Operations Research Department
Naval Postgraduate School

Academic Program Review
Introduction and Executive Summary

July 2016
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1. Mission / Strategy / Organization

The Operations Research Department at NPS is guided by the following vision and mission.

**OR Department Vision**

The security of the United States depends on continued research, development and application of operations research to study, evaluate, plan, and analyze military and security operations.

**OR Department Mission**

To provide premier graduate education in military operations research and to produce high-quality, objective, academically rigorous research and professional advice in support of military- and security-related operations.

A Strategic Plan for the Department was originally written in 2001. It was updated most recently in 2012. There is a new Strategic Plan for 2016.

The OR Department is part of the Graduate School of Operational and Information Sciences (GSOIS) within NPS. The Department is led by its Chair: James Eagle was Chair from 2001 to 2008; Robert Dell followed from 2009 to 2015; and Patricia Jacobs took over as Chair in July 2015. Currently, there are no specific succession plans for the next Chair.

The Department is also supported by several associate chair (AC) positions—AC for Instruction (Kyle Lin), AC for Research (Johannes Royset), AC for Distributed Programs (Steven Pilnick), AC for Operations (Kevin Maher)—as well as Academic Associates (Matt Carlyle, Kevin Maher, Steve Pilnick, Larry Shattuck) and Program Officers (CAPT Jeff Hyink, LCDR Connor McLemore, CDR Peter Ward).

The Department is home to two research centers: the Simulation, Experimentation & Efficient Designs (SEED) Center for Data Farming, and the Center for Infrastructure Defense (CID). The Department is currently evaluating new research and education opportunities in the data science and cyber domains.

The Department has recently hired two new tenure-track positions, our first external hires in over five years. Faculty hiring plans dating back to 2010 show that there is a longstanding recognized need to hire more tenure-track faculty members, particularly at the junior ranks. This need persists and is becoming more acute.

2. Faculty

The OR Department has a distinguished faculty that includes three members of the National Academy of Engineering and many fellows of professional societies (Military Operations Research Society, INFORMS, American Statistical Association, Institute for Mathematical Statistics, American Association for the Advancement of Science, and the Royal Statistical Society). We are the only department to have had more than one faculty member receive the prestigious "Prize for the

Our department has also been a leader in its contribution to the practice of operations research. NPS OR was the recipient of the 2013 UPS George D. Smith Prize for “effective and innovative preparation of students to be good practitioners of operations research, management science, or analytics.” NPS OR has also consistently led the practice literature as reported in the Rothkopf rankings. (Details are available in the Research Section of this report.)

The NPS OR Department is one of the largest OR departments in the United States, comprising 18 tenure track, 22 non-tenure track faculty members (counting telework people who may work part time), and eight senior active duty officers. Tenured or tenure-track faculty members hold Ph.D. degrees in operations research or a related discipline (e.g., mathematics, statistics, computer science). Most of those without Ph.D. degrees are current or former military officers who have deep military operations and applied operations research experience. Table 1 summarizes these demographics:
<table>
<thead>
<tr>
<th>Rank</th>
<th>Number Male/Female</th>
<th>Number US/Foreign</th>
<th>Number with PhD</th>
<th>Total Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distinguished Professor</td>
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<td>2/0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Professor</td>
<td>4/1</td>
<td>5/0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Associate Professor</td>
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<td>10/0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Assistant Professor</td>
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<td>1/0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total tenure/tenure-track</strong></td>
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<td><strong>18/0</strong></td>
<td><strong>18</strong></td>
<td><strong>18</strong></td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
</tr>
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<td>1/0</td>
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<td>Research Assistant Prof</td>
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<td>1/0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Professor of Practice</td>
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<td>2/0</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Senior Lecturer</td>
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<td>10/0</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Lecturer</td>
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<td>2/0</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Research Associates</td>
<td>1/1</td>
<td>2/0</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Military faculty</td>
<td>8/0</td>
<td>8/0</td>
<td>1</td>
<td>8</td>
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<tr>
<td><strong>Total non-tenure/tenure-track</strong></td>
<td><strong>23/3</strong></td>
<td><strong>26/0</strong></td>
<td><strong>9</strong></td>
<td><strong>26</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>36/8</strong></td>
<td><strong>44/0</strong></td>
<td><strong>27</strong></td>
<td><strong>44</strong></td>
</tr>
</tbody>
</table>

Table 1: NPS OR Faculty members, as of December 2015

Appendix B provides a faculty roster as of July 2015. Full details of faculty can be found at the department webpage (http://www.nps.edu/or).

**Research Funding**

A typical faculty member brings in at least one quarter of external research support each year. Some faculty members are fully supported by their research funding. About half of this funding comes from other Navy organizations, while over a third comes from the Army, with the remainder provided by other DoD and U.S. government organizations. This research funding includes both applied research that directly assists a Department of Defense organization, and pure research support from sponsors such as the Air Force Office of Scientific Research, the Army Research Office, and The Office of Naval Research. This funding is critical for keeping OR faculty connected to the issues and problems that our DoD sponsors seek to solve.

**Military Faculty**

While all NPS OR faculty members have familiarity and competence in OR practice, one of the strengths of our faculty is its background in practical OR that our military faculty members provide in the classroom. We currently have eight active duty military faculty members (5 Navy, 2 Army, and 1 Marine Corps) with diverse educational and operational experience. One military faculty member has a Ph.D. degree in an OR-related discipline. The other seven have degrees earned from NPS, and have returned to NPS after serving at least one tour as a practicing military analyst. Each military faculty member typically spends three to six years on our faculty. The wealth of first-hand information these officers bring regarding the relevancy and value of our curricula, combined with the first-hand working knowledge of both the decision space for many current DoD issues and the means of analytic approach, uniquely enables these officers to teach and advise the next generation of analyst students. Through normal rotation, the military faculty billets represent diverse areas of capability within the armed services. Current faculty bring over 125 years of combined service in
areas of strike-fighter aviation, infantry warfare, airborne early warning, naval logistics, aviation psychology, and helicopter aviation.

### 3. Research and Scholarship

In fiscal year 2014, the OR faculty brought in over $5.5 million in external research funding, all focused on the development, implementation, or practice of operations research. This sum is even more significant given that none of our students need support. At the same time, the faculty published widely in professional journals such as *Operations Research, Interfaces, Military Operations Research*, and *Naval Research Logistics* (to name a few), and many technical reports, almost all of which are available to the public through the Defense Technical Information Center (DTIC). Additionally, OR faculty members have published a total of 18 books or textbooks, as well. Appendix C provides a listing of faculty publications and presentations in FY14.

Table 2 summarizes the reimbursable research activity of the department over the last five years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Publications</th>
<th>Number of Grants</th>
<th>External Research Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>81</td>
<td>63</td>
<td>$5,512,000</td>
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<tr>
<td>2013</td>
<td>52</td>
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<tr>
<td>2012</td>
<td>67</td>
<td>60</td>
<td>$7,904,000</td>
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<tr>
<td>2011</td>
<td>82</td>
<td>63</td>
<td>$6,594,000</td>
</tr>
<tr>
<td>2010</td>
<td>64</td>
<td>65</td>
<td>$5,162,000</td>
</tr>
</tbody>
</table>

*Table 2: Research activity of NPS OR during FY10-FY14*

Although we view basic theory as the essential foundation of OR, and value real-world practice as laudable and necessary products of OR, we also seek to influence policy. We are a trusted source of policy advice for our government. We have been credited with advising and shaping defense investments of over a trillion dollars. We also often receive thank-you letters and messages for lesser feats, e.g., “during our emergent transit, your convex hulls fuel saving paper and spreadsheet was never out of sight of our CO, XO, or Chief Engineer. We made the transit without replenishment.” We practice OR to constructively influence not just tactics, operations, or strategy, but also high-level policy. We know that we have succeeded via feedback from our students who have become general officers.

