sullivan, Military Faculty
Jimmy Liberato, Research Associate
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: TRAC-Monterey

OBJECTIVE: This work will enhance networking technical support for TRAC Monterey.

DEVELOPING EXPERT PERFORMANCE ON COMPLEX COGNITIVE TASKS
Joseph A. Sullivan, Military Faculty
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Office of Naval Research

OBJECTIVE: The goal of this research project is to extend our understanding of training methods and performance assessment techniques related to expert performance on continuous, complex cognitive tasks. Many of the training challenges for the defense and security communities involve complex cognitive tasks. Typically these tasks are not only difficult to master, but they occur in operational environments that are not conducive to training. Because of the prevalence and importance of these complex tasks, the application of simulation to raise the efficiency of training is a critical research topic. Environments to study the utility of simulation in training continuous complex cognitive tasks are difficult to establish; however the Naval Postgraduate School (NPS ) Modeling, Virtual Environments and Simulation (MOVES) Institute has experience and resources that can serve as a uniquely valuable test bed. Previous work in the domain of helicopter over land navigation provides key in sight into the role of simulation in the acquisition of complex skills. Related work at NAWCTSD focused on determining a trainee’s cognitive state has involved discrete tasks with clear beginning and end points. Extending and eventually merging these research threads
will allow us to study continuous tasks that interrelate with discrete tasks and will improve our understanding of the role of simulation in the development of expertise. We expect that our results from this research will be generalized to any complex cognitive task with both discrete and continuous elements. Comparison of novice versus expert scan may provide useful information to guide instructional systems.

THE MOVES INSTITUTE - FISCAL YEAR 2010
Joseph A. Sullivan, Military Faculty
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Navy Modeling and Simulation Office

OBJECTIVE: The Naval Postgraduate School, in conjunction with RDA CHENG (NMSO), has established a degree program, the Modeling, Virtual Environments and Simulation (MOVES) curriculum and a research institute, the MOVES Institute. The degree program generates officers capable of filling 6202-P coded billets upon graduation. The program is roughly half computer science, and half operations analysis. MOVES graduates have an in-depth understanding of modern modeling, virtual environments and simulation. This proposal seeks to provide faculty, student, and staff support on issues of interest to the NMSO Community stakeholders (Analysis, Acquisition, Training, and Marine Corps) and to couple student theses to NMSO programs.

EXAMINING TOOLS AND METHODS FOR ASSESSMENT OF NETWORK SECURITY AND INTEROPERABILITY
Joseph A. Sullivan, Military Faculty
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: DOT&E

OBJECTIVE: This proposal is for the initial study / student thesis sponsored by DOT&E to examine tools and methods that can be used in the assessment of network security and interoperability. This initial study will focus on developing a specific tool for use in network training and network defense evaluation, with potential follow-on studies that will expand the use and context of the tool and derivative tools as well as enhance the analytical support for network assessments and testing.

ADVANCED DISTRIBUTED LEARNING INITIATIVES AT NPS - PHASE 2
Robert Wisher, Research Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Advanced Distributed Learning Program Office

OBJECTIVE: The purpose of the second phase of this project is to expand the work performed during the initial phase, from July to December 2009. Harnessing the current and future potential of distributed learning technologies is critical to the success of NPS as a university. The Advanced Distributed Learning (ADL) program (http://www.adlnet.gov) is a leading advocate for the development and distribution of learning content that is accessible, interoperable, and durable. High quality education and training content that can be freely imported to NPS and the opportunity for NPS to contribute its content to others is of great interest to this university.
ANALYSIS OF SYSTEM TRAINING IMPACT FOR MAJOR DEFENSE ACQUISITION PROGRAMS

Robert Wisher, Research Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Defense Human Resources Activity

OBJECTIVE: Traditionally, training for major new systems is not fully provided until after initial operational capability. The purpose of this research is to assess the value of early consideration of Acquisition System Training requirements for new systems being acquired by the Department of Defense. This research addresses key topics raised in the recent Strategic Plan for the Next Generation of Training for the Defense Department, issued by the research sponsor, the Office of the Under Secretary of Defense, Readiness. The two central questions are: Is there a benefit to the warfighters (operators, maintainers and leaders) and the acquisition community with early consideration of systems training in major acquisitions? and, Does early system training contribute to initial readiness and full utilization of system’s capability upon initial delivery?

RIGID AND ARTICULATED OBJECT DETECTION IN AERIAL IMAGERY

Robert Zaborowski, Student
Mathias Kolsch, Assistant Professor
Modeling, Virtual Environments and Simulation (MOVES) Institute
Sponsor: Space and Naval Warfare Systems Center-San Diego

OBJECTIVE: UAVs (Unmanned Aerial Vehicles) collect several hours of video per mission individually, and several years of video in a one year period collectively. Therefore, operators must commit a proportional number of hours reviewing the collected imagery. This process makes the operators, whose review is susceptible to degradation caused by complacency, a single point of failure and potentially reduces the effectiveness of UAV collections. Real-time review of video from UAVs is limited by bandwidth. This project aims to use vision techniques for detection of rigid and articulated objects (cars and people) in aerial video for review, and to allow onboard detection to support transmitting only pertinent images back to a controlling station. Analysis will be performed to determine the spatial and temporal resolution required for effective object detection, ability to perform onboard object detection, and feasibility of articulated object detection for aerial imagery.
MOVES INSTITUTE

CONFERENCE PUBLICATIONS & PROCEEDINGS


CONFERENCE PRESENTATIONS


TECHNICAL REPORTS


WORKING PAPER

CENTER FOR INTERDISCIPLINARY REMOTELY PILOTED AIRCRAFT STUDIES

ROBERT T. BLUTH
DIRECTOR
OVERVIEW:

The Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS) is a research center at the Naval Postgraduate School (NPS). The Office of Naval Research established CIRPAS in the spring of 1996. CIRPAS provides measurements from an array of airborne and ground-based meteorological, aerosol, and cloud particle sensors, radiation and remote sensors to the scientific community. The data are reduced at the facility and provided to the user groups as coherent datasets. The measurements are supported by a ground-based calibration facility. CIRPAS conducts payload integration, reviews flight safety, and provides logistical planning and support as a part of its research and test projects around the world. The Center operates a variety of manned aircraft and unmanned aerial vehicles (UAV). CIRPAS is also a National Research Facility of UNOLS.

The facility provides unique flight operation and scientific measurement services by:

• Providing access to manned aircraft, UAVs, support equipment, and scientific instruments, thus sparing users the cost of ownership and guaranteeing equal access by all interested parties on a first-come first-served basis.
• Instrumenting and operating aircraft to meet the requirements of a variety of individual research and test programs.
• Developing new instrumentation to meet increasing challenges for improvements in meteorological and oceanographic measurements.
• Calibrating, maintaining, and operating the facility’s airborne instruments in accordance with individual mission specifications.
• Integrating auxiliary payloads as required and handling flight safety and logistics tasks, allowing the user to concentrate on his specific mission goals.

The facility has unique UAV flight services, including:

• An available and centralized repository of diverse UAV assets to meet the needs of individual programs.
• Access to the UAVs and support equipment on a “lease” basis so the user is spared the cost of ownership.
• Turnkey UAV operations, including payload integration, flight safety, and logistics support.
• Low-cost services using shared assets.

CIRPAS provides cost-effective flight services, which benefits a broad spectrum of research. CIRPAS operates out of two facilities. The primary site is located near the NPS campus at the Marina Municipal Airport. This facility includes a 30,000 square foot hangar and maintenance and administrative spaces for CIRPAS staff. These include a fully outfitted machine shop, an electronics room, and a calibration lab for the upkeep of scientific instrumentation. The second site is at McMillan Airfield, Camp Roberts, California, 90 miles south of the Marina facility. The Camp Roberts site provides the Center with a base of operations for both manned and unmanned aerial-vehicle flight activities.

The California Institute of Technology supports CIRPAS as the prime contractor. It is also partners with NPS in providing the latest instrumentation for atmospheric research.

RESEARCH THRUSTS:

• Atmospheric and Oceanographic Research
• Fleet and USJFCOM Exercises
• Support for CONOPS Development
• Payload Test and Evaluation
• UAV Experimentation with Operational Forces supported by Analysis Provided by NPS Departments and Institutes

THE CIRPAS AIRCRAFT:

UV-18A “Twin Otter”: The CIRPAS UV-18A “Twin Otter” has two primary missions. The vehicle’s large, useful load makes it ideal for carrying instrumentation for atmospheric/oceanographic research. The twin turboprop Short Takeoff and Landing (STOL) aircraft can cruise at very low speeds for long durations. The aircraft has a maximum takeoff weight of 13,500 pounds.
CIRPAS

Characteristics of the CIRPAS Twin Otter include:
- Maximum endurance of 5 hrs. (extended further during ferry operations)
- Maximum altitude of 25kft
- 70-160 KIAS operational speed range
- 200 amp of payload power (DC and AC combined)
- Wing span of 65 ft.
- GTOW of 13,500 lbs. (~6000 lbs. useful)

Pelican: The Pelican is a highly-modified Cessna 337 Skymaster originally developed by the Office of Naval Research for low-altitude, long-endurance, atmospheric and oceanographic sampling. With additional support from NASA's ERAST Program, the air vehicle has been configured to operate as a UAV surrogate. In the UAV surrogate role, Pelican provides a low-risk, low-cost, test and evaluation platform by avoiding the airspace restrictions and other complications associated with unmanned aircraft operations. CIRPAS' second Pelican air vehicle is a converted Cessna O2-A. It is operated without the Predator avionics equipment and is available for use in support of a variety of generic payload demonstrations.

Characteristics of the Pelican include:
- Maximum endurance of 15 hrs.
- Maximum altitude of 15kft
- Cruise speed of 90 KIAS
- Nose payload bay capacity of 330 lbs.
- Wing hardpoints and cabin space for additional payloads
- 1.2 kW of payload power
- Wing span of 42 ft.
- GTOW of 4600 lbs.

Altus ST UAV: The Altus Single Turbo (ST) UAV was developed by General Atomics ASI to support the high-altitude atmospheric-monitoring requirements of NASA's Environmental Research Aircraft and Sensor Technology Program. The Altus TM UAV is based on the proven Predator TM and GNAT TM line of unmanned aircraft. The Department of Energy’s Sandia National Labs funded the fabrication of a singlestage turbocharged Altus TM UAV to support the Atmospheric Radiation Measurement (ARM) Science Campaign. As a result of a cooperative agreement with the DoE, CIRPAS provides the vehicle’s services during the remainder of the year to other users.

Characteristics of the Altus ST include:
- Maximum endurance of 30 hrs.
- Maximum altitude of 45kft
- Cruise speed of 70 KIAS
- Nose payload bay capacity of 330 lbs.
- 1.2 kW of payload power
- Wing span of 55 ft.
- GTOW of 2100 lbs.

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

Characteristics of the Predator UAV include:
- Maximum endurance of 36 hrs.
- Maximum altitude of 25kft
- Cruise speed of 70 KIAS
- Nose payload bay capacity of 450 lbs., wing hardpoints
- 1.8 kW of payload power
- Wing span of 48 ft.
CIRPAS

- GTOW of 2250 lbs.

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

Characteristics of the GNAT-750 UAV include:
- Maximum endurance of 30 hrs.
- Maximum altitude of 18kft
- Cruise speed of 70 KIAS
- Nose payload bay capacity of 125 lbs.
- 1.2 kW of payload power
- Wing span of 35 ft.
- GTOW of 1450 lbs.

**Ground-Control Station:** The General Atomics ASI Ground-Control Station (GCS) provides aircraft control functions for the CIRPAS-operated UAVs. The GCS has redundant pilot/payload operating stations and is housed in a rugged, 18-foot-long, wheeled container. CIRPAS currently owns two GCSs and associated ground data terminals capable of operating Predator/Altus/GNAT-750/Pelican air vehicles. GCS #1 includes one UHF and dual VHF radios for communication to other aircraft, range, or ATC personnel. Additional radios provide direct communication between flight crew and other personnel if a requirement exists. GCS #1 also has a video closed-captioning system to overlay aircraft and target position data on imagery before transmission to user.

**Atmospheric/Oceanographic Aircraft Payloads:** CIRPAS can provide use of a wide variety of atmospheric and oceanographic sensors to the research community. The CIRPAS sensor suite includes off-the-shelf instrumentation, as well as one-of-a-kind, custom-built packages. CIRPAS possesses a variety of scientific instruments and instrument suites. The basic meteorological and GPS suite consists of a Rosemount temperature probe, an Edgetech chilled-mirror, a dew-point sensor, a Rosemount flow-angle probe with static ports, Vaisala temperature and dew point sensors, a Novatel GPS receiver with a ground survey station for differential correction, a TANS Vector GPS attitude system, a CMidget-II INS-GPS system, an IRGA humidity and carbon-dioxide sensor, and an Aerodyne fast absolute humidity sensor. The CIRPAS aerosol instrumentation suite consists of a TSI three-color nephelometer, a radiance soot photometer, a TSI ultrafine-particle counter, and a TSI condensation-nuclei counter. The CIRPAS cloud and particle instrumentation suite consists of an FSSP-100, a PCASP-100X (both with upgraded electronics), a CAPS scatter and occultation probes, DMT 2D-P and 2D-PP probes, and a TSI aerodynamic particle spectrometer.

**RESEARCH FACILITIES:**

**Marina Facility**
- 30,000 sq ft. maintenance hangar
- 3000 ft. runway - manned operations only
- Naval Reserve Unit
- Office space, flight operations

**Maintenance Facility**
- Payload development and integration
- Logistics planning and support to research and test projects

**Camp Roberts Facility**
- Friendly airspace for testing and training (R2503)
- Military ground maneuvers (equipment, personnel)
- 3500 x 60 ft. runway
- 2000 sq ft. hangar
- Shared utilization of NRL temporary office space
RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Center for Interdisciplinary Remotely Piloted Aircraft Studies is provided below:

Size of Program: $2.9M
AECV PUMA UAV OPERATIONS AT ROBERTS PROJECT  
Robert T. Bluth, Research Associate  
Center for Interdisciplinary Remotely Piloted Aircraft Studies  
Sponsor: USSOCOM  

OBJECTIVE: Support Puma flight testing at Camp Roberts.  

DANTE TEST ON PELICAN  
Robert T. Bluth, Research Associate  
Center for Interdisciplinary Remotely Piloted Aircraft Studies  
Sponsor: SPAWAR System Center-Pacific  


ENGINEERING FLIGHT TESTING  
Robert T. Bluth, Research Associate  
Center for Interdisciplinary Remotely Piloted Aircraft Studies  
Sponsor: Aeromech Engineering, Inc.  

OBJECTIVE: CIRPAS will provide pre-flight coordination, flight coordination, range management, flight safety and facility management of AeroMech Engineering, Inc. activities while conducting flight testing of the UAV at the CIRPAS facility and ensure compliance with all CIRPAS and Caltech policies and procedures per Appendix A.  

LGUNS TESTING AT MCMILLAN AIRFIELD  
Robert T. Bluth, Research Associate  
Center for Interdisciplinary Remotely Piloted Aircraft Studies  
Sponsor: Naval Air Warfare Center Weapons Division  

OBJECTIVE: Support LGuns testing at McMillan Airfield at Camp Roberts.  

NPS SBIR PROGRAM SUPPORT  
Robert T. Bluth, Research Associate  
Center for Interdisciplinary Remotely Piloted Aircraft Studies  
Sponsor: Office of Naval Research  

OBJECTIVE: Support ONR Small Business Innovative Research (SBIR) program in the development and management of SBIR contracts.  

SCAN EAGLE OPERATIONS AT ROBERTS PROJECT  
Robert T. Bluth, Research Associate  
Center for Interdisciplinary Remotely Piloted Aircraft Studies  
Sponsor: COMNAVSPECWARGRU ONE  

OBJECTIVE: Scan Eagle flight testing at Camp Roberts.
UAV OPERATIONS AT ROBERTS PROJECT
Robert T. Bluth, Research Associate
Center for Interdisciplinary Remotely Piloted Aircraft Studies
Sponsor: AFRL/RV

OBJECTIVE: UAV flight testing at Camp Roberts.

WTI 10-1
Robert T. Bluth, Research Associate
Center for Interdisciplinary Remotely Piloted Aircraft Studies
Sponsor: Marine Corps Air Station

OBJECTIVE: Support WTI 10-1 activities with Pelican configured as a DAV surrogate with Predator EO-IR Payload.

WTI 10-1-2
Robert T. Bluth, Research Associate
Center for Interdisciplinary Remotely Piloted Aircraft Studies
Sponsor: Marine Corps Air Station

OBJECTIVE: Support WTI 10-1 and 2 activities with Pelican configured as a UAV surrogate with Predator EO-IR Payload.

WTI 11-1 & 2
Robert T. Bluth, Research Associate
Center for Interdisciplinary Remotely Piloted Aircraft Studies
Sponsor: Marine Corps Air Station

OBJECTIVE: Support WTI 11-1 & 2 activity with Pelican configured as a UAV surrogate with Predator EO-IR Payload.

DEPLOYMENT EQUIPMENT FOR A MOBILE WEATHER RADAR
Haflidi H. Jonsson, Research Associate
Center for Interdisciplinary Remotely Piloted Aircraft Studies
Sponsor: Office of Naval Research

OBJECTIVE: An AN/MPQ-64 air defense X-band radar was acquired by the Center of Interdisciplinary Remotely Piloted Studies at the Naval Postgraduate School from the Army in 1998. The radar has been modified for weather research, providing the Navy with cutting-edge capability to assess battle space weather in real time. The modified radar also is proving to be a valuable tool in thunderstorm and tornado research due to the speed with which it is able to scan entire storms with its phased array antenna. To make optimal use of the radar in storm research it needs to be easily deployable. It needs to be mounted on a suitable truck that is equipped with a personnel and equipment-sheller, a power plant, a radar lift, and platform levelers. It is this need for a complete deployment system that is addressed in this proposal.
CIRPAS

ENHANCEMENTS OF CIRPAS TWIN OTTER MEASUREMENT CAPABILITIES
Haflidi H. Jonsson, Research Associate
Center for Interdisciplinary Remotely Piloted Aircraft Studies
Sponsor: Office of Naval Research

OBJECTIVE: For over 14 years Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS) has supported ONR funded researchers from various Universities and Laboratories with its instrumented aircraft. It has become well accepted in the scientific community that CIRPAS’ function of providing to its collaborators, not only aircraft, but also reliable data sets from a myriad of instruments, enables small groups of researchers and students to do their studies cheaply and efficiently, and without having to involve numerous colleagues as single-instrument PIs. Hundreds of peer-reviewed publications and conference papers have resulted from CIRPAS missions, many built on student theses and dissertations. As a result a growing number of scientists sponsored, not only by ONR, but by other DOD and non-DOD agencies, is seeking the facility’s collaboration. The facility measures quantities relevant to meteorological phenomena, quantities of air-sea exchanges, visibility and signal transmittance in the marine boundary layer, aerosol formation and composition, optical properties of aerosol particles, activation of aerosol particles and cloud formation, cloud micro-physical properties, and both solar and terrestrial radiation. However, the facility’s original instrumentation is aging, and is becoming outdated in performance and difficult to maintain. It needs to be renewed. New techniques and instruments have also come on the market in recent years that are useful to many researchers and are simple enough to be operated on a facility level. The purpose of this proposal is to seek funds for renewal of CIRPAS’ meteorological sensors and sat-com system, as well as for enhancement and expansion of its other capabilities. He funds will secure that CIRPAS’ future support of University and Laboratory collaborators will continue to be successful.

NPS/CIRPAS SUPPORT OF THE CALNEX EXPERIMENT IN 2010
Haflidi H. Jonsson, Research Associate
Center for Interdisciplinary Remotely Piloted Aircraft Studies
Sponsor: Pacific Northwest National Laboratory

OBJECTIVE: The objective of this proposal is to obtain funds to bring the CIRPAS Twin Otter with a team of flight operations and scientific personnel to Ontario, CA and participate in the CalNEX project. The plane will carry CIRPAS instrumentation as well as instruments provided by other project participants, and measure meteorological and aerosol properties above and around Los Angeles.

NPS/CIRPAS SUPPORT OF DOE EXPERIMENT CALWATER
Haflidi H. Jonsson, Research Associate
Center for Interdisciplinary Remotely Piloted Aircraft Studies
Sponsor: Pacific Northwest National Laboratory

OBJECTIVE: NPS/CIRPAS support of ONR funded field champagnes.

NPS/CIRPAS SUPPORT OF OFFICE OF NAVAL RESEARCH AIRBORNE RESEARCH OBJECTIVES
Haflidi H. Jonsson, Research Associate
Center for Interdisciplinary Remotely Piloted Aircraft Studies
Sponsor: Office of Naval Research

OBJECTIVE: NPS/CIRPAS support of ONR funded field campaigns.
OBJECTIVE: Long-term continuous characterization of cumulus cloud fields in Oklahoma.
NPS-USSOCOM FIELD
EXPERIMENTATION PROGRAM
FIELD EXPERIMENTATION PROGRAM–USSOCOM

OVERVIEW:

The Naval Postgraduate School Field Experimentation Program began in FY02 with the goal of providing an opportunity for students and faculty to evaluate some of their latest technologies in an operational environment and, when appropriate, to rapidly transition them to the warfighter. Today, the United States Special Operations Command (USSOCOM), the United States Naval Postgraduate School (NPS), and the Biometrics Task Force (BTF) conduct field experiments at multiple locations: Camp Roberts, California; Fort Hunter Liggett, California; Camp Dawson, West Virginia; Camp Atterbury, Indiana; and the ocean/port/riverine area of San Francisco Bay.

The primary objectives of the program are to experimentally explore the viability of new SOF technology concepts as solutions for identified current and future capability gaps; to provide a venue to rapidly assess, develop, counter, and exploit emerging capabilities; to provide and maintain an evolving, flexible, and adaptive plug-and-play infrastructure; and to provide a unique education and research environment for students and faculty at NPS. Secondary objectives include examining dual-use capabilities for homeland security, stabilization, reconstruction, disaster relief/humanitarian assistance, and for other government agencies.

These goals are accomplished by providing a unique field experiment venue in which innovation and collaboration between the Department of Defense, government agencies, industry, and universities are encouraged, and in which SOF operator participation and feedback are utilized. The Camp Roberts/Fort Hunter Liggett/Camp Atterbury/Camp Dawson portion focuses on urban and rural terrain, whereas the San Francisco Bay/European and other maritime locations focus on maritime interdiction operations, port security, and riverine operations. The major emphasis at Camp Roberts and Fort Hunter Liggett is on prerequirements experimentation and rapid response to USSOCOM component command requests. The Camp Atterbury emphasis is on SOF/first responder concepts, training, and evaluations of newly available technologies for near-term utilization. Camp Dawson emphasizes untethered biometrics collection and related communications.

RESEARCH PROGRAM–FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Field Experimentation Program–USSOCOM is provided below:

![Graph showing research program budget](graph.png)

Size of Program: $2.1M
FIELD EXPERIMENTATION PROGRAM- USSOCOM

FIELD EXPERIMENTATION PROGRAM FOR SPECIAL OPERATIONS (FEPSO)
Wolfgang Baer, Research Associate Professor (Information Science)
Raymond Buettner, Associate Professor (Information Science)
Alexander Bordetsky, Associate Professor (Information Science)
Timothy Chung, Assistant Professor (Systems Engineering)
Peter Guest, Research Associate Professor (Meteorology)
Nancy Haegel, Professor (Physics)
Douglas Horner, Research Assistant Professor (Mechanical & Aerospace Engineering)
Mathias Kolsch, Associate Chair of Academic Affairs (Computer Science)
Oleg Yakimenko, Professor (Systems Engineering)

Sponsor: United States Special Operations Command

OBJECTIVE:
- Explore viability of new SOF technology concepts as solutions for identified current and future capability gaps, as well as provide a venue for short fused experimentation requirements.
- Provide unique interdisciplinary graduate education experience for NPS students and research opportunities for NPS faculty in which the latest technologies, concepts of operation, and human systems integration are evaluated for SOF applications in a field environment.