**Rothkopf Rankings**

Since 1996, *Interfaces* has published ten rankings of universities that contribute to the INFORMS practice literature. These rankings are now referred to as the Rothkopf Rankings in honor of the late Mike Rothkopf, the originator of these rankings. The ninth Rothkopf ranking appeared in Interfaces in 2011 and reported the following quote: “As with the Eighth Rothkopf Rankings for U.S. universities, the Naval Postgraduate School earns the top ranking for visibility and second for yield.” In addition to the most recent ranking, NPS has been a consistent leader in its contributions to the practice literature. From the ninth rankings: “Among all US universities, only the Naval Postgraduate School has ranked in the top six for all the rankings since 2002.” From the fifth rankings: “Over the five rankings, some schools have been consistent performers. Four schools have
always been in the top 10: MIT, the Naval Postgraduate School, Stanford University, and Temple University.” We are proud of this continued excellence.

**Simulation, Experimentation & Efficient Designs (SEED) Center for Data Farming**

The SEED Center for Data Farming was created to address the high-dimensional aspects inherent in models of real-world phenomena. It enhances our national security by providing unique research and support for faculty and students, U.S. armed forces, and our allies. Bringing a team approach to defense-oriented problem-solving by using faculty and students, it is able to leverage strong ties with international military and civilian simulation communities. Recent research initiatives include a series of international workshops and over fifty students successfully completing their thesis research in the past three years.

**Center for Infrastructure Defense (CID)**

The principal activity of the CID is to develop new theoretical and applied analysis techniques to understand how regional and national infrastructure systems respond in the face of major disruptions, whether deliberate or non-deliberate events. It focuses on the continued operation of critical military and civilian infrastructure in the presence of accident, failure, and attack. CID addresses both long-term and emergent issues related to national and international infrastructure systems to make these systems resilient to such disruptions. CID has completed 150 “Red Team” case studies (many being student theses) on infrastructure by viewing domestic critical infrastructure through the eyes of intelligent adversaries. Their research has resulted in identifying the fragility of systems and recommendations on where to mount effective hardening and defensive efforts.

**Military-Relevant Research Activities**

Members of the OR Department are also actively engaged in leading a number of coordinated NPS-wide research activities.

- The **Warfare Innovation Continuum**, led by Professor of Practice Jeff Kline (Captain, U.S. Navy, Retired), is an ongoing project that carries out a series of cross-campus educational and research activities exploring the creation of asymmetric warfighting advantages across all domains.

- The **Wargaming Activity Hub**, led by Dr. Jeff Appleget (Colonel, U.S. Army, Retired), serves as the focal point for the DoD, its allies, and partners to access the unique wargaming capabilities of NPS students and faculty.

Appendix D provides a comprehensive listing of faculty research projects for FY14. These have resulted in far-reaching positive impact on both effectiveness and efficiency of DoD operations.
4. Education Programs

The Operations Research Department is home to seven M.S. degree programs: four of them are resident programs and three are distance-learning (DL) programs. Both resident programs and non-resident DL programs typically run eight quarters in length. Resident programs typically require a Master’s thesis for degree completion, whereas non-resident DL programs require a capstone project instead of a Master’s thesis. Each program has a curriculum number that identifies it. These curricula are identified by the following numbers and titles:

- 358: Operations Analysis (Energy)
- 360: Operations Analysis
- 361: Joint Operational Logistics
- 362: Human Systems Integration
- 359: Master of Human Systems Integration (DL)
- 363: Master of Systems Analysis (DL)
- 379: Master of Cost Estimating and Analysis (DL)

The OR Department also offers three DL certificate programs:

- 262: Human Systems Integration
- 281: Systems Analysis
- 289: Cost Estimating and Analysis

In addition, the OR Department supports the M.S. Systems Engineering Analysis (Curriculum 308).

The OR Department has a Ph.D. program that typically has 1–3 students enrolled at any given time. Small student numbers require highly individualized programs of study, and any Ph.D.-level coursework is developed and delivered as an overload for the faculty involved. Ph.D. students are required to pass written and oral examinations to be admitted to candidacy; they must then write and successfully defend a dissertation in order to receive their Ph.D. A large number of our Ph.D. students have pursued the degree in order to fill Permanent Military Professor positions at the U.S. Naval Academy, and we have many alumni currently filling those positions.

Each of our curricula is specifically designed and tailored to meet the needs of a DoD sponsor, who oversees and critically reviews each program regularly to ensure rigor, applicability, and most especially relevancy. The specific educational goals of each curriculum are spelled out in Educational Skill Requirements (ESRs). These ESRs define the knowledge and skills a graduate should possess to function effectively as an operations research professional in a specialized field. The curricula are designed to meet academic standards for a master’s degree. Academic requirements for each master’s degree are met en route to satisfying the ESRs of each curricular program. Degree requirements are specified and approved by the NPS Academic Council. NPS is institutionally accredited by the Western Association of Schools & Colleges (WASC).

The content of each curriculum is reviewed by its sponsor every two years. The review begins by validating stakeholder requirements and ESRs, reviewing degree requirements, proposing new ESRs (if necessary), and conducting an assessment of the design and execution of the existing curriculum. The review then culminates with a two-day, on-site final curriculum review by the sponsor and its representatives. The curriculum review additionally examines a department’s foundation for providing a quality program, including issues related to faculty, research programs,
and resources. This examination includes confidential interviews of current students, graduates, and employers of our graduates. The resulting report identifies explicit areas for improvement and change, if necessary.

Most of the courses in our curricula cover topics similar to courses in civilian O.R. programs, such as computational methods, statistics and data analysis, stochastic models, linear and non-linear optimization, network flows, simulation, and decision analysis. But in our program, all of these are enriched with examples that relate to the students’ experiences and the professors’ research. We also have topics that are not commonly found in other programs, including combat modeling, campaign analysis, strategy and policy, cost analysis, and search theory. These topics are critical to our sponsors and are in keeping with the foundational roots of operations research. These courses help directly prepare our graduates to be military practitioners of OR.

Most resident students complete a curriculum that consists of one quarter of “refresher” courses, plus seven quarters of instruction for students not completing Joint Professional Military Education (JPME). Students completing JPME will stay for eight quarters.

In addition to coursework, each resident student is required to complete a Master's thesis under the supervision of at least one advisor on the OR faculty, and with the review of a second reader. Appendix E provides a list of student theses completed in 2015.

**The Experience Tour**

An important piece of our approach to education is an internship that we call the “experience tour.” This is a three-week period that provides each student with an opportunity to apply theory from the classroom to a problem in the real world. After completing core coursework for the first five quarters, each student has an opportunity to participate in an experience tour at a relevant DoD organization. The student then spends the remaining time at NPS in advanced coursework and thesis research under the direct supervision of a faculty member. This combination of an experience tour with a thesis helps the student understand how to conduct independent analytical studies of military problems, provides low-cost support to various interested analytical organizations, requires the student to produce a complete, coherent document describing the work accomplished, and connects us with the military analytical community. The unique set of circumstances we have created at NPS makes this all possible and does much to prepare our graduates to be practitioners.

This last point is essential because our graduates will frequently fill an analysis position immediately upon graduation, perhaps without any interaction with their predecessor. On day one, this graduate is expected to be a fully capable and mature analyst, and will also likely supervise the work of contractors and/or junior analysts, which means our graduates have to be prepared not only to function as individual analysts, but they must also be capable of supervising a team of operations research analysts.

A wide variety of experience tours is available to our students. These experience tours generally fall into three broad categories: First, some experience tours are based on long-standing relationships between our department and various analytical agencies; second, some tours are based on the
student's past experience. Many students arrive at NPS with a desire to improve some aspect of a past assignment, or an early classroom topic coupled with their fleet/work experience suggests a topic; and third, some tours are based on faculty research efforts. NPS faculty conduct DoD-sponsored research for a wide range of organizations and frequently send students they advise to these organizations to develop a thesis topic that supports their broader research efforts.