FIELD EXPERIMENTATION PROGRAM FOR SPECIAL OPERATIONS (S&T)
Alexander Bordetsky, Associate Professor (Information Science)
Vladimir Dobrokhodov, Research Assistant Professor (Mechanical & Aerospace Engineering)
Peter Guest, Research Associate Professor (Meteorology)

Sponsor: United States Special Operations Command

OBJECTIVE:
- Explore viability of new SOF technology concepts as solutions for identified current and future capability gaps, as well as provide a venue for short fused experimentation requirements. Identify potential new operational concepts and technological enablers for these concepts.
- Support efforts to provide unique interdisciplinary graduate education experience for NPS students and research opportunities for NPS faculty in which the latest technologies, concepts of operation, and human systems integration are evaluated for SOF applications in the field environment.

CAMP ROBERTS AND PELICAN FOR TNT/CBE VIA ZIVKO CONTRACT
Raymond Buettner, Associate Professor (Information Science)

Sponsor: United States Special Operations Command

OBJECTIVE:
- Support efforts at Camp Roberts, CA to explore viability of new SOF technology concepts as solutions for identified current and future capability gaps, as well as provide a venue for short fused experimentation requirements.
- Support efforts to provide unique interdisciplinary graduate education experience for NPS students and research opportunities for NPS faculty in which the latest technologies, concepts of operation, and human systems integration are evaluated for SOF applications in a field environment.
DEVELOPMENT OF A MULTI-INTUITIONAL SEMI-STRUCTURED LEARNING ENVIRONMENT (MISSLE) TO ENHANCE THE EDUCATION, EXPERIMENTATION AND EQUIPAGE (E3) OF SPECIAL OPERATIONS FORCES

Raymond Buettner, Associate Professor (Information Science)
Field Experimentation Program-USSOCOM
Sponsor: United States Special Operations Command

OBJECTIVE:
- Extend the successful elements of the USSOCOM-NPS Field Experimentation Cooperative and the Masters of Technology Integration degree pilot to an East Coast venue to support efforts to explore viability of new SOF technology concepts as solutions for identified current and future capability gaps, as well as provide an additional venue for short fused experimentation requirements.
- Support efforts to provide unique interdisciplinary graduate education experience for NPS students and research opportunities for NPS faculty in which the latest technologies, concepts of operation, and human systems integration are evaluated for SOF applications in a field environment.

FEPSO HYBRID EDUCATION PILOT

Raymond Buettner, Associate Professor (Information Science)
Field Experimentation Program-USSOCOM
Sponsor: United States Special Operations Command

OBJECTIVE:
- Support efforts to explore viability of new SOF technology concepts as solutions for identified current and future capability gaps, as well as provide a venue for short fused experimentation requirements.
- Support efforts to provide unique interdisciplinary graduate education experience for NPS students and research opportunities for NPS faculty in which the latest technologies, concepts of operation, and human systems integration are evaluated for SOF applications in a field environment.

RELIEF STAR-TIDES COLLABORATION

Raymond Buettner, Associate Professor (Information Science)
Field Experimentation Program-USSOCOM
Sponsor: National Defense University

OBJECTIVE: The Naval Postgraduate School (NPS) will support the National Defense University effort to conduct analyses, assessments, and testing of Sustainable Technologies, Accelerated Research-Transformative Innovation for Development and Emergency Support (STAR-TIDES) technologies for potential application in theater as part of NPS RELIEF project.

FIELD EXPERIMENTATION PROGRAM FOR SPECIAL OPERATIONS (FUTURES)

Raymond Buettner, Associate Professor (Information Science)
Field Experimentation Program-USSOCOM
Sponsor: United States Special Operations Command

OBJECTIVE:
- Explore viability of new SOF technology concepts as solutions for identified current and future capability gaps, as well as provide a venue for short fused experimentation requirements. Identify potential new operational concepts and technological enablers for these concepts.
- Support efforts to provide unique interdisciplinary graduate education experience for NPS students and research opportunities for NPS faculty in which the latest technologies, concepts of operation, and human
OBJECTIVE:
• Support efforts to explore viability of new SOF technology concepts as solutions for identified current and future capability gaps, as well as provide a venue for short fused experimentation requirements.
• Support efforts to provide unique interdisciplinary graduate education experience for NPS students and research opportunities for NPS faculty in which the latest technologies, concepts of operation, and human systems integration are evaluated for SOF applications in a field environment.
NATIONAL SECURITY INSTITUTE

DAN C. BOGER
EXECUTIVE DIRECTOR
OVERVIEW:

The National Security Institute (NSI) is a partnership of three entities – the Naval Postgraduate School, the University of California at Santa Barbara, and the Lawrence Livermore National Laboratory – each recognizing that the new era of research and development will require the complete engagement of talent from academia, national laboratories, and the private sector.

Under NSI, a superior class of joint research programs is being created from the combination of intellectual and technological capabilities of these three institutions. New and innovative research programs will create unparalleled opportunities and will attract the best M.S. and Ph.D. students and post-doctoral fellows – all focused within the critical skills areas identified by the Departments of Defense, Energy, and Homeland Security. These activities will lead many of these graduate students and post-doctoral fellows into careers that support national security science and technology in national laboratories or defense and security industries.

MISSION:

The mission of the National Security Institute is to combine the scholarship and expertise of top scientific institutions in service to national, homeland, and global security, while engaging the next generation of graduate students in vital defense and homeland security research and development, field experimentation, and interdisciplinary student research.

PARTNERS:

The Naval Postgraduate School (NPS) is an academic institution whose emphasis is on study and research programs relevant to the Navy’s interests, as well as to the interests of other arms of the Department of Defense. The programs are designed to accommodate the unique requirements of the military.

The Lawrence Livermore National Laboratory (LLNL) is one of the nation’s foremost applied-science and engineering laboratories. LLNL’s defining responsibility is national security, with missions that include stockpile stewardship, nonproliferation, and multidisciplinary research to enhance national security.

The University of California at Santa Barbara (UCSB) houses eight national centers and institutes, with a top-twenty engineering school, five Nobel laureates, and substantial federal funding in critical research.
The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the National Security Institute is provided below:

**Size of Program: $4.8M**

- **Army**: $331K
- **DHS**: $262K
- **Joint**: $2.5M
- **Other-Fed**: $723K
- **Navy**: $968K
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ed Lesnowicz</td>
<td>Associate Director–Research</td>
<td>831-656-2599</td>
<td><a href="mailto:eilesnow@nps.edu">eilesnow@nps.edu</a></td>
</tr>
<tr>
<td>Jomana Amara</td>
<td>Assistant Professor</td>
<td>831-656-3591</td>
<td><a href="mailto:jhamara@nps.edu">jhamara@nps.edu</a></td>
</tr>
<tr>
<td>Alexander Bordetsky</td>
<td>Associate Professor</td>
<td>831-656-2287</td>
<td><a href="mailto:abordets@nps.edu">abordets@nps.edu</a></td>
</tr>
<tr>
<td>Gordon H. Bradley</td>
<td>Professor</td>
<td>831-656-2359</td>
<td><a href="mailto:gbradley@nps.edu">gbradley@nps.edu</a></td>
</tr>
<tr>
<td>Raymond Buettner</td>
<td>Associate Professor</td>
<td>831-656-3387</td>
<td><a href="mailto:rrbuettner@nps.edu">rrbuettner@nps.edu</a></td>
</tr>
<tr>
<td>Constance Chang-Hasnain</td>
<td>Research Professor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Security Science &amp; Engineering Faculty Fellowship (NSSEFF)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michael Chapman</td>
<td>Research Professor</td>
<td>831-656-3254</td>
<td></td>
</tr>
<tr>
<td>Walter Christman</td>
<td>Associate Professor</td>
<td>831-656-3190</td>
<td></td>
</tr>
<tr>
<td>John Powers</td>
<td>Associate Director–Education</td>
<td>831-656-2679</td>
<td><a href="mailto:jpowers@nps.edu">jpowers@nps.edu</a></td>
</tr>
<tr>
<td>Peter C. Chu</td>
<td>Professor</td>
<td>831-656-3688</td>
<td><a href="mailto:pccchu@nps.edu">pccchu@nps.edu</a></td>
</tr>
<tr>
<td>William Fox</td>
<td>Professor</td>
<td>831-656-3753</td>
<td><a href="mailto:wpfox@nps.edu">wpfox@nps.edu</a></td>
</tr>
<tr>
<td>Simson Garfinkel</td>
<td>Associate Professor</td>
<td>831-656-7602</td>
<td><a href="mailto:slgarfin@nps.edu">slgarfin@nps.edu</a></td>
</tr>
<tr>
<td>Heather S. Gregg</td>
<td>Assistant Professor</td>
<td>831-656-3689</td>
<td><a href="mailto:hsgregg@nps.edu">hsgregg@nps.edu</a></td>
</tr>
<tr>
<td>Diana Huffaker</td>
<td>Research Professor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Security Science &amp; Engineering Faculty Fellowship (NSSEFF)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>David C. Jenn</td>
<td>Professor</td>
<td>831-656-2254</td>
<td><a href="mailto:jenn@nps.edu">jenn@nps.edu</a></td>
</tr>
<tr>
<td>Thomas Johnson</td>
<td>Research Associate Professor</td>
<td>831-656-3190</td>
<td><a href="mailto:thjohnson@nps.edu">thjohnson@nps.edu</a></td>
</tr>
<tr>
<td>Magdi N. Kamel</td>
<td>Associate Professor</td>
<td>831-656-2494</td>
<td><a href="mailto:mkamel@nps.edu">mkamel@nps.edu</a></td>
</tr>
<tr>
<td>Jeffrey E. Kline</td>
<td>Senior Lecturer</td>
<td>831-656-7946</td>
<td><a href="mailto:jekline@nps.edu">jekline@nps.edu</a></td>
</tr>
<tr>
<td>Mathias N. Kolsch</td>
<td>Assistant Professor</td>
<td>831-656-3402</td>
<td><a href="mailto:kolsch@nps.edu">kolsch@nps.edu</a></td>
</tr>
<tr>
<td>Kyle Y. Lin</td>
<td>Associate Professor</td>
<td>831-656-2648</td>
<td><a href="mailto:kylin@nps.edu">kylin@nps.edu</a></td>
</tr>
<tr>
<td>Thomas W. Lucas</td>
<td>Associate Professor</td>
<td>831-656-3039</td>
<td><a href="mailto:twlucas@nps.edu">twlucas@nps.edu</a></td>
</tr>
<tr>
<td>Stephen Mayo</td>
<td>Research Professor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Security Science &amp; Engineering Faculty Fellowship (NSSEFF)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>James Bret Michael</td>
<td>Professor</td>
<td>831-656-2655</td>
<td>b <a href="mailto:michael@nps.edu">michael@nps.edu</a></td>
</tr>
<tr>
<td>Ed Lesnowicz</td>
<td>Associate Director–Research</td>
<td>831-656-2599</td>
<td><a href="mailto:eilesnow@nps.edu">eilesnow@nps.edu</a></td>
</tr>
<tr>
<td>Jomana Amara</td>
<td>Assistant Professor</td>
<td>831-656-3591</td>
<td><a href="mailto:jhamara@nps.edu">jhamara@nps.edu</a></td>
</tr>
<tr>
<td>Alexander Bordetsky</td>
<td>Associate Professor</td>
<td>831-656-2287</td>
<td><a href="mailto:abordets@nps.edu">abordets@nps.edu</a></td>
</tr>
<tr>
<td>Gordon H. Bradley</td>
<td>Professor</td>
<td>831-656-2359</td>
<td><a href="mailto:gbradley@nps.edu">gbradley@nps.edu</a></td>
</tr>
<tr>
<td>Raymond Buettner</td>
<td>Associate Professor</td>
<td>831-656-3387</td>
<td><a href="mailto:rrbuettner@nps.edu">rrbuettner@nps.edu</a></td>
</tr>
<tr>
<td>Constance Chang-Hasnain</td>
<td>Research Professor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Security Science &amp; Engineering Faculty Fellowship (NSSEFF)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michael Chapman</td>
<td>Research Professor</td>
<td>831-656-3254</td>
<td></td>
</tr>
<tr>
<td>Walter Christman</td>
<td>Associate Professor</td>
<td>831-656-3190</td>
<td></td>
</tr>
</tbody>
</table>
Chad Mirkin  
Research Professor  
National Security Science & Engineering Faculty Fellowship (NSSEFF)

Margaret Murnane  
Research Professor  
National Security Science & Engineering Faculty Fellowship (NSSEFF)

Daniel A. Nussbaum  
Visiting Professor  
831-656-2387  
dnussbaum@nps.edu

R. Chris Olsen  
Professor  
Department of Physics  
831-656-2019  
olsen@nps.edu

Phillip E. Pace  
Professor  
Department of Electrical and Computer Engineering  
831-656-3286  
pace@nps.edu

Eugene Paulo  
Associate Professor  
Department of Systems Engineering  
831-656-3452  
epaulo@nps.edu

Carey Priebe  
Research Professor  
National Security Science & Engineering Faculty Fellowship (NSSEFF)

Susan M. Sanchez  
Professor  
Department of Operations Research  
831-656-2780  
ssanchez@nps.edu

Barbara Shinn-Cunningham  
Research Professor  
National Security Science & Engineering Faculty Fellowship (NSSEFF)

Susan Trolir-McKinstry  
Research Professor  
National Security Science & Engineering Faculty Fellowship (NSSEFF)

Lyn Whitaker  
Associate Professor  
Department of Operations Research  
831-656-3482  
lwhitaker@nps.edu

R. Kevin Wood  
Professor  
Department of Operations Research  
831-656-2523  
kwood@nps.edu
NATIONAL SECURITY INSTITUTE

NPS PROGRAM SUPPORT TO THE STAFF OF THE SECRETARY OF THE NAVY
Daniel C. Boger, Director (Information Science)
National Security Institute
Sponsor: Operations Integration Group

OBJECTIVE: This proposal provides personnel for the support of science, technology, and research recommendations to the staff of the Secretary of the Navy for optimizing ongoing classified program support.

RADIO FREQUENCY IDENTIFICATION TO SUPPORT JWAC
Daniel C. Boger, Director (Information Science)
National Security Institute
Sponsor: Navy Engineering Logistics Office

OBJECTIVE: FY10 RDT&E N Funds in amount of $50,000 are provided for Radio Frequency Identification to supply GWAC Statement of work classified at SECRET level.

COMMAND AND CONTROL TECHNOLOGY INTEGRATION FOR A COMMON TACTICAL PICTURE BY THE SALINAS, CALIFORNIA POLICE DEPARTMENT
Shelley P. Gallup, Research Associate Professor (Information Science)
National Security Institute
Sponsor: Department of Homeland Security

OBJECTIVE: The Department of Information Science, Naval Postgraduate School (hereafter. “Principal Investigator” or “NPS”) shall focus on using and transferring knowledge gained in past use of technologies and procedures to create a Common Tactical Picture, for the benefit of the Salinas Police Department (SPD). This development is intended to be performed in phases, leaning most heavily on NPS military oriented technology at first, then shifting to a CTP developed with resources expected to be available to the police department, or that can be procured in the future.

TRIDENT WARRIOR 2010 EXPERIMENTATION (FLEET SUPPORT)
Shelley P. Gallup, Research Associate Professor (Information Science)
National Security Institute
Sponsors: NETWARCOM / Fleet Forces Command / SPAWAR Systems Center – San Diego

OBJECTIVE: Field experimentation for Fleet enabling technologies.

SUMMARY: Research methodology development including objectives, questions, measurements, and analysis framework for over 60 technologies. Included test sequence oversight, data collection, and analysis/reporting.

KEYWORDS: Fleet experimentation, knowledge management, experimentation management.
ACHIEVING INTEROPERABILITY IN HOMELAND SECURITY COMMUNICATIONS AND OPERATIONS: A “MODEL COUNTY” FIELD TEST

Thomas J. Housel, Professor (Information Science)
National Security Institute
Sponsor: U.S. Department of Homeland Security

OBJECTIVE: The focus on the study will be to examine various networking information systems interoperability problems in combination with various methods for information sharing in a “model county” field test context. In the model county scenario, we will be able to examine a variety of planning issues that guide responders in daily and emergency contexts.

CA HOMELAND SECURITY CONSORTIUM
Charles Kimzey, Director
National Security Institute
Sponsor: Department of Homeland Security

OBJECTIVE: A Memorandum of Agreement (MOA) was entered into by and between the Department of Homeland Security (DHS) Science and Technology Directorate (S&T) and the Naval Postgraduate School (NPS) to conduct research, develop, test and evaluate technology to enable the DHS component agencies and their customers, the local and state first responder communities, to carry out their missions. The collaboration established through the MOA allows S&T to leverage NPS’s in-house research capabilities and those associated with NPS’s partners in the state of California.

SUMMARY: The California Homeland Security Consortium (CHSC) was reconstituted to represent the Central California emergency response community by utilizing the CHSC Advisory Board members to set priorities and evaluate progress of S&T’s High Priority Technology Needs (HPTNs). The CHSC Advisory Board worked to identify and evaluate potential research projects that could be relevant to S&T’s mission and to the Monterey County first responder community. Research projects were vetted and awarded funds for research activity in the 2011 calendar year. The projects that will be awarded funding in March 2011 are focused on interagency communications, persistent surveillance tracking and tagging, independently powered communications and social networking data collection and analysis.

REIMBURSABLE DETAIL OF MILT NENNEMAN
Charles Kimzey, Director
National Security Institute
Sponsor: Dept. of Homeland Security

OBJECTIVE: The Department of Homeland Security (DHS), Science and Technology (S&T) and the Naval Postgraduate School (NPS) entered into a Memorandum of Agreement to employee Milt Nenneman to coordinate and investigate projects in the general field of technology transition that relate to homeland security priorities. He is responsible for reviewing policy-related homeland security issues for current and emerging technology topics that are applicable to the California Homeland Security Consortium matters.

SUMMARY: Mr. Nenneman is serving as a First Responder Liaison. As such, he is serving as a subject matter expert on first responder technical requirements to enhance the division’s and directorate’s depth of knowledge for enhancing the safety and security of our nation’s first responders. Mr. Nenneman attends and participates in First Responder related conferences and meetings seeking opportunities to promote technical outreach to the community and soliciting feedback on technical requirements. In this capacity, Mr. Nenneman represents the division, and in some cases, the directorate, requiring sound tact and professional judgment in all matters. Mr. Nenneman provides feedback on such requirements to the division and directorate leadership, as appropriate.
SENSOR SYSTEMS FOR PROPULSION SAFETY, AFFORDABILITY AND READINESS

Charles Kimzey, Director
Richard C. Millar, Associate Professor (System Engineering)
National Security Institute
Sponsor: Office of Naval Research

OBJECTIVE: Propulsion Safety, Affordability and Readiness (PSAR) encompasses needs for more cost effective and suitable sensor systems in all three types of sensor application: T&E instrumentation, and operational health management and systems control. Preliminary systems engineering study has identified requirements that are common to all three applications, but with varying impact and priority. Sensor precision, repeatability, durability and compatibility with the environment and components to which it is applied are usually addressed in sensor S&T. The proposed research intends to integrate these needs with overall sensor system issues: total instrumentation/sensor system acquisition and life cycle cost, suitability to the T&E process and in-service operation including sustainment, faster and less costly change to address unanticipated instrumentation/sensor requirements, and the desire for open-system interfaces to facilitate timely and cost effective incorporation of sensor technology advances.

The proposed effort will refine and formalize this initial systems engineering assessment in consultation with the US Navy, DoD and industry propulsion community to define requirements with quantitative measures, use these to identify and assess potential technological.

NAVAL POSTGRADUATE SCHOOL SUPPORT TO JOINT IED DEFEAT TEST BOARD (JTB)

Charles Kimzey, Director
Edward Lesnowicz, Jr., Research Associate
National Security Institute
Sponsor: NSWC Dahlgren Division

OBJECTIVE: The activities of the JTB in the effort to evaluate technologies and procedures to defeat IEDs produces significant testing, data analysis, modeling and simulations (M&S) and equipment development challenges. The purpose of this agreement is to develop a collaboration with the Naval Postgraduate School (NPS) to leverage the educational and research capabilities of NPS in support of the JTB.

NPS ACADEMIC SUPPORT TO JOINT IED DEFEAT ORGANIZATION

Charles Kimzey, Director
Alejandro Hernandez, Associate Professor
John W. Van Hise, Research Associate
National Security Institute
Sponsor: NSWC Dahlgren Division

OBJECTIVE: NPS will provide to enhance and bridge capability gaps in the Joint IED Defeat Organization’s (JIEDDO) research and development efforts. It further outlines anticipated deliverables and resources from the Naval Postgraduate School (NPS) that fulfill the requirements corresponding to this expanded support. The period of performance for this effort is March 30, 2008 - March 30, 2010.

For this performance period, the Naval Postgraduate School (NPS) will provide the support outlined in the tasks below. The NPS Principal Investigator (PI) will coordinate directly with the JIEDDO Operations Research (ORSA) Division Chief and Technical Gaming Team (TGT) Branch Chief (or designated representatives) to ensure that research activities and analyses are appropriate, relevant and timely. In addition, the NPS PI will designate a study lead for each internal study related to the execution of these tasks and supporting research. The result should be a
NATIONAL SECURITY INSTITUTE

set of recommendations for investment, fielding, and application of future systems and procedures closely aligned to JIEDDO’s present and future strategic objectives. The primary emphasis will be on analyzing the IED network and applying a cross-disciplinary approach to determine which key nodes and arcs of the network may be influenced. This research includes, but is not limited to, modeling and simulation, operations research, systems engineering, and business analysis, which become deliverables to JIEDDO. NPS will use JIEDDO approved operations scenarios, as well as data and intelligence derived from actual incidents to perform these studies. NPS will use qualitative and quantitative methodologies that are transferable to JIEDDO.

NPS SUPPORT TO OSD COUNTER-NARCOTICS/COUNTERTERRORISM OFFICE

Charles Kimzey, Director
Edward Lesnowicz, Jr., Research Associate
National Security Institute
Sponsor: NSWC Dahlgren Division

OBJECTIVE: The objective of this proposal is for NPS to provide continued support to the Office of the Secretary of Defense (OSD) in the office of the Deputy Assistant Secretary for Defense of Counter-Narcotics, Counterterrorism, and Counter-proliferation. Specific guidance on counter-narcotics intelligence, technology gaps, policy or procedural changes, analysis formation, and budget responsibilities are encompassed in this proposal.

MARITIME INFORMATION SHARING TASKFORCE (MIST) NEW YORK/NEW JERSEY

Jeffery E. Kline, Senior Lecturer
National Security Institute
Sponsor: Global Maritime and Air Intelligence Integration (GMAII)

OBJECTIVE: The Maritime Information Sharing Taskforce (MIST) is a two-way process for understanding and communicating the needs of local private sector communities when sharing maritime security information. The proposal will partially fund our MIST New York/New Jersey effort, in combination with funds already pledged by the Department of Transportation’s Maritime Administration (DOT-MARAD). The MIST New York/New Jersey process is scheduled to begin in June 2010, and culminate in a report to be released by the end of October 2010.