**Resident Programs**

*Curriculum 360 Operations Analysis (OA)* is the M.S. program with the largest number of students. This curriculum is sponsored by OPNAV N81 Assessment Division, and the department’s commitment is to provide coursework and thesis advising that supports eight Educational Skills Requirements (ESRs) for operations analysts. This curriculum has eight ESRs:

1. **Basics:** The graduate will possess the mathematical and computer programming skills required to support graduate study in operations research and have the ability to use computers as a tool to aid in analysis.
2. **Probability, Statistics, and Data Analysis:** The graduate will be well-versed in the applications of probability, statistics, and data analysis to support the modeling and analysis of a broad range of military decision problems.
3. **Optimization:** The graduate will be able to formulate and solve a wide variety of optimization problems and also be conversant with the major uses of such models in DoD and the private sector.
4. **Stochastic Modeling:** The graduate will be able to formulate stochastic models, calculate measures of performance for them, and be familiar with major applications of such models.
5. **Simulation:** The graduate will be able to employ simulation methods to model situations of interest to the defense community, be able to formulate, implement, explore, and analyze simulations, and make informed recommendations.
6. **Systems Analysis:** The graduate will be able to apply systems analysis concepts as a basis for making key decisions on force requirements, weapon systems, and other defense problems, with particular emphasis in risk-benefit and cost-benefit analysis.
7. **Analysis of Military Operations:** The graduate will have significant exposure to and be able to model and analyze military operations using operations analysis techniques to support concept development, tactics, and operations.
8. **Practice:** The graduate will have gained experience working on all aspects of an analytical study, and will demonstrate the ability to conduct independent analytical studies and proficiency in presenting the results both orally and in writing.

Officers who complete Curriculum 360 receive a Master of Science (M.S.) in Operations Research and the Navy subspecialty code 3211P.

The curriculum runs eight quarters and offers students an opportunity to also complete their Joint Professional Military Education (JPME). Figure 1 shows the standard course matrix and how they are designed to support the eight OA ESRs. Students also have the option to enroll in a refresher quarter, which offers math courses at undergraduate levels to prepare students for the upcoming graduate coursework.
A key differentiator of our curricula compared to those offered in civilian universities is that our students often do not have the requisite academic background, or are many years removed from academia, when they enter our program. Our course matrix is designed to provide all foundational material, including calculus, linear algebra, probability, statistics, and computer programming, to allow the student to perform at the cutting edge of Masters-level work in a short time.

**Figure 1: Standard Course Matrix for Curriculum 360 and eight ESRs.** This course matrix includes optional support for Joint Professional Military Education (JPME) track. Each ESR is supported by one or more courses, and each course in the matrix supports one or more ESRs.

**Curriculum 361 Joint Operational Logistics (JOL)** is sponsored by OPNAV N42 Strategic Mobility and Combat Logistics Division. The course matrix is a modification of Curriculum 360, with students taking OA3611 (Principles of Operational Logistics), OA3501 (Inventory I), OA4613 (Energy Logistics in Warfare Operations) and OA4611 (Joint and Combined Logistics), instead of OA3602, OA4604, and OA electives. In addition to core OA ESRs, the 361 curriculum addresses the following specialized ESRs covering (1) Joint Logistics, (2) Joint Military Operations, Strategy and Planning, and (3) Joint OL Practice. Details of this curriculum are available in the online catalog [http://www.nps.edu/Academics/GeneralCatalog](http://www.nps.edu/Academics/GeneralCatalog). Completion of this curriculum results in a M.S. in Operations Research and qualifies an officer as an Operational Logistics Subspecialist with a Navy subspecialty code of 3212P.

**Curriculum 358 Operations Analysis (Energy)** was created in 2012 to respond to Secretary of the Navy’s vision of the importance of energy in the Navy. This curriculum sponsor is OPNAV N45 Energy and Environmental Readiness Division. The required courses are a modified version of Curriculum 360 to address core OA ESRs plus additional OA Energy ESRs. Instead of OA3602, OA4604, and OA electives, students are required to take PH3998 (Fundamentals of Energy),
MN4970 (Energy Economics), OS3007 (Operations Research for Energy Analysts) and OA4613 (Energy Logistics in Warfare Operations), as well as a series of seminars focused on energy. The curriculum has additional OA Energy ESRs. Officers who complete this curriculum receive a M.S. in Operations Research and Navy subspecialty code 3213P.

**Curriculum 362 Human Systems Integration (HSI)** is sponsored by OPNAV N12. HSI acknowledges that the human is a critical component in any complex system. It is an interdisciplinary approach that makes explicit the underlying tradeoffs across the HSI domains, facilitating optimization of total system performance in both materiel and non-materiel (DOTLPF) solutions to address the capability needs of organizations. This curriculum is substantially different from Curriculum 360. The students take courses that focus on human capabilities and limitations, systems engineering, statistical analysis, and the defense acquisition process. In recent years, the student enrollment in this program has been very low. Students who complete this curriculum receive a Master of Science in Human Systems Integration and qualify for Navy subspecialty code 4600P. Details of this curriculum, including ESR information, are available in the online catalog (http://www.nps.edu/Academics/GeneralCatalog).

Table 3 compares the four OR resident programs.

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</tr>
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<td><strong>Program Officer</strong></td>
<td>Peter Ward</td>
<td>Connor McLemore</td>
<td>Peter Ward</td>
<td>Peter Ward</td>
</tr>
<tr>
<td><strong>Academic Associate</strong></td>
<td>Steve Pilnick</td>
<td>Matt Carlyle</td>
<td>Steve Pilnick</td>
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<td><strong>Sponsor</strong></td>
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</tr>
<tr>
<td><strong>Length</strong></td>
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<td>8 quarters</td>
<td>8 quarters</td>
<td>8 quarters</td>
</tr>
<tr>
<td><strong>Yearly Throughput</strong></td>
<td>~2</td>
<td>~60</td>
<td>~10</td>
<td>~1</td>
</tr>
</tbody>
</table>

Table 3: The Four OR Resident Programs

After completing core coursework, each in-resident student has a three-week Experience Tour period in which to travel to a military activity to conduct in-person research and data collection, gaining first-hand experience to support the thesis each student must write. The student then works on the thesis while completing advanced coursework. Every student presents his or her thesis at a mini-conference held during their final quarter, and the top theses are presented in a special competition for the Military Operations Research Society (MORS) Stephen A. Tisdale Graduate Research Award.

Practice has always been an ESR in our curricula. This is a point we proudly advertise: Our students learn not only the theory of operations research, but they put that theory into practice, both in their studies here at NPS and, most importantly, in the jobs they assume once they graduate. Here at NPS, practice is emphasized in OR coursework, the experience tour, and the thesis. After NPS, operations research is practiced by our graduates throughout the Department of Defense, from the battlefields of Afghanistan and Iraq, to the major logistics and operational centers both
here and abroad, and to operational units across the globe. In addition, once our students retire from the military, they take their skills and practical experience out into the private sector.

**Interdisciplinary Programs**

*Curriculum 308 Systems Engineering Analysis (SEA)* is sponsored by OPNAV N9I (Director, Warfare Integration). It is an 18-month, combat-oriented systems engineering and analysis program. NPS built this curriculum in 2002 with significant Fleet input to teach U.S. Navy Unrestricted Line Officers how the Navy builds and fights large combat systems. There are six interdisciplinary threads interwoven in the curriculum: SEA Preparation (Basics), Analysis, Systems Technology, Systems Engineering, a Capstone Project, and JPME. The thesis is replaced with a group project that requires students to interact with senior Naval leaders and address significant issues of immediate relevance to the Fleet.

The SEA program is led by the OPNAV N9I Chair for Systems Engineering Analysis (Professor of Practice Jeff Kline, Captain, U.S. Navy, retired). The Academic Associate is Mark Stevens (Lieutenant Colonel, U.S. Army, Retired), and the Program Officer is LCDR Vince Naccarato (USN). Students who complete this curriculum receive a Master of Science in Systems Engineering Analysis (MSSEA)—awarded jointly by the Chair of the Systems Engineering Department and the Chair of the OR Department—and qualify for Navy subspecialty code 6500P.

**Non-Resident (Distance Learning) Programs**

Unlike students in resident programs who attend school full-time, students in non-resident distance learning (DL) programs take classes while working in full-time positions, typically at Navy and other DoD installations. As a result, students in these programs typically take two classes per quarter during a two-year period, and they typically complete a capstone project in lieu of a Master’s thesis. The resulting degree is not a Master of Science, but a specialized Masters degree consistent with the needs of practitioners.