COUNTERING THE IED THREAT: CAPABILITIES TO SUPPORT ASSESSMENT OF STRATEGIES, SYSTEMS, AND EMPLOYMENT OPTIONS THROUGH COMPUTATIONAL EXPERIMENTS

Thomas W. Lucas, Associate Professor (Operations Research)
Susan M. Sanchez, Professor (Operations Research)
National Security Institute
Sponsor: J9 Joint Improvised Explosive Device Defeat Organization (JIEDDO)

OBJECTIVE: Provide direct support to the JIEDDO J9 staff, including a person on-site, by improving the ability to rapidly build or extend models and scenarios, conduct computational experiments (through better design of experiments), and analyze/synthesize the output from multiple experimental tools.

SUMMARY: The SEED Center for Data Farming continued ongoing support to JIEDDO in the counter improvised explosive device (C-IED) fight. An analyst located on-site gave direct staff support in helping JIEDDO with data architecture, metric definition, remote sensing and graphical information systems, modeling and simulation methods, analysis, and visualization to aid specific and ongoing efforts. The SEED Center also organized two workshops in which teams of subject matter experts, modelers, and analysts examined cultural geography models. Direct analytical support included participation in route clearing studies, exploring a social network model of Helmand province,
and augmenting field experiments at Camp Roberts and Yuma Proving Grounds with simulation. Methodological advances to support the simulation studies were made by developing and applying algorithms to better handle large numbers of discrete and/or categorical factors in experimental designs and new sequential procedures.

PUBLICATIONS:


PRESENTATIONS:


THESES DIRECTED:


KEYWORDS: Improvised explosive devices, data analysis, design of experiments, simulation, social network modeling.

IMPROVING THE INTEGRATED TRAINING CENTER MODEL FOR USABILITY TO ENABLE ACCURATE TIME TO TRAIN MODELING

Thomas W. Lucas, Associate Professor (Operations Research)
Susan M. Sanchez, Professor (Operations Research)
National Security Institute
Sponsor: MCCDC Operations Analysis Division

OBJECTIVE: The MCCDC Operations Analysis Division (OAD) is supporting the F-35 community in determining resource requirements for pilot training. A critical component of this is the Integrated Training Center (ITC) Model developed by Mr. Paul Kenny of Spyglass. Both the aircraft developer (Lockheed Martin) and the Joint Program Office use this model to determine class flows and time to train (TTT). However, initial tests based on comparisons to the well established F-16B’s training requirements have raised the concern that the ITC model is producing overly optimistic estimates of TTT. The SEED Center will team with OAD, the model developers, pilots, and the F-35 training community to do a careful review of the ITC model. Furthermore, based on the findings of the review, a series of experiments will be done to identify sets of input parameters that produce accurate TTT predictions.
MULTI-SOURCE INTELLIGENCE DATA INTEGRATION AND ASSIMILATION
Richard C. Olsen, Professor (Physics)
National Security Institute
Sponsor: National Geospatial-Intelligence Agency

OBJECTIVE: The proposed effort is in support of the National Geospatial-Intelligence Agency in the area of multi-source intelligence.

REMOTE SENSING TECHNIQUES FOR IMPROVED EARTHQUAKE WARNING, MONITORING, AND RESPONSE
Richard C. Olsen, Professor (Physics)
National Security Institute
Sponsor: Department of Homeland Security, Science and Technology Directorate

OBJECTIVE: This project helps DHS understand new and emerging remote sensing technologies that will enable states such as California to better prepare for and respond to earthquakes. The intent of this project is to define, demonstrate, and incorporate improved technology and methods, by drawing on expertise at the Naval Postgraduate School (NPS) and in the surrounding communities to enhance the capability of and work in partnership with state and local agencies on the Monterey Peninsula and other areas of California. New technologies and methods determined to be of value in improving preparation for and response to earthquake events in this region of California will be communicated to other state and local governments by DHS to improve the nation’s ability to prepare for this hazard.

This project has three distinct phases: (1) technologies and methods identification workshop, (2) test and evaluation pilot project and report and (3) support for transition/generalization to other areas of California and the U.S. Each phase builds content that supports the execution of the next phase. This is a continuing project with a start date of 1 September 2010 and an end date of 31 December, 2012.

SUMMARY: For the period of time from September 2010 to March 2011 the following work related to this project was accomplished. A workshop exploring the use of remote sensing technologies for improved earthquake warning, monitoring, and response was conducted on 25 – 27 January 2011 under the auspices of the Department of Homeland Security, Science and Technology Directorate (DHS S&T) and the Naval Postgraduate School Remote Sensing Center (NPS RSC). The workshop brought first responders, emergency management personnel and experts on earthquakes and the use of remote sensing technology together to discuss the current state-of-the-art with respect to earthquake forecasting, prediction, warning, and post-disaster response, and the role that remote sensing technology could play in improving capabilities. First responders and emergency management professionals from the cities of Monterey; and San Diego, Los Angeles, and Riverside Counties; and the California Emergency Management Agency (CalEMA) participated. Also attending were representatives of the Pacific Disaster Warning Center/NOAA, the Federal Emergency Management Agency (FEMA), and the U.S. Geological Survey’s Earthquake Hazards Reduction Program. Remote sensing and GIS scientists from NPS and other universities, DHS S&T, private industry, and several NASA centers provided extensive practical experience on the use of a variety of remote sensing data and analysis approaches. From the information gathered at this workshop, a report has been drafted and is currently in review by the sponsor. The next phase of the project will be determined and planned based on the final workshop report and follow-on discussions with First Responders.
OBJECTIVE: In years two and three (FY10/FY11) of this project’s continued effort, the principle investigator (PI) will team with ONR, other DoD organizations, appropriate industry representatives, and faculty and student-officers at NPS to support the comprehensive systems engineering effort. Based on the previous work regarding the systems design of the Sea base Enabler focused on two broad operational concepts, the primary effort for FY2010-FY2011 is to develop and utilize a robust modeling and simulation (M&S) capability to examine various T-Craft operational and performance requirements, while other research addresses a “fleet” architecture of T-Craft mixed with other transport platforms, as well as an in-depth life-cycle cost analysis of the T-Craft.


CENTER FOR ASYMMETRIC WARFARE

ALAN JAEGER
DIRECTOR
OVERVIEW:

The Center for Asymmetric Warfare (CAW) is a Federal Government operational research and field experimentation center with over 12 years of experience in providing comprehensive education, training, and exercise programs; technology integration, test, and evaluation programs; and capability assessment and improvement programs to partners on a global scale. These programs include participation by Department of Defense; local, state, and federal government agencies; private sector and non-governmental organizations; academia; and international government agencies.

CAW’s mission is to increase the safety and security of the United States and its strategic allies through focused training and experimentation, in addition to tactical, operational, and strategic-level exercise and assessment programs. These proven programs allow organizations to effectively share intelligence and operational information; communicate and coordinate with subordinate, adjacent, and supported organizations; perform deliberate or crisis planning in response to a threat; and successfully execute response and recovery operations.

CAW joined the Naval Postgraduate School in 2008 as a satellite division, located at Point Mugu, California, and is aligned under the National Security Institute. CAW has the flexibility to operate across the four institutes and four schools that make up NPS and to capitalize on the expertise of many distinguished alumni, faculty, and students.

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. A profile of the research program for the Center for Asymmetric Warfare is provided below:
# CENTER FOR ASYMMETRIC WARFARE

Alan Jaeger  
Director  
ajaeger@nps.edu

Joyce Borgen  
Deputy Director  
805-989-5218  
jborgen@nps.edu

<table>
<thead>
<tr>
<th>Brendan Applegate</th>
<th>Carol Evans</th>
<th>Craig Powell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navy Programs</td>
<td>East Coast Regional Manager</td>
<td>Special Projects Program Manager</td>
</tr>
<tr>
<td><a href="mailto:bjapleg@nps.edu">bjapleg@nps.edu</a></td>
<td><a href="mailto:cvevans@nps.edu">cvevans@nps.edu</a></td>
<td><a href="mailto:cpowell@nps.edu">cpowell@nps.edu</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scott Brewer</th>
<th>Eydie Herrera</th>
<th>Maria Reynoso</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Exercise Manager</td>
<td>Executive Assistant</td>
<td>Administrative Assistant</td>
</tr>
<tr>
<td><a href="mailto:ssbrewer@nps.edu">ssbrewer@nps.edu</a></td>
<td><a href="mailto:eherrera@nps.edu">eherrera@nps.edu</a></td>
<td><a href="mailto:mjreynos@nps.edu">mjreynos@nps.edu</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maryann Calleja</th>
<th>Jay Huston</th>
<th>Josh Stolsig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>Program Manager, Battelle</td>
<td>IT Support</td>
</tr>
<tr>
<td><a href="mailto:maryann.calleja@us.army.mil">maryann.calleja@us.army.mil</a></td>
<td><a href="mailto:jhuston@nps.edu">jhuston@nps.edu</a></td>
<td><a href="mailto:jstolsig@nps.edu">jstolsig@nps.edu</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tom Coyle</th>
<th>Ron Kimmelmann</th>
<th>Jeannie Taylor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Exercise Manager</td>
<td>IT Manager</td>
<td>Navy Programs</td>
</tr>
<tr>
<td><a href="mailto:thomas.coylejr@us.army.mil">thomas.coylejr@us.army.mil</a></td>
<td><a href="mailto:rkimmelmann@nps.edu">rkimmelmann@nps.edu</a></td>
<td><a href="mailto:jmtaylor@nps.edu">jmtaylor@nps.edu</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ian Pinkham</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacific Program Manager</td>
<td></td>
</tr>
<tr>
<td><a href="mailto:ipinkham@nps.edu">ipinkham@nps.edu</a></td>
<td></td>
</tr>
</tbody>
</table>
OBJECTIVE: Develop and conduct a program to define and demonstrate practicality of unmanned technologies in support of real-time, wild land firefighting decision-making and define the metrics necessary to integrate unmanned systems into the fire management operations.

SUMMARY: The Center for Asymmetric Warfare (CAW) developed and conducted a workshop (TTX) and field level demonstration designed to evaluate various Unmanned systems (air and ground) in wildland fire fighting applications. In addition, specific metrics defining the need for continued research and better understanding of the integration of unmanned aerial systems (UAS) and unmanned ground systems (UGS) into the fire-fighting environment was developed.

CNIC TRAINING AND EXERCISE DEVELOPMENT AND ASSESSMENT

OBJECTIVE: Develop, conduct and assess training for Commander Navy Installations Command (CNIC).

SUMMARY: In 2010 The Center for Asymmetric Warfare (CAW) supported CNIC’s intent to continue “operationalization” of the Navy’s shore infrastructure by supporting the training and exercise activities of the CNIC Shore Support Center, Shore Training Center, and Regional Operations Centers in the United States and around the world. The efforts included development and integration of the classroom training of Regional Operations Centers and installation Emergency Operations Centers into exercises which included a diverse array of realistic threat scenarios, modeling and simulation, and coordination of response and recovery efforts with military and civil authorities.

Conducted 2010 exercises summaries are as follows:

Solid Curtain/Citadel Shield 2010

Solid Curtain/Citadel Shield is the annual capstone anti-terrorism event in the Navy Warfare Training System. It is the integrated training event by which United States Fleet Forces (USFF) and CNIC exercise and assess Navy anti-terrorism command, control, and communications capabilities and evaluate the readiness and effectiveness of each Numbered Fleet and Region anti-terrorism program throughout the US Northern Command Area of Responsibility. Solid Curtain/Citadel Shield exercises and assesses anti-terrorism policies and procedures in a simulated heightened threat environment to identify gaps and seams at the operational level (Solid Curtain) and tactical level (Citadel Shield).

For the Solid Curtain/Citadel Shield 2010 exercise, CAW supported the Exercise Planning Team with the development of the overarching scenario, including supporting intelligence vignettes; development of anti-terrorism and force protection drills, field training exercises, and recovery workshops; development of simulated media broadcasts to provide realism and situational awareness of the exercise scenario to exercise participants; and development of all exercise documentation.
HURREX/Citadel Gale 2010

HURREX/Citadel Gale is the annual USFF and CNIC hurricane preparedness exercise for all Gulf of Mexico, Caribbean, and East Coast commands. It is the integrated training event by which USFF and CNIC exercise and assess the Echelon II All Hazards Plan and test the operational capabilities of Echelon III and IV participants in response to a severe weather event.

For the HURREX/Citadel Gale 2010 exercise, CAW supported the Exercise Planning Team with the development of the overarching scenario, including supporting weather vignettes; development of emergency preparedness and emergency management drills, field training exercises, and recovery workshops; development of simulated media broadcasts to provide realism and situational awareness of the exercise scenario to exercise participants; and development of all exercise documentation.

Citadel Rumble 2010

Citadel Rumble is the annual all-hazards response and recovery for shore forces not affected by the threat of hurricanes. It is the West Coast and Midwest equivalent of HURREX/Citadel Gale and the integrated training event by which USFF and CNIC assess the Echelon II All Hazards Plan and test the operational capabilities of Echelon III and IV participants in response to a no-notice all-hazards event. For HURREX/Citadel Gale 2010, the scenarios involved earthquake and wildfire incidents.

For the HURREX/Citadel Gale 2010 exercise, CAW supported the Exercise Planning Team with the development of the overarching scenario, including supporting wildfire and earthquake vignettes; development of emergency preparedness and emergency management drills, field training exercises, and recovery workshops; development of simulated media broadcasts to provide realism and situational awareness of the exercise scenario to exercise participants; and development of all exercise documentation.

Crisis Action Planning Training

CNIC has established policy and planning guidance under the Shore Response Plan to align and standardize command, control, and communications across the Navy shore enterprise. As part of an ongoing effort to ensure that each Region is certified at a standard operational capability, CNIC conducts Regional Operations Center (ROC) Operations and Crisis Action Planning (CAP) training courses on an annual basis.

For the ROC Operations and CAP training courses, CAW supports the CNIC Training and Readiness Directorate with development and maintenance of the course of instruction, including all documentation and printed planning aids; and development of region-focused practical application exercise activities to reinforce seminar-based training.

In 2010, CAW supported ROC Operations and CAP training courses for the following Regions:

- Commander, Naval Forces Japan in January 2010
- Commander, Naval District Washington, Reserve Unit in January 2010
- Commander, Joint Region Marianas in June 2010
- Commander, Navy Region Hawaii in August 2010
- Commander, Navy Region Southwest in August 2010
- Commander, Navy Region Midwest in September 2010

Liberty Champion

The Liberty Champion exercise series is the means by which CNIC is able to certify that a ROC has achieved or maintained a standard operational capability. The Liberty Champion exercises provide opportunities for the ROC staff to reinforce the ROC Operations and CAP training objectives and perform operational level planning in response to a simulated disaster, including the activities associated with watch turnovers and development of higher headquarters briefing deliverables.

For the Liberty Champion exercise series, CAW supports the CNIC Training and Readiness Directorate with development and execution of a custom-tailored exercise scenario consistent with a likely regional threat. This
includes development of the Master Scenario Events List, exercise injects, and operation of a White Cell to simulate outside agencies during the conduct of the exercise.

In 2010, CAW conducted Liberty Champion exercises for the following Regions:
- Commander, Naval Forces Japan in January 2010
- Commander, Joint Region Marianas in June 2010
- Commander, Navy Region Hawaii in August 2010

**FY10 COLLABORATIVE ASSISTANCE AND RAPID TEAM OPTIMIZATION SYSTEM (CARTOS)**

Alan Jaeger, Research Associate
Joyce Borgen, Research Associate
Brendan Applegate, Research Associate
Ron Kimmelmann, Research Associate
Center for Asymmetric Warfare

Sponsor: Aptima Inc. and Perceptronics Solutions Inc.

**OBJECTIVE:** The program objectives were to research, evaluate and demonstrate the initial Collaborative Assistance and Rapid Team Optimization System (CARTOS). The tasks focused on analyzing the capabilities to organize teams into solving specific problems, sharing knowledge among emergency response teams, identification of current capabilities for problem solving and provide feedback for areas of improvement.

**SUMMARY:** The Center for Asymmetric Warfare (CAW) collaboratively evaluated the prototype tool in a dynamic military or military like organization, in a mix with multi-agency emergency managers. The value of autonomously capturing relative dynamic interaction information and converting this information into a real-time planning and problems solving in a complex environment was demonstrated.

**FY10 DEFENSE COORDINATING OFFICER/DEFENSE COORDINATING ELEMENT**

Alan Jaeger, Research Associate
Joyce Borgen, Research Associate
Brendan Applegate, Research Associate
Ron Kimmelmann, Research Associate
Center for Asymmetric Warfare

Sponsor: US ARMY 196th Infantry Brigade

**OBJECTIVE:** Design, develop and conduct a DCO/DCE certification exercise for the 196th Infantry Training Brigade. Providing scenarios (MSELS), Injects, Modeling, Script, White Cell, provide coordination and controller staff (Lead, Core, SME’s and Trainers), as well as manage partners and participants in the development and delivery of the certification exercise.

**SUMMARY:** The Center for Asymmetric Warfare (CAW) developed and conducted a DCO/DCE Certification Exercise for the 196th Infantry Training Brigade. CAW produced a realistic Category III Hurricane scenario (including MSELS, Injects. Modeling, Script, White Cell, presentation and guides), managed partners and participants, developed and delivered the Certification Exercise with internal controllers, subject matter experts and trainers. Final outcome was a certified DCO/DCE.
OBJECTIVE: Collaborate in an effort to determine the requirements for the development, design, planning, preparation, analysis and continuous process improvements of a Pacific based Regional Homeland Security Center.

SUMMARY: The Center for Asymmetric Warfare (CAW) provided subject matter experts (SMEs), in the area of disaster management and homeland security, researched and evaluated current capabilities and provided recommendations to improve current tools, hardware and software used in developing situational awareness, communication and command/control for regional homeland security and emergency management capabilities.

FY10 OPERATION GOLDEN PHOENIX TRAINING AND EXERCISE DEVELOPMENT

OBJECTIVE: This primary objective was to evaluate interoperable devices and systems related to CBRNE information/data to improve information sharing and collaboration between first responder and public safety personnel at the local, State, and federal levels

SUMMARY: The Center for Asymmetric Warfare (CAW) in partnership with DHS S&T and the cities and agencies within the Los Angeles Operational Area (LAOA) developed and conducted combined exercise and training events for over 120 agencies (included Public Health, Emergency Management and Response agencies, DOD and Private Sector) focused around the response and management of a detonation of a Improvised Nuclear Device (IND) in the LA Metropolitan Area. In addition to the evaluation of interoperable devices and systems, the program strengthen existing emergency management plans, systems, and capabilities in order to broaden applicability to the full spectrum of emergencies. The CAW was responsible for exercise planning and preparation including planning meetings and exercise documentation as well as conducting, coordinating and controlling the pre and post exercise activities. Overall, the program involved 1,200 participants, 118 agencies and 6 venues.
OBJECTIVE: Collaborative multi agency research to identify, validate and improve current policy level issues and plans that apply to emergency response and security in a multi-jurisdictional maritime environment for the Port of Hueneme.

SUMMARY: The Center for Asymmetric Warfare and the Oxnard Harbor District collaborated on the operational research of existing plans and procedures for response capabilities in a multi-jurisdictional, civil-military port environment. The Port of Hueneme is a dual use port having both commercial and Navy operations occurring within its boundaries. The primary goal of this effort was to increase the overall safety, security and the ability of the Oxnard Harbor District, the Navy and local civilian response agencies to effectively manage an emergency disaster or security incident affecting the Port of Hueneme. The CAW conducted the evaluation and analysis of current emergency policies, planning and training relating to the Port of Hueneme and identified future training and exercises needs for the District Staff, FSOs and partner agencies.

OBJECTIVE: This program objective was to research existing and proposed solutions related to radio frequency identification to support a better understanding of the communications environment around the country.

SUMMARY: The Center for Asymmetric Warfare (CAW) was able to collect and identify various current and proposed communication and process methods and provide a detailed written status report. This CAW research has been classified at the Secret level, limiting the full description of the project and objectives.
FY10 STUDY OF PAKISTAN ARMY OPERATIONAL LESSONS LEARNED IN COUNTER-IED & COUNTERINSURGENCY (COIN)
Alan Jaeger, Research Associate
Joyce Borgen, Research Associate
Brendan Applegate, Research Associate
Ron Kimmelmann, Research Associate
Center for Asymmetric Warfare
Sponsor: Joint IED Defeat Organization (JIEDDO)

OBJECTIVE: The primary objective was to study the tactics used by the insurgents groups and IED networks in the North West Frontier Province and the Federally Administered Tribal Areas of Pakistan and use them as lessons learned, providing valuable insight for US policy makers and the US Military Commanders in Afghanistan.

SUMMARY: The Center for Asymmetric Warfare (CAW) through expertise support from Atlantic Council, was able to research, collect, and analyze various tactics and techniques experienced in the North West Frontier Province and Federally Administered Tribal Areas of Pakistan in order to build recommendations and best approaches for the US Army to consider in their efforts to build better plans and strategies.

INFRAGARD FY10 CYBER ATTACK AND SECURITY EXERCISE (CASE) TRAINING AND EXERCISE PROGRAM
Alan Jaeger, Research Associate
Joyce Borgen, Research Associate
Brendan Applegate, Research Associate
Ron Kimmelmann, Research Associate
Center for Asymmetric Warfare
Sponsor: INFRAGARD Los Angeles Members Alliance

OBJECTIVE: Research and demonstrate the consequences, impacts and implications in the event of a cyber terrorism attack on critical United States infrastructure such as: utilities, transportation, banking and military operations. The primary objective was to bring awareness on recognizing possible vulnerabilities as cyber security attack activities are increasing and becoming a major crime threat, specially in the theft (involving personal financial data, industrial espionage) or malicious attacks (involving purposely damage to systems or organizational entities).

SUMMARY: The Center for Asymmetric Warfare (CAW) collaborated with the Los Angles Infragard Members Alliance in the development and execution of two activities: the Cyber Vulnerability Seminar (CVS) and the Cyber Attack an Security Tabletop Exercise (TTX). These forums allowed participants to better understand the threat and risks associated with cyber based attacks. CAW facilitated real world scenarios to the group in order to create discussions on threats, consequences and response/recover. The participants of these programs generally acknowledged that it is imperative to create innovative, efficient and strong company/agencies policies to support the security systems in place.
OBJECTIVE: Collaborative research with the City of Los Angeles to evaluate and refine mass evacuation plans and procedures

SUMMARY: The Center for Asymmetric Warfare collaborated with the Emergency Management Department of the City of Los Angeles to provide a comprehensive review of existing emergency evacuation plans of the various Disaster Management Coordinator areas representing all cities in the Los Angeles County. Collaborative effort included the development and execution of a table top exercise to operationalize the multi-agency mass evacuation plan for the cities within the Los Angeles urban area security initiative UASI. Collaborators designed and executed scenarios that explored areas such as, alert, notification, evacuation, transportation, management, logistics, etc. The outcome was a Mass Evacuation Template Annex that will be tailored to the various cities individual requirements.

TECHNICAL SUPPORT FOR AIRBORNE ELECTRONIC ATTACK, JAMMING AND TECHNICAL OPTIMIZATION
OBJECTIVE: Provide technical support for NAVAIR Airborne and Electronic Attack program development and sensor visualization capability

SUMMARY: The Center for Asymmetric Warfare provided technical assistance and operational and networking support for Airborne and Electronic Attack (AIEA) program development and testing, Jamming and Technique Optimization (JATO). Effort included: evaluation of user needs, development of concept and network architecture, specification review and technical support.
GLOBAL PUBLIC POLICY ACADEMIC GROUP

OVERVIEW:

The Global Public Policy Academic Group (GPPAG) was established by the Naval Postgraduate School in 2009 as an inter-disciplinary approach to explore the interconnections of globalization and U.S. national security policy. GPPAG conducts inter-disciplinary research and develops research-led educational programs investigating the relationships between globalization and national security.