*Curriculum 363, Systems Analysis (MSA)* is the main DL program offered by the OR Department. Systems Analysis is a “basis for aiding key decisions on force requirements, weapon systems, and other defense matters.” This curriculum is sponsored by OPNAV N81 Assessment Division, and students receive a Master of Systems Analysis degree and get an OR-related subspecialty code upon graduation (Code: 3210P). Table 4 shows the typical coursework for this curriculum defined by ten ESRs (detailed in the online catalog):
Table 4: Standard course matrix for Curriculum 363

Curriculum 359, Human Systems Integration (HSI) is sponsored by OPNAV N12, who also sponsors the Navy Education and Training. HSI acknowledges that the human is a critical component in any complex system. It is an interdisciplinary approach that makes explicit the underlying tradeoffs across the HSI domains, facilitating optimization of total system performance in both materiel and non-materiel solutions to address the capability needs of organizations. HSI domains include manpower, personnel, training, human factors engineering, habitability, safety and occupational health, force protection and survivability. HSI has six ESRs: (1) Systems Approach, (2) HSI Domain Knowledge, (3) Human Performance, (4) Implementing HSI Tradeoffs, (5) Analytical Techniques, (6) Modeling and Simulation. Students completing this program receive a Master of Human Systems Integration degree. The matrix for HSI is found in Table 5.

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
<th>Q8</th>
</tr>
</thead>
</table>

Table 5: Standard course matrix for Curriculum 359

Curriculum 379, Cost Estimating and Analysis (MCEA), was created in 2010 in response to President Obama signing the Weapons System Acquisition Reform Act (WSARA) in 2009. Primary seed money was provided by NAVSEA, with additional funds from NAVAIR. MCEA is sponsored by NAVSEA with significant support from the three service cost agencies (NCCA, AFCAA, and DASA-CE). Students completing this program receive a Master of Cost Estimating and Analysis degree. Table 6 shows the typical coursework for this curriculum defined by twelve ESRs (detailed in the online catalog):
These DL programs differ in that they are funded via the Department of Defense Acquisition Workforce Development Funds (DAWDF). Table 7 compares the three DL programs:

<table>
<thead>
<tr>
<th>Program Manager</th>
<th>Program Officer</th>
<th>Academic Associate</th>
<th>Sponsor</th>
<th>Funding Resources</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larry Shattuck</td>
<td>Steve Pilnick</td>
<td>Greg Mislick</td>
<td>OPNAV N12</td>
<td>NPS/DAWDF</td>
<td>8 quarters</td>
</tr>
<tr>
<td>Larry Shattuck</td>
<td>Jeff Hyink</td>
<td>Kevin Maher</td>
<td>OPNAV N81</td>
<td>NPS</td>
<td>8 quarters</td>
</tr>
<tr>
<td>Larry Shattuck</td>
<td>Steve Pilnick</td>
<td>Kevin Maher</td>
<td>NAVSEA 05C</td>
<td>DAWDF</td>
<td>8 quarters</td>
</tr>
</tbody>
</table>

Table 7: The Three OR Distance Learning Programs

Certificate Programs

NPS OR also offers three certificate programs that can be taken in residence or via DL. Each of these is a one-year program, and requires four courses to complete.

**Curriculum 262: Human Systems Integration**
- OA3411 Introduction to Human Systems Integration
- OA3412 Human Systems Integration in the Acquisition Lifecycle
- OA3413 Human Systems Integration Tools, Tradeoffs, and Processes
- OA4414 Human Systems Integration Case Studies and Applications

**Curriculum 281: Systems Analysis**
- OS2080 Probability and Statistics I
- OS3380 Combat Systems Simulation
- OS3680 Naval Tactical Analysis
- OS4680 Naval Systems Analysis
Curriculum 289: Cost Analysis

- OS3006 Operations Research for Cost Analysts
- OS3701 Cost Estimation I: Methods and Tools
- OS4702 Cost Estimation II: Advanced Concepts in Cost Estimation
- OS4012 Cost Estimation III: Risk and Uncertainty Analysis

Support for Other Curricula at NPS

The OR Department also offers many courses to support the other curricula on the NPS campus, including Curricula 580 (Systems Engineering), 311 (Systems Engineering DL), 721 (Systems Engineering Management PD21), 399 (Modeling, Virtual Environment & Simulation), 525 (Undersea Warfare), 368 (Computer Science), 370 (Information Systems & Technology), 847 (Manpower Systems Analysis), 837 (Financial Management), 817 (Defense Systems Analysis), and 691 (Homeland Security and Defense). Curriculum 308 (Systems Engineering Analysis) is co-managed by OR and the Systems Engineering (SE) Department, with each department providing a subset of the courses and both the SE and OR chairs signing a final capstone project report.

While some curricula require their students to take existing OR courses, many others request our department to develop new courses to meet the specific needs of their students.

In 2015, 39 course sections were offered to other curricula, with 24 of these sections being offered in the SE Department. In recent years, about 20–25% of our course sections have been offered to other NPS curricula.

5. Students

Our students are all mid-grade employees of the DoD who have already served operationally from five to 15 years prior to attending NPS—they bring first-hand knowledge of the challenges the DoD faces and leave as OR practitioners to immediately meet these challenges.

As of September 2015, there were 118 students enrolled in the resident MSOR degree program, including 103 U.S. Officers from the Army, Navy, and Marine Corps, and 15 international officers from nine countries: Australia, Germany, Israel, Korea, Malaysia, Pakistan, Singapore, Spain and Turkey. These “on board” numbers have remained very consistent over the past decade. There are about 55 MSOR graduates each year.

Our students arrive as accomplished leaders and professionals who have achieved early success sufficient to earn them assignment to NPS, and with much to contribute to establishing a continuous bridge linking our research, students and our DoD organization. Recently, many of our students have been combat veterans. Classes are held 48 weeks per year with two weeks off in both June and December. Our over 4,300 alumni represent all four US military services as well as those of 56 other countries--these bridges reach around the world and are durable over time.
**Resident Students**

Resident students in the Operations Research department are enrolled in one of four curricula, of which the most populous are Operations Analysis (OA), Joint Operational Logistics (JOL), and Systems Engineering Analysis (SEA). Table 8 shows the average number of students by source (U.S. military branch, civilian, or international), and by curriculum, as recorded by NPS quarterly enrollment reports since Spring of 2013. The final row gives the enrollment in the final quarter of 2015.

<table>
<thead>
<tr>
<th>Source</th>
<th>Energy (358)</th>
<th>OA (360)</th>
<th>JOL (361)</th>
<th>HSI (362)</th>
<th>SEA (308)</th>
</tr>
</thead>
<tbody>
<tr>
<td>International</td>
<td>0</td>
<td>17.7</td>
<td>1.3</td>
<td>1.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Civilian</td>
<td>0</td>
<td>0.8</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Army</td>
<td>0</td>
<td>10.8</td>
<td>0</td>
<td>0.5</td>
<td>4.2</td>
</tr>
<tr>
<td>Air Force</td>
<td>0</td>
<td>0.2</td>
<td>0</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>Marines</td>
<td>0</td>
<td>20.6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Navy</td>
<td>3.1</td>
<td>48.8</td>
<td>13.5</td>
<td>0.8</td>
<td>22.2</td>
</tr>
<tr>
<td>10-qtr avg.</td>
<td>3.1</td>
<td>98.9</td>
<td>14.8</td>
<td>3.8</td>
<td>26.8</td>
</tr>
<tr>
<td>2015-Q4</td>
<td>5</td>
<td>93</td>
<td>14</td>
<td>2</td>
<td>21</td>
</tr>
</tbody>
</table>

Table 8: Average Resident Enrollment, by Source and Curriculum, 2013Q3 to 2015Q4

The number of enrolled students has been fairly constant across quarters, with some fluctuation in the number of Navy personnel enrolled. Figure 2 shows the number of students by quarter, by source, for both resident (left panel) and DL (right panel) programs. In the left panel, the small number of civilian and Air Force students has been added into the total for the Navy; in the right panel the small number of International students has been added into the total for Civilians.

![Figure 2. Left: Number of Resident Students by Source and Quarter. Right: Number of DL Degree Students by Source and Quarter.](image-url)
Distance-Learning (DL) Degree Students

The makeup of the department's distance-learning students is quite different from that of resident students. The three DL curricula award a Master of Human Systems Integration (HSI), a Master of Systems Analysis (MSA), and a Master of Cost Estimating and Analysis (MCEA). Table 9 shows the average number of students across the last ten quarters, by curriculum and source.