A core competency of the Naval Postgraduate School (NPS) is the linking of traditional disciplines to national security and defense applications. NPS faculty provide a wide range of relevant expertise on leadership, program management, economic development, strategy and planning, cross-cultural communications, conflict resolution, metrics, organizational learning, and other relevant subjects. A core mission of NPS is to prepare security practitioners for the emerging security environment.

Through the Global Public Policy Academic Group, the Naval Postgraduate School endeavors not only to broaden the understanding of the forces of globalization and their potential impact on national security, but to also shape U.S. national policy.

A primary mission of the Global Public Policy Academic Group is to foster research. Consequently, GPPAG has assembled a group of inter-disciplinary faculty representing a variety of academic disciplines within NPS and other universities to conduct funded research on the national security implications of globalization. Faculty from all NPS departments and from other universities are eligible to participate in GPPAG’s research and educational programs. NPS faculty may participate informally or through formal joint appointments between their home departments and the Global Public Policy Academic Group.

The Global Public Policy Academic Group is developing curricula for both a Master’s and a Ph.D. in Global Public Policy. NPS may also enter into dual degree arrangements with other universities for the Global Public Policy degrees. Potential students include military officers, Department of Defense civilians, students in education for government service programs, and international students. GPPAG will integrate ongoing efforts to provide certificate and Master’s degree programs now resident in NPS’ Cebrowski Institute Security and Global Environment Program with talent resident across NPS.


The Global Public Policy Academic Group is focused on the following key topics in the globalization and national security area: energy security, global governance and development, critical defense technologies, and terrorism.

RESEARCH PROGRAM-FY2010:

The Naval Postgraduate School’s research program exceeded $186 million in FY2010. Research programs include both research and educational activities funded from an external source. The size of the GPPAG’s program was $836K in FY2010, all of it sponsored by the Department of Defense.
GLOBAL PUBLIC POLICY ACADEMIC GROUP

Charles J. LaCivita
Chairman
831-656-2306
clacivita@nps.edu

Frank J. Barrett
Associate Chairman
831-656-2328
fbarret@nps.edu

Mie Augier
Associate Professor
meaugier@nps.edu

Walter L. Christman
Associate Professor
wlchrist@nps.edu

Karen Guttieri
Assistant Professor
831-656-2294
guttieri@nps.edu

Thomas R. Hazard
Operations Officer US PTC
831-656-3777
trhazard@nps.edu

Robert M. McNab
Associate Professor
Defense Resources Management Institute
831-656-3132
rmmcnab@nps.edu

Maria-Dubravka Pineda
Visiting Professor
202-460-8269
mdpineda@nps.edu

Wayne Porter
Captain, USN
Visting Research Professor
831-656-7672
nwporter@nps.edu

Marc J. Ventresca
Research Associate Professor
831-656-2694
mjventre@nps.edu
GLOBAL PUBLIC POLICY ACADEMIC GROUP

UNDERSTANDING CHINESE ORGANIZATIONS: INTERVIEWS AND RESEARCH ON THE INFLUENCE OF CHINESE CULTURE ON ORGANIZATIONAL BEHAVIOR, DECISION MAKING AND STRATEGY

Mie-Sophia Elisabeth Augier, Research Associate Professor
Global Public Policy Academic Group
Sponsor: Office of Net Assessment

OBJECTIVE: There is growing agreement among senior US civilian and military officials who have been involved in formulating or implementing national-security and military strategies and policies relating to China that, overall, China is becoming an increasingly important player on the global national-security scene. Publicly available US national-security documents, including from the US-China commission, have pointed to the potential challenges with the rise of China as an important player and the need for a better understanding of them, their behaviors, decision making processes, etc. The Office of Net Assessment has done some important work in advancing our knowledge of China over the past few decades. This project will contribute to this knowledge by focusing specifically on Chinese organizations. In particular, the project aims to help develop a better understanding of decision making and behavior in Chinese organizations and identify some main issues (characteristics, problems and strengths) of Chinese organizations, in particular those influenced by Chinese culture.

RECOGNIZING PATTERNS OF ANOMIE THAT SET THE CONDITIONS FOR INSURGENCY

Karen Guttieri, Assistant Professor
Global Public Policy Academic Group
Sponsor: Office of Naval Research

OBJECTIVE: The goal of this project is to better understand and depict how social unrest leads to insurgencies in order to develop better decision making options. This work will better prepare civilian and military decision making for future insurgencies in places of unrest by compiling scientific evidence for cause-targeted interventions aimed at anticipating and mitigating societal disorder. If instability related patterns and risks of societal disorder are to be detected and reversed in time, it is crucial to perform an in-depth assessment of invisible but measurable attitudes that precede subsequently observable patterns of behavior. We seek to detect relevant correlations and interactions between social change and societal disorder at an early stage, as well as to identify the potential for sustainable operational interventions.

RESEARCH SUPPORT TO HYBRID KNOWLEDGE MANAGEMENT SYSTEM FOR COMPLEX OPERATIONS

Karen Guttieri, Assistant Professor
Global Public Policy Academic Group
Sponsor: Office of Naval Research

OBJECTIVE: The objective of this proposed research by the Naval Postgraduate School Principal Investigator is to provide research support for the Milcord LLC development of a semantic and structured wiki service that will serve the information and knowledge management needs of the Complex Operations community responsible for mission training, planning, and operations. The HYKNOCO Project by Milcord LLC, of which this proposal is a part, seeks to research, design, and develop a hybrid answers engine prototype. This proposal responds to the BAA objectives for an ‘effects and open source reliability scoring capability, integrating fact and opinion-based knowledge sources’. The overall project goal is to build our application using open source semantic wiki tools (e.g. Semantic MediaWiki) for knowledge representation, open source structured wiki tools (e.g. TikiWiki) for structured content representation, and our Knowledge Management (CKM) framework for fact discovery and management. We propose to use open source knowledge and data sources (e.g. doctrine manuals, encyclopedic knowledge, historical databases and current news)
to build a sufficiently rich application that will attract community participation in order to grow the machine-extracted knowledge with user participation.

SOCIAL SCIENTISM AND THE ART OF MODEL DEVELOPMENT: A REVIEW
Karen Guttieri, Assistant Professor
Global Public Policy Academic Group
Sponsor: US Army TRAC-Monterey

OBJECTIVE: Research on insurgency, now revitalized after a long period of neglect, is still in need of a working model of origins; practitioners and analysts are predominantly focused on situations that are already violent. Large number quantitative studies and country-level data fail to provide the granularity we need to understand social dynamics. A proactive posture for conflict management requires a conceptual shift, particularly regarding problem framing and analysis. Political and military decision makers, supported by researchers, must better understand social structures and processes that are commonly hidden from view - how societies interpret change. Internal conflicts, including insurgency, are pernicious, contagious, prevalent, and expected to become more so as financial and environmental crises displace and deprive populations. A massive investment to develop Human Socio-Cultural Behavioral (HSCB) models is under way. Drawing upon multiple social disciplines. I propose to identify the social science behind the modeling in a literature review and paper supporting TRAC-Monterey. This review discusses problem framing, decision analytics, evolutionary theories and phenomenological approaches as some of the components of current research trends with potential to advance the state of the modeling art.

USPTC FY10 MULTI-LATERAL OUTREACH SUPPORT UNDER THE U.S.-SWEDEN MEMORANDUM OF UNDERSTANDING (MOU)
Alan R. Howard, Research Associate
Global Public Policy Academic Group
Sponsor: U.S. JFCOM

OBJECTIVE: Provide multi-lateral outreach support to the U.S. Joint Forces Command (JFCOM) in furtherance of the stated principles and objectives described in the Memorandum of Understanding between the Government of the Kingdom of Sweden and the United States Department of Defense related to the continued cooperation in support of development and utilization of the Persistent Partner Simulation Network (P2SN) under the Partnership for Peace (PfP) Framework Document (dated 10 January 1994) promoting the P2SN training, transformation, and multinational interoperability efforts of the respective countries. NPS will research proposed solutions and explore potential opportunities for partnering and collaboration with the institutions designated by the Swedish Armed Forces Joint Staff as its principal research and academic agents: the Swedish Armed Forces International Centre (SWEDINT), the Swedish National Defense College, and the Swedish Folke Bernadotte Academy. NPS will explore opportunities to work jointly and collaboratively on a wide range of academic, research, technical, and other activities in furtherance of objectives related to building partner nation capacity, promoting sustainable peace support systems and infrastructures, and other stated objectives. NPS will explore areas of common interest, competencies, and possible collaboration on a variety of programs and content development in the areas of technology, networks, information systems, globalization, security, and public policy.
GLOBAL PUBLIC POLICY ACADEMIC GROUP

USPTC AND GPPAG FY10 PREPARATORY WORK IN SUPPORT FOR THE GLOBAL CHALLENGES FORUM

Alan R. Howard, Research Associate
Global Public Policy Academic Group
Sponsor: U.S. JFCOM

OBJECTIVE: This project supports the preparatory work for the Global Challenges Forum (GCF) in 2010. The GCF will be an organization of think tanks, research centers, and academic institutions with the goal of contributing to the much-needed resolution of existing and future global security challenges.

MODELING CORRUPTION EFFECTS WITHIN IRREGULAR WARFARE

Robert McNab, Associate Professor (DRMI)
Tom Hazard, Director of Operations US PTC
Global Public Policy Academic Group
Sponsor: TRAC Monterey

OBJECTIVE: This proposal, through an extensive review of the literature and the development of a theoretical model of the interaction between corruption, violence, and economic development, aims to develop knowledge and algorithms to more accurately represent the influence of corruption in the irregular warfare environment. The first objective of this project is to survey the economics, political science, and sociology literature as to the determinants and outcomes of corruption. Building upon the first objective, the second objective seeks to construct a theoretical model (or models) of corruption, to include a model that explicitly incorporates the indirect effects of corruption on economic development and security. Finally, the third objective of this project is to assist in developing metrics to quantify corruption at the tactical and operational levels to help foster tools for advising commanders on corruption’s influence in irregular warfare environments.

CYBER SECURITY - DISTRIBUTED LEARNING CURRICULUM DEVELOPMENT

James Bret Michael, Professor (Department of Computer Science)
Alan Howard, Research Associate
Global Public Policy Academic Group
Sponsor: U.S. Joint Forces Command

OBJECTIVE: The primary purpose of this support to JFCOM is to provide graduate-level subject matter expertise (SME) that will be valuable in the planning, development and analysis of Information Operations (IO) and Cyberspace Operations curriculum to be used in distributed training and education. The faculty member will support the IO and Cyberspace Operations Training Requirements Branch within JFCOM J7 Training Development Group, Suffolk, VA.
GLOBAL PUBLIC POLICY
ACADEMIC GROUP

2010
Faculty Publications
and Presentations

**CONTRIBUTIONS TO BOOKS**

INDEX BY PRINCIPAL INVESTIGATOR

A

Abuan, Lillian A. 133
Adams, Christopher A. 314
Agrawal, Brij N. 271, 314-319
Alderson, David L. 167-169
Amara, Jomana 9
Appleget, Jeffrey 169-170
Arquilla, John 109
Ashton, Robert William 269
Atkinson, Michael 170
Augier, Mie-Sophia Elisabeth 681
Auguston, Mikhail 69

B

Baer, Wolfgang 133-134, 635
Baker, Steven R. 433
Balogh, Imre 595
Barma, Naazneen H. 23
Becker, William J. 595-596
Bell, Michael M. 359
Berzins, Valdis A. 69
Biediger, Jeremy 433
Blais, Curtis 596-599
Bluth, Robert T. 625-626
Boger, Daniel C. 645
Borden, Brett 433
Bordetsky, Alexander 635
Borges, Carlos F. 237
Bradley, Gordon H. 171
Brewer, Luke N. 319
Brook, Douglas A. 533
Brophy, Christopher M. 320-322
Brown, Gerald G. 172-174
Brown, Ronald E. 434-435
Brutzman, Donald P. 479, 600-602
Budden, Nancy A. 109
Buettner, Raymond 635-637
Burton, Douglas 174
Butler, Jon T. 269-270