<table>
<thead>
<tr>
<th>Source</th>
<th>HSI (359)</th>
<th>MSA (363)</th>
<th>MCEA (379)</th>
</tr>
</thead>
<tbody>
<tr>
<td>International</td>
<td>0.4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Civilian</td>
<td>12.2</td>
<td>5.9</td>
<td>49.5</td>
</tr>
<tr>
<td>Army</td>
<td>0</td>
<td>4.4</td>
<td>0</td>
</tr>
<tr>
<td>Marines</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Navy</td>
<td>13.2</td>
<td>40.4</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>10-qtr avg.</strong></td>
<td><strong>25.8</strong></td>
<td><strong>52.7</strong></td>
<td><strong>50.6</strong></td>
</tr>
<tr>
<td><strong>2015-Q4</strong></td>
<td><strong>26</strong></td>
<td><strong>56</strong></td>
<td><strong>56</strong></td>
</tr>
</tbody>
</table>

Table 9: Average DL Enrollment by Curriculum and Source, 2013Q3 to 2015Q4

Figure 2 (Right) shows the distribution of DL students by source and quarter. Here the small number of international students has been included with civilians, while Army and Marine students have been combined into one group. While the numbers of Navy and civilian students are comparable, it is worth noting that the Cost Estimation curriculum is made up almost entirely of DoD civilians, while Systems Engineering is primarily Naval students and HSI is about evenly split.

Distance-Learning (DL) Certificate Students

A certificate typically requires about a quarter of the coursework that a DL degree does: one course in each of four quarters. Table 10 shows the average certificate enrollment by source over the most recent ten-quarter period. Some students in degree programs also receive certificates; we are unsure whether these enrollment numbers exclude those students. In this table, the tiny number of International students has been added into the Civilian group.

<table>
<thead>
<tr>
<th>Source</th>
<th>HSI (262)</th>
<th>MSA (281)</th>
<th>MCEA (289)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civilian</td>
<td>9.4</td>
<td>6.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Air Force</td>
<td>3.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Marines</td>
<td>0.3</td>
<td>1.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Navy</td>
<td>3.7</td>
<td>10</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>10-qtr avg.</strong></td>
<td><strong>16.5</strong></td>
<td><strong>17.3</strong></td>
<td><strong>3.8</strong></td>
</tr>
<tr>
<td><strong>2015-Q4</strong></td>
<td><strong>15</strong></td>
<td><strong>14</strong></td>
<td><strong>2</strong></td>
</tr>
</tbody>
</table>

Table 10: Average DL Enrollment by Curriculum and Source, 2013Q3 to 2015Q4

The proportions of OR Department students allocated across Resident, DL Degree and Certificate programs has been roughly constant across the last ten academic quarters. Figure 3 shows the number of students by program for each of the last two academic quarters.
6. Resources

Administrative Staffing

Currently, administrative support for 44 faculty members is being served by two full-time staff positions that fall directly under the Chair: Administrative Management (Angela Abeillard) and Office Automation Assistant/travel-OFTA (currently unfilled). NPS OR also relies on support staff in the office of the Dean of GSIS for specific functions (e.g., financial management, and an educational technician to process students). Currently, there are no administrative resources to support DL programs.

Contract Teaching

During the last several years, NPS OR has needed to look outside the Department to find enough instructors to cover all of its courses. In FY15, of the total 170 course sections taught, 20 of them (~12%) were not taught by full-time OR faculty members and were covered instead by interim faculty members, research associates, faculty from other departments, and contractors. In fact, the total amount of outside “contract teaching” during the last five years is as follows:

- AY2012: 5 sections
- AY2013: 7 sections
- AY2014: 6 sections
- AY2015: 7 sections
- AY2016: 8 sections

In AY2016, we are projected to offer 171 sections, and 20 are projected to fall into this category.
In general, a single full-time employee (FTE) equates to eight sections of teaching. However, since a tenure-track faculty member teaches four sections a year, the Department essentially has recently been short by at least five professors, roughly speaking. As a result, non-tenure track faculty and military faculty teach the majority of the DL courses.

Facilities and Equipment

In addition to office space for faculty and staff, the OR Department maintains the following shared facilities and equipment:

- **A Student Study Center**: GL 285 consists of 33 study carrels, two work tables, monitors, a copier, and a shredder to support students working on their theses.

- **Two conference rooms**: GL 286 seats 20 people, and GL 232 seats 6. Each conference room is equipped with a computer, a projector, and video teleconference equipment.

- **A Technology Enhance Active Learning (TEAL) room**: GL 128 consists of four round tables each supporting eight students and their laptops, multiple projectors, and video teleconference equipment. It is used primarily for active classroom and laboratory sessions.

The Department also has the following dedicated research facilities:

**Optimization Lab (GL-206)**: This lab contains restricted access high performance computers for large-scale optimization modeling. Specifically, there are six desktop tower computers, up to 36 CPU cores, 128 GB memory, multiple modeling languages and solvers as well as language compilers. Additionally, two high performance Secret level laptops are available for classified computing.

**SEED Barn (GW 2007/2007A)**: About 400 ft² total. Air-conditioned server room, with cluster computing resources (about 100 ft²), including RAID storage system, 160 Windows-only CPUs, 96 multi-boot CPUs, loaded with necessary cluster control software, multiple simulation modeling platforms. Flexible space (about 300 ft²): Workspaces for our Faculty Associates—Research when they are in town, SEED Center visitors, student interns, and center table for research meetings, presentations to visitors, or tutorial sessions between our research associates and students.

**SEED lab (GL 284)**: About 400 ft² total. Dedicated workspaces for up to 9 students, each with a recent model desktop (up to 32 GB memory, 1 TB hard drives, 16 CPUs), Laptops (both Windows & OSX) for student work, flexible work space including Smart-board and overhead projector for group work and student interns.

**Human Systems Integration Laboratory**: About 2200 ft² of configurable space, used extensively for laboratory and class exercises, thesis data collection and analysis. Equipped with human performance measurement equipment, including Usability analysis system (Noldus Observer system); Eye-tracking equipment; Visual acuity, depth perception, color blindness; Auditory perception; 3-D motion capture system; Anthropometric measurement equipment; Actigraphy and Psychomotor Vigilance Testing (PVT); Physiological monitoring equipment; Team Performance Laboratory.

The Department also has access to the Secure Technology Battle Laboratory (STBL) and other classified space on campus, in which faculty members maintain classified computing resources.
7. Assessments and Review

The department solicits both internally and externally generated feedback as a tool for course refinement and curriculum alignment with sponsor needs. Internal feedback largely comes from the student body immediately after completed courses, but also in the form of student surveys upon graduation, and through sponsor channels and surveys of previous graduates. External feedback is primarily generated during sponsor visits to NPS. This feedback strongly influences the Educational Skill Requirements and military-focused courses in the curricula.

Sponsor Visits

All of the resident programs with attached curricula at NPS are sponsored at the 3-star level within OPNAV—The Chief of Naval Operations Staff. Individual sponsors are empowered to both underwrite the school’s mission funds to support active duty student enrollment and engage with Department Chairs on writing the Educational Skill Requirements needed to enable graduates to function in “coded billets” throughout the Fleet that are specially annotated to hold graduates of the sponsored program. The sponsor is in essence the underwriter for the curriculum, and likely—as in the case of Operations Research—the biggest employer of our graduates through the large number of coded billets within their command. Sponsor visits for curriculum reviews are required biennially by NPS instruction (NAVPGSCOLINST 1550.1F). This on-site review typically consists of an end-to-end review of the core curriculum, student briefings, and discussion. The Operations Research Department curricula are all quite mature and have enjoyed exceptional support and alignment with our OPNAV sponsor. Significant action items from the three most recent reviews for Curriculum 360 (Operations Analysis) are summarized in Table 11 below:

<table>
<thead>
<tr>
<th>Review</th>
<th>Item</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>Provide means to further develop graduates’ oral and written communication skills</td>
<td>Complete. Numerous presentation requirements added to coursework. Writing rubric endorsed. All graduates required to brief thesis in executive format during quarterly conferences.</td>
</tr>
<tr>
<td>2011</td>
<td>Consider shortening Experience Tour block</td>
<td>Complete. Shortened to 3 weeks</td>
</tr>
<tr>
<td>2013</td>
<td>Continue to develop the means to improve graduates’ oral and written communication skills. Institutionalize use of military faculty in this role.</td>
<td>Complete. Military faculty members now lead the quarterly Thesis Conference. Graduate Writing Center now open. Some interaction with GWC is mandated—lots of support available.</td>
</tr>
<tr>
<td>2013/15</td>
<td>Enhance breadth and depth of spreadsheet modeling in curriculum.</td>
<td>Complete. Spreadsheet modeling course overhauled and continues to be high visibility.</td>
</tr>
<tr>
<td>2015</td>
<td>Move Wargaming from elective to required. Move Human Factors from required to elective.</td>
<td>Complete.</td>
</tr>
<tr>
<td>2015</td>
<td>Continue to work to increase fill rate of Navy quotas aboard NPS</td>
<td>In work. Continued visibility. Largely a personnel system action.</td>
</tr>
</tbody>
</table>

Table 11: Significant action items from the last three biennial Curriculum Reviews
Internal Surveys

Upon course completion, all students are required to submit Student Opinion Forms (SOF) prior to seeing their earned grade. This process is native to the NPS Registrar’s system. Instructors see open text commentary on the delivered course as well as numerical scores. The Department Chair sees numerical scores and uses these for purposes of recognition and future teaching assignments. The Military Program Officer frequently does systematic polling of graduates on broad issues such as workload, curriculum focus areas and resonance with service needs recognized by the students. Previous issuances of these surveys have supported some of the decisions enumerated above during curriculum reviews, but have also reshaped some of the classroom material. Specific examples from recent surveys include: Continued broad student support for the refresher quarter for those who were afforded one (this additional time at NPS is frequently scrutinized); reshaping the Non-Linear Programming course material to a more applied format to help students make connections to more military applications; and the shortening of the Experience Tour to recoup some of the unused time for classroom instruction.
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   Vision for Success ............................................................................................................................. 2
   Assessment..................................................................................................................................... 3
2. Our Products ................................................................................................................................ 4
   Vision for Success ............................................................................................................................. 5
   Assessment..................................................................................................................................... 6
3. Our Market .................................................................................................................................... 8
   Vision for Success ............................................................................................................................. 8
   Assessment..................................................................................................................................... 10
4. Our Environment ........................................................................................................................... 11
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Introduction

This is the second of two documents resulting from the 2015-2016 Academic Program Review (APR) conducted by the Naval Postgraduate School (NPS) Operations Research (OR) Department. The first document is a comprehensive Self-Study that objectively describes the current state of affairs and activities within the Department in support of its educational and research missions.

This sequel document provides (i) a Strategic Assessment that revisits the goals of the Department and looks at how NPS-OR is currently performing relative to these goals, and (ii) a Strategic Plan that provides guidance and identifies specific activities for NPS-OR over the next five years.

The overall goal of this Strategic Assessment and Plan is to provide a framework for decision-making in the Department. Success for this document will be measured in terms of the extent to which it is used to guide decisions.

Framework for Assessment

As an organization, NPS-OR shares many features with a small business operating in a highly competitive environment. Specifically, long-term success of the Department depends on its ability to manage risk in the following four dimensions.

1. **People.** The Department needs the right mix of skills and abilities in its faculty and staff in order to address the modern challenges faced by the Navy and the DoD.
2. **Products.** The Department must continue to produce outstanding education and research that is responsive to the changing needs of its sponsors.
3. **Market.** The Department must work proactively to understand the needs of its current customers as well as develop new relationships in places where it can add value.
4. **Environment.** As part of the Navy and DoD, the Department must operate in an environment that presents opportunities and challenges very different from those of most academic and research organizations.

The following sections discuss these issues in detail.
1. Our People

The people of the Department—the faculty and staff—are its most valuable asset. Therefore, the strategic thinking of the department must include a plan to retain existing employees and to recruit new ones as they become needed.

The faculty, particularly the tenure-track faculty, provide leadership for the department and are the ones that are ultimately responsible for the output of the department. This document devotes greater attention to the subject of academic faculty than on the other components, not because they are inherently more valuable, but in the belief that career academics are harder to find, nurture, and retain than military faculty or staff members.

Vision for Success

We define success for our people along the following lines.

**Academic Reputation:** A primary measure of success for the department is its academic reputation. As a Department, we should be a recognized leader for operations research broadly, and be the undisputed home of military operations research worldwide. Our expertise should be highly demanded by research sponsors and the military services. Our faculty members should play leading roles in professional organizations and be sought after by the broader academic community to serve in various leadership roles, as referees and editors for top journals, as members of prominent research committees and/or review panels, and as organizers of top-tier meetings and conferences. Our faculty members should be viewed as award-winning scholars with stellar reputations. Based on this collective reputation, advertised faculty job openings should attract many qualified candidates.

**An Academic Hub:** Our department should be a place that other scholars know and want to visit, and we should proactively encourage and facilitate such visits. These might be one- or two-day stays to present a seminar, or one- to six-week stays for focused work with an NPS collaborator, or stays of a quarter or more as visiting faculty involved with a full-fledged research project and/or teaching. Faculty should be encouraged to organize small workshops, and there should be little administrative burden for doing so, particularly when the costs are small.

**Coverage of Diverse Academic Interests and Needs:** From its origins in World War II, military operations research has been a diverse enterprise, and the rapidly changing nature of modern warfare and national security problems makes this even more true today. NPS-OR faculty interests and expertise reflect this diversity, and it enables our academic programs to cover a range of topics that exceeds the offerings of many of our competitors. It is therefore important that our faculty be diverse in their coverage of what we internally view as the “pillars” of OR, and that each pillar include faculty members at various stages of their careers. It will always be important that the Department actively manage the number of faculty with expertise in each of the areas of OR.

**Recruiting and Retention:** Recruiting and retention of top-tier faculty does not stop when new hires arrive. Rather, new faculty should be mentored by experienced ones, to ensure that they develop as researchers, as teachers, and as members of the academic community. Mentorship can
take many forms, but the department should help each faculty member create a career development plan, that includes suggested steps that senior members might take as part of their mentorship. We know we are successful when junior faculty members develop into senior leaders within the department and there is little attrition.

**Military Faculty:** A substantial portion of our faculty are active-duty military officers with postgraduate degrees but who are not career academics. The Department depends greatly on these officers to teach and manage students. But the collective benefit is even greater when these officers are involved in research efforts—our faculty and research products are enhanced by this additional military expertise, and these officers become better prepared for subsequent jobs. The department should ensure that military faculty have a balanced teaching load that provides these developmental opportunities. The department must also continue to create opportunities for professional development for these individuals. In turn, the Department needs to maintain high expectations in recruiting the best possible military faculty.

**Staff:** Having an adequate number of well-trained administrative staff is vital to the success of the department. These professionals can—by handling the processes and paperwork associated with research funding, travel, contracting, and legal—free up faculty members so that the latter can work on tasks essential to the core mission of education and research. Staff members should not only be able to perform well at their own jobs, but also should have enough cross training to help other staff members during unusual periods of high activity. It is important that the department recruit and retain staff, allow them time to train, nurture them professionally, and offer them development opportunities.

**Assessment**

On one hand, our faculty is strong, as evidenced by the department's continuing strong performance in the Rothkopf rankings and the recent award of the INFORMS Smith Prize. The Department now has three members of the National Academy of Engineering (NAE) as well as senior fellows of many professional academic societies.

However, for more than 15 years it has been recognized the Department has been at risk because of an aging faculty—a significant number of senior faculty members have retired or are eligible for retirement. Several of them continue to work in an emeritus capacity (including two of three NAE members). Due to administrative and/or budget restrictions, we did not hire any external tenure-track faculty between 2011-2015 (although one non-tenure track faculty member was hired onto the tenure track during this period). During the last few years we have suffered from attrition—two of our recent assistant professor hires (from 2009-2010) and our senior statistician have left NPS OR and moved to other universities. In Spring 2016, we hired two new tenure-track professors, but the demographics of the department remains skewed with very few junior faculty.