C

Calvano, Charles N. 479
Canright, David R. 238-239
Carlson, Ronald R. 479
Carlisle, W. Matthew 174-175
Chakwin, Mark 24
Chandrasekhar, Muguru S. 322-323
Chang, Chih-Pei 359
Chatelier, Paul R. 603-605
Chiu, Ching-Sang 383-386
Chung, Timothy H. 175-176
Chu, Peter C. 387-390, 579
Ciavarelli, Anthony 605
Clunan, Anne L. 24-27
Collins, Curtis A. 391-392
Colosi, John A. 394
Colson, William B. 435-438
Craparo, Emily 177
Cristi, Roberto 271
INDEX BY PRINCIPAL INVESTIGATOR

D
Dahl, Erik J.  27
Danielson, Donald A.  239
Darken, Christian J.  606
Darken, Rudolph P.  606-607
Dell, Robert F.  178
Denardo, Bruce  438, 439
Denning, Peter J.  561
Dew, Nicholas  534
Didoszak, Jarema M.  323
Dinolt, George W.  71
Dixon, Joshua  561
Dobrokhodov, Vladimir N.  324
Driels, Morris R.  325
Drusinsky, Doron  72
Durkee, Philip A.  360
Dutta, Indranath  326

E
Eagle, Chris  72-73
Eagle, James N.  480
Ear, Sophal  28
Ehlert, James  136-137
Ellis, Winford G.  580
Enns, John  534
Euske, Kenneth J.  534-535
Everton, Sean  110
Ewing, P. Lee  178-179

F
Fargues, Monique P.  272
Ferrer, Geraldo  535
Ford, Barbara  535
Ford, David K.  440
Fouts, Douglas J.  272
Fox, William P.  111-113
Frederickson, Paul A.  361
Freeman, Michael  113
Fricker, Jr., Ronald D.  180-181

G
Gallup, Shelley P.  137-139, 645
Garcia, Vincente  272
Garfinkel, Simson L.  73-75, 561
Gera, Raluca  239-241
Giammarco, Kristin  480-481
Gibbons, Deborah E.  535-536
Gibson, John H.  562
Giraldo, Francis X.  242-244
Gordis, Joshua H.  327
Goshorn, Rachel E.  273-274
Green, John M.  481
Greenshields, Brian  113-114
Gregg, Heather  114
Guest, Peter S.  362
Gunderson, Chris  563
Guttieri, Karen  563, 681-682
INDEX BY PRINCIPAL INVESTIGATOR

H

Hacker, Joshua 362
Haegel, Nancy M. 441-444
Hafez, Mohammed M. 29
Harkins, Richard M. 445
Harris, John R. 446
Harr, Patrick A. 363-364
Hayes-Roth, Rick 141, 564
Hayward, Justin 142
Heath, Susan K. 536
Herbers, Thomas H.C. 395-396
Higgins, Susan 564-565
Hixson, Robert S. 446-447
Hobson, Garth V. 327-329
Horner, Douglas 329-330
Housel, Thomas J. 646
Howard, Alan R. 682-683
Hoyt, Jennith 30
Huffmire, Ted 75
Huntley, Wade L. 30-31
Hutchins, Susan G. 144-146

I

Irvine, Cynthia E. 76-79

J

Jacobs, Patricia A. 182
Jaeger, Alan 663-669
Jaskoski, Maiah 31-32
Jenn, David C. 275

Johnson, Jean M. 482
Johnson, Rachel T. 182-183
Johnson, Thomas 33
Jones, Benjamin 397
Jones, Lawrence R. 536-537
Jonsson, Hafliid H. 626-628
Joseph, John E. 397-399
Julian, Alexander L. 276

K

Kadhim, Abbas 34
Kaminer, Isaac 331
Kang, Wei 245-246
Kapur, Paul 34
Karunasiri, Gamani 447-449
Kays, James L. 483
Khan, Feroz Hassan 34-35
Kimzey, Charles 646-648
King, Cynthia 538-539
Kline, Jeffrey E. 184-187
Knopf, Jeffrey W. 35
Kolar, Ramesh 331
Koyak, Robert A. 187-188
Kragh, Frank E. 276-278, 565
Krener, Arthur J. 246-247
Kress, Moshe 189-191
Kwon, Young W. 331-334, 580

L

Langford, Gary O. 484-485
INDEX BY PRINCIPAL INVESTIGATOR

Larraza, Andres  449-450
Leavitt, Sandra  36
Lesnowicz, Jr., Edward J.  192-193
Lewellen, John  451
Liberato, Jimmy  607
Lieberman, Steve  607-608
Lin, Kyle Y.  194
Longley, Carrick  146
Loomis, Herschel H.  278-281, 511
Lucas, Thomas W.  194-197, 648
Luqi  79-81

M

MacKinnon, Douglas J.  147
MacMahan, Jamie  399-401
Madachy, Raymond  485
Maier II, William B.  452
Malley, Michael S.  37
Marquis, Fernand D.S.  580
Martell, Craig H.  566
Maslowski, Wieslaw  401-405
Maule, William Randy  147
McCuenly, Michael E.  198-199, 608
McCormick, Gordon H.  114
McDowell, Perry  608-609
McEachen, John C.  282-288
McGregor, Don  609
McNab, Robert M.  9
McNelley, Terry R.  335
Melese, Francois  10
Melich, Michael E.  581-582
Michael, James Bret  84-86, 683
Michael, Sherif N.  289-290, 512
Millar, Richard C.  487-489
Miller, Gregory A.  490
Miller, Scott  566
Millsaps, Knox T.  335-336
Mislick, Gregory K.  199
Moltz, James Clay  38
Montgomery, Michael T.  364-366
Montgomery, Paul  491
Moran, Daniel J.  38
Morgan, Michael A.  290-291
Murphree, Tom  366-368

N

Nestler, Scott  200
Neta, Beny  247-248
Newman, James H.  336, 512-515
Nissen, Mark E.  148
Nussbaum, Daniel A.  200-203
Nuss, Wendell A.  368-369

O

O’Connor, Paul  203
Olsen, Richard C.  452-456, 651
Olwell, David H.  491-492
Oriti, Giovanna  291-292, 583
Oros, Carl L.  149
Osmundson, John S.  149
<table>
<thead>
<tr>
<th>Name</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otte, Douglas</td>
<td>204</td>
</tr>
<tr>
<td>Owen, Guillermo</td>
<td>249</td>
</tr>
<tr>
<td>Pace, Phillip E.</td>
<td>292-294</td>
</tr>
<tr>
<td>Paduan, Jeffrey D.</td>
<td>405-407</td>
</tr>
<tr>
<td>Panholzer, Rudolf</td>
<td>515-516</td>
</tr>
<tr>
<td>Papoulas, Fotis A.</td>
<td>336</td>
</tr>
<tr>
<td>Parker, Andrew</td>
<td>294</td>
</tr>
<tr>
<td>Paulo, Eugene P.</td>
<td>204, 492, 652</td>
</tr>
<tr>
<td>Peterson, Zachary</td>
<td>86</td>
</tr>
<tr>
<td>Pfeiffer, Karl D.</td>
<td>149-150</td>
</tr>
<tr>
<td>Phillips, Brian E.</td>
<td>294</td>
</tr>
<tr>
<td>Pilnick, Steven E.</td>
<td>205</td>
</tr>
<tr>
<td>Piombo, Jessica</td>
<td>38-39</td>
</tr>
<tr>
<td>Place, William David</td>
<td>151</td>
</tr>
<tr>
<td>Powley, Edward H.</td>
<td>539</td>
</tr>
<tr>
<td>Radko, Timour</td>
<td>408-409</td>
</tr>
<tr>
<td>Rasmussen, Craig W.</td>
<td>250</td>
</tr>
<tr>
<td>Rasmussen, Maria J.</td>
<td>39</td>
</tr>
<tr>
<td>Regnier, Eva</td>
<td>205-206</td>
</tr>
<tr>
<td>Rhoades, Mark M.</td>
<td>492</td>
</tr>
<tr>
<td>Rice, Joseph A.</td>
<td>456-460</td>
</tr>
<tr>
<td>Roberts, Dave</td>
<td>151</td>
</tr>
<tr>
<td>Roberts, Nancy</td>
<td>115</td>
</tr>
<tr>
<td>Robertson, Ralph C.</td>
<td>294-297</td>
</tr>
<tr>
<td>Robinson, Glenn E.</td>
<td>115-116</td>
</tr>
<tr>
<td>Roeting, William</td>
<td>151</td>
</tr>
<tr>
<td>Romano, Marcello</td>
<td>337-339</td>
</tr>
<tr>
<td>Romero, Ric</td>
<td>297</td>
</tr>
<tr>
<td>Ross, Alan A.</td>
<td>298</td>
</tr>
<tr>
<td>Ross, Isaac Michael</td>
<td>339-340</td>
</tr>
<tr>
<td>Roth, John</td>
<td>298</td>
</tr>
<tr>
<td>Rothstein, Hy S.</td>
<td>116-117</td>
</tr>
<tr>
<td>Rowe, Neil C.</td>
<td>87-88</td>
</tr>
<tr>
<td>Royset, Johannes O.</td>
<td>206-208</td>
</tr>
<tr>
<td>Rubin, Aviel D.</td>
<td>88</td>
</tr>
<tr>
<td>Rusnak, Brian</td>
<td>460</td>
</tr>
<tr>
<td>Russell, James</td>
<td>39-41</td>
</tr>
<tr>
<td>Sadagic, Amela</td>
<td>610</td>
</tr>
<tr>
<td>Salmerón, Javier</td>
<td>208</td>
</tr>
<tr>
<td>Sanchez, Susan M.</td>
<td>209-210</td>
</tr>
<tr>
<td>Scandrett, Clyde</td>
<td>251-252</td>
</tr>
<tr>
<td>Schramm, Harrison C.</td>
<td>210</td>
</tr>
<tr>
<td>Scott, Alan D.</td>
<td>341, 517</td>
</tr>
<tr>
<td>Shattuck, Nita Lewis</td>
<td>210-212</td>
</tr>
<tr>
<td>Shebalin, Paul V.</td>
<td>583</td>
</tr>
<tr>
<td>Shen, Yu-Chu</td>
<td>540</td>
</tr>
<tr>
<td>Shore, Zachary</td>
<td>41</td>
</tr>
<tr>
<td>Silvestrini, Rachel T.</td>
<td>212</td>
</tr>
<tr>
<td>Sinibaldi, Jose O.</td>
<td>461</td>
</tr>
<tr>
<td>Smith, Kevin B.</td>
<td>461-463</td>
</tr>
<tr>
<td>Smith, Kip</td>
<td>213</td>
</tr>
<tr>
<td>Snider, Keith F.</td>
<td>540-544</td>
</tr>
<tr>
<td>Sotomayor, Arturo C.</td>
<td>41</td>
</tr>
<tr>
<td>Stanica, Pantelimon</td>
<td>253-254</td>
</tr>
</tbody>
</table>
INDEX BY PRINCIPAL INVESTIGATOR

Stanton, Timothy P.  410
Steckler, Brian  567
Stone, Rebecca E.  410
Sullivan, Joseph A.  610-611
Su, Weilian  298
Szechtman, Roberto  213

T
Thomas, Gail Fann  544
Tokmakian, Robin T.  410
Tucker, David  117
Twomey, Christopher P.  42

V
Vaidyanahan, Ravi  493
Volpano, Dennis M.  89

W
Wall, Kent D.  10
Wang, Qing  369-370
Washburn, Alan R.  213
Weatherford, Todd  298-299
Whitaker, Lyn R.  214
Whitcomb, Clifford  493-494, 583-584
Wirtz, James J.  44
Wisher, Robert  611-612
Wood, R. Kevin  214

X
Xie, Geoffrey C.  90-91, 567

Y
Yakimenko, Oleg A.  342
Yost, David S.  44
Yun, Xiaoping  300
Yu, Warren  567-568

Z
Zhou, Hong  254-255