In addition, the existing salary caps make NPS compensation uncompetitive for intermediate to senior faculty levels. Moreover, in recent years it has become extremely difficult to hire non-US citizens, thus shrinking the pool of potential faculty hires.
As a result, our faculty is under-sized. Although recent changes have made it possible to hire more faculty members, the lengthy approval process of making an offer to a job candidate puts us in a disadvantage to compete with peer institutions. The Department must make an effort to mentor new faculty and to retain existing ones. It must also prepare for the inevitable retirements of its more senior members. These members bring more than just classroom and teaching experience; they also collectively represent thousands of friendships and contacts in DoD and academia which will be lost upon their retirements.

The Department has a solid reputation among the military and within parts of academia, but we are not as well-known as we need to be. The Department should support efforts to have faculty members forge connections to academics with overlapping interests at nearby academic institutions (for example, UC Berkeley, Stanford, UCSC, Cal Poly, UCSB), at civilian think-tank type organizations (for example, the Panetta Institute, MIIS-Monterey) and at Navy/DoD/Government agencies (e.g., N81, Combatant Commands, Defense Innovation Unit Experimental DIUx). We need to proactively engage with the outside world; our members should visit, and give seminars at, institutions that house academics with similar interests.

The Department has fewer visitors than in the past, at least in part because of the high administrative burden for inviting guests and getting them access to NPS. The department should actively encourage visitors and have budget for an active program in which scholars from other institutions are encouraged to visit. There should also be funds available for faculty to organize small meetings involving scholars working on problems of acute interest. NPS and DoD can support the department’s mission by smoothing these organizational difficulties.

The notion of the “pillars of OR” is widely used in our department to refer to key areas of expertise (e.g., statistics, stochastics, simulation, optimization), though perhaps not as much in the broader academic community. To some extent this idea helps to organize the various areas of academic expertise among the faculty. However, the diverse and interdisciplinary nature of many military OR problems necessitates expertise across these pillars, and the Department is most effective when faculty collaborate across these domains. To the extent that internal (albeit informal) organization of faculty along these pillars creates boundaries that discourage this collaboration, the department should consider if it might be better served by organizing its identity in a different way, perhaps around important problem areas (like infrastructure defense, data analytics, or unmanned systems). Having a clear notion of departmental identity organization can only be a benefit in hiring, retaining and managing the faculty workforce.

2. Our Products

Our department produces three primary products: our teaching, our research, and our graduates. We evaluate success for these products in the following ways.
Vision for Success

Research: Academic research is a core mission of our faculty. OR faculty contributions to theory and practice should almost always be documented through publication to the appropriate communities.

We are successful when our faculty produce high-quality peer-reviewed journal publications, books, conference presentations, and other academic products. Historically, much of this research has resulted in awards for individual faculty members, and it should be the explicit goal of the Department and its faculty to produce award-winning research, which brings prestige to the Department and enhances its reputation.

However, another important research product consists of sponsored projects—research that is more applied and often not suitable for academic peer review—delivered to DoD sponsors for particular projects. These projects provide an important mechanism for directly supporting the warfighter via quality analysis of operations and/or better planning. Even when not suitable for public academic peer-review, faculty have the ability to document the output in two ways:

(1) As a technical report—NPS supports the creation and management of technical reports that are unclassified, restricted distribution, or classified.

(2) As a project “transition”—the documented delivery of a project into the hands of practitioners.

Publishing is healthy for the OR community, the Department, and the individual faculty member, and it is expected, even when not required by the research sponsor. The department should provide incentives for faculty to complete projects of real value to the Navy and DoD and document them appropriately. Research transitions, especially if they can be shown to lead to changes in strategies and policies, are highly valued by some sponsors such as the Office of Naval Research. Currently, research transitions are not measured or rewarded by the Department, but they might be measured and used by the department in its assessments. Moreover, although not all student Masters theses involve applied project work, or should, the extent to which our students’ theses are put to use in ways that specifically benefit DoD might be another measure of faculty productivity. Collectively, these products demonstrate ongoing value and relevance of the NPS-OR research enterprise to the Navy and DoD.

Research output is recorded in the Faculty Annual Reports that each member produces. It might be useful to monitor the total output of the faculty to ensure that standards of quality and productivity are being maintained.

Teaching: The breadth and depth of our Department’s expertise becomes less relevant if our faculty cannot collectively impart their knowledge to our students. We expect all of our faculty members to excel in the classroom. In aggregate, we measure success in terms of the knowledge and capabilities that our graduates take with them into the field upon graduation. However, we measure success for individual instructors and course offerings according to standards maintained for each course or sequence of courses.
It will also be a positive sign when our students report that the teaching is successful, but measures of teaching quality that are better than the current Student Opinion Forms are needed. We need to create and institutionalize reasonable measurements of teaching quality. These might include observation by other faculty, something which is rare today. This activity might be part of a robust mentorship program to develop and guide newer faculty. Faculty should be encouraged, and incentivized, to avail themselves of the teaching-skills classes conducted by the PETAL (Promoting Excellence in Teaching to Advance Learning) group on campus.

Because the set of faculty members is fluid, it may be inevitable that from time to time certain core courses need to be taught by contractors or military faculty members. Moreover, our department is unique in that we have a large contingent of military faculty who are able to bring their military experience into the classroom. Still, it should be our goal that all or most of the department’s core courses are taught by the tenure-track faculty. We will know we are successful when almost all of our core courses, and a substantial fraction of service courses, are taught by the tenure-track faculty.

**Graduates:** Our graduates are well-prepared to be analysts upon graduation, but only a fraction of them immediately take positions in military analytic community. In many cases, our students follow graduation with more training and then sea duty, which deprives them of the opportunity to put their education to immediate use. Only a fraction of our graduates end up serving in an analytic billet, and only a fraction of the analytic billets are filled by officers trained (by NPS-OR or otherwise) as analysts. Although NPS has little control over how our graduates are employed by their military services, we should always be advocating to have them placed in positions where analysis can influence operations or policy.

Our graduates continue to interact with us as alumni. They end up being one of the biggest advocates for what we do. However, the nature of their duty assignments after graduation often makes it difficult for them to continue close ties with the Department. Collectively, they have positions in offices all over the military analytic community, DoD, and the globe. Beyond relationships that are maintained by individual faculty members, there is little ongoing connection with them unless they end up in a sponsoring organization such as N81.

A strong network of NPS-OR graduates within the military analytic community could serve as an additional resource to exchange ideas, solve common problems, and break down organizational barriers. Professional societies such as the Military Operations Research Society (MORS) help to facilitate this interaction, but the Department does not currently coordinate any activities to this effect. The Department should make efforts to manage alumni relations to keep our graduates engaged with the department, with one another, and with the practice of OR in the military.

**Assessment**

The Department continues to produce high-quality, award-winning research, but the number of faculty members producing this work is lower than it needs to be to maintain our academic reputation. Also in some cases, faculty members are electing to conduct applied project work at the expense of peer-reviewed publications. Arguably, the Department could be better insured over the long haul by increasing the volume high-value applied work to DoD sponsors. However, in order to
maintain a strong presence within the academic community and military sponsors, this balance needs to be carefully managed for individual researchers as well as for the Department as a whole.

Overall, we believe the quality of education received by our students is high. However, we need more effective methods to evaluate teaching performance, and mechanisms to motivate instructors to excel. Often, the quality of individual courses and course sequences is left to the subjective management of faculty members involved in their delivery. Each course has a course coordinator, whose job is to oversee the course from offering to offering, provide guidance to new instructors, and ensure that each offering is consistent regardless of its instructor. However, the level of involvement by many course coordinators is low. The department should instill a culture and motivate course coordination, so that each course coordinator takes real responsibility for his or her course.

Moreover, while the aforementioned “vertical integration” of courses is fairly good, the department has done relatively little to encourage “horizontal integration” among courses that students take concurrently. Better coordination might result in stronger learning outcomes for our students, or perhaps more simply, a more pleasant experience. Again, this is a place where course coordinators could play an important role.

The Department last revised its primary course matrix (for Curricula 360 and 361) approximately four years ago following a sponsor Curriculum Review. At that time, there were several changes in the number and sequence of required and elective courses. In the meantime, there has been demand for new areas of study (e.g., the new data analytics sequence) as well as discussion of other new offerings (e.g., a cyber focused track). It is time for the Department to revisit this internal conversation (regular conversations with our sponsors happens during Curriculum Reviews every two years), evaluate the performance of our existing offerings, and consider the potential for proactive changes to our matrix so that it continues to adapt to the needs of our students and the broader analytic community.

The Department has seen considerable growth in its distance learning (DL) programs over the last 15 years and now has three strong DL programs. During this period, we have gone from a student body that was 100% in-residence students to one that is now approximately 50% in-residence and 50% DL. Yet, the emphasis on teaching and educational program development by the tenure-track faculty remains on the in-residence students. At the current time, it seems unlikely that the Department should be trying to expand its DL programs or Certificates. These create additional resource needs for teaching and administration, which are not always consistent with our stated goals of having the majority of our courses taught by tenure-track faculty as well as our end-strength authorizations. Currently, we have not articulated the desired end-state mix of tenure-track and non-tenure-track faculty. These need to be considered in a manner that is consistent with our teaching goals.

As a Department, we are extremely proud of our graduates. The Department can and should make efforts to track, and continue communication with, its graduates. In addition, the Department should consider ways in which it can encourage the network of graduate interaction, not just with the Department, but with each other. One potential way to do this would be to offer ongoing
executive learning opportunities, perhaps in the form of webinars, guest seminars (e.g., in Washington D.C.) or informal meet-and-greet events (perhaps sponsored in partnership with the NPS Foundation).

3. Our Market

The OR Department serves several customers: the U.S. Navy and all of the U.S. armed services, the Department of Defense, and the U.S. Government. It is important that the Department maintain an acute awareness of the needs of these customers, in order to remain relevant and responsive to their needs. To this end, we evaluate success in this market in the following ways.

Vision for Success

Curriculum Sponsors. First and foremost, because the sponsor of our two largest curricula (Operations Analysis 360 and Systems Analysis 363) is the Assessments Branch of OPNAV (N81), it is imperative that we maintain the excellent relationship that we have established with this office. The bi-annual curriculum review process provides some continuity for making sure our curricula are satisfying their needs. And the Department has also recently engaged components of N81 on limited sponsored research projects. However, the ongoing rotation of personnel within that office requires that we remain vigilant in connecting, ideally in person, at every opportunity.

We want the Navy to be avid consumers of our products, the Navy should want to send people here, they should want to direct theses, and they should be excited about putting our research into practice. Therefore, another way to measure our success is by the amount of reimbursable money received from Navy and DoD sponsors.

The Department also serves students from other branches of service, notably the US Marine Corps (USMC) Operations Analysis Division (OAD), which is the locus for military analysis in the USMC, as well as the US Army, specifically the FA49 Executive Agent (Director of Program Analysis and Evaluation, United States Army) and FA49 Army Civilian School Committee Head. Officers from these sponsors take slightly modified course matrices as part of their degree program. Relationships with these sponsors are maintained in large part by individual military faculty members from the respective services who serve as primary points of contact with these offices to make sure that NPS-OR is meeting their needs. The recently launched “analytics track” for Army officers is an example of NPS-OR responding to these changing needs.

More than 15 years ago, NPS-OR also had students from the US Coast Guard (USCG), but they are currently sending students to other schools. This is a potential future opportunity that should be pursued by Department leadership.

Combatant Commands and DOD agencies. The military analytic community is broader than what resides at headquarters in Washington, D.C., however, and it is important that we serve the needs of the combatant commands (COCOMs) as well. The use of analyst billets in the COCOMs is not uniform, and therefore relationships between NPS-OR and COCOM leadership is ad hoc and typically left to initiatives of individual faculty. As a Department, we do not systematically reach out or engage the COCOMs to understand and serve their needs. This is true of NPS as a whole, so NPS-
OR is not “out of the norm” in this regard. However, the Department should work to maintain relationships with analytic organizations at the COCOMs so that we can respond with thesis projects or sponsored research when appropriate, and we should work to help establish analytic outposts at the COCOMs when they do not already exist.

The techniques of operations research cover a large segment of the decision space for our military services, but principally focus in a few areas: Tactics and operational practices, procurement decisions, resource allocation decisions including personnel policy. Visibility with Flag leadership and communication with support staffs will strengthen the department’s standing and focus attention on our graduates. Targets of departmental engagement should include:

- **OPNAV**: Procurement decisions, personnel policy, logistics policy. Our largest billet holder.
- **USFFC**: Resource allocation decisions (man/train/equip spectrum)
- **SYSCOMS**: Procurement decisions, warfare analysis. Large volume of theses at the PM level.
- **ONR**: Warfare analysis. Excellent linkage across diverse research areas.
- **COCOMS**: Warfare and logistics analysis.

Due to the high rotational turnover at many of these commands, the department should devote resourcing necessary to support repeated engagement with these commands. A successful “road show” for the department will accomplish three main goals:

1. Educate the target audience on the applications of OR to military problems. We can’t be asked to contribute to the solution if the decision-maker can’t connect problems to OR techniques.
2. Review of applied/theoretical work within the scope of the decision maker’s responsibility.
3. Discussion of resources available to be “tapped” including our graduates (billets) and conduits for research.

This implies that a key priority is ensuring that we have a solid connection with Navy and DoD leadership; and that part of our charter is to be ambassadors of the discipline needed to educate and connect with a circulating executive branch of the services. We want the Navy to reach out to us to solve the problems that they face.

**Research Sponsors.** Traditionally, NPS-OR faculty have received basic research funding mainly from Office of Naval Research (ONR) and the Air Force Office of Scientific Research (AFOSR), and to a less extent from the Army Research Office (ARO), the National Science Foundation (NSF), and the Defense Advanced Research Projects Agency (DARPA). These funding sources are especially attractive because they provide faculty significant freedom in pursuing new concepts and theories that might not be of immediate relevance to the DoD. As these funds are obtained in competition with other academic institutions, they are also instrumental in enhancing the standing of the department overall. NPS-OR should encourage and provide incentives to faculty members to seek such funding. Successful engagement with basic funding agencies should amount to multiple (e.g., two to three) projects at any point in time. Because these funding agencies themselves are subject to fluctuations in priority, it is also important that the Department as a whole maintain some diversity in the sources of research funding.
Military Operations Research. We believe that our department serves as the stewards of military operations research. Historically, we have defined ourselves internally in terms of competencies (i.e., some of our faculty members are statisticians, others are optimizers, and so on). These labels may, however, be outdated; they might create barriers that impede cross-collaboration, and indeed, many of the most important emerging problem areas are inherently interdisciplinary, even from an OR perspective. The department, as it seizes the opportunity to define and promote exactly what constitutes military OR, can list the competencies of military OR, both those of the faculty and those we can expect of our graduates. But it might also define a few thrust areas, say “smart defense systems,” “data analytics and intelligence,” “infrastructure,” that collectively cover important current problems in military OR. A shared vision for military OR might create a collective consciousness that will help to inform the decisions we make for investing in research areas and faculty hiring.

Assessment
To this end, we should help manage the existing analytical community. The following three steps could help significantly in this area:

- Provide better coordinated efforts for outreach to research sponsors and employers of our students. The Navy and N81 need to understand and appreciate not only what we can do and the value of Operations Analysis, but they also need to understand what our students can do. We need to actively market the impact that OR can have on organizations within the operational and supporting naval commands with a structured yet tailored approach (see below). It is particularly important that our civilian faculty connect with their civilian counterparts in other organizations to create relationships that can last longer than a three-year military tour.

- Provide a better “road show.” OR faculty need to reach out and travel to potential sponsors of topics and theses. We need to highlight that our graduates are continually assigned to prestigious positions of analytical and operational responsibility upon graduation, and ensure that the Navy continues to do so. The department should encourage and incentivize travel of this sort, perhaps matching faculty to sponsors. These types of trips should be made to the COCOMs as well as existing sponsors.

- Reach out to the detailing mechanisms of the services. The department should be providing information about what we do to the people who send students here, and describe how our analytical education can make them strong.

Upon implementing these actions, the department must then try to measure its success. Some possible measurements include:

- Keeping track of the number of projects with “impact,” and the number of “reach-backs” from our graduates with real world problems that we can help solve;

- Tracking the number of students that the Navy sends to our department each year;
• Tracking the number of Letters of Appreciation and other types of recognition received on studies helping DoD;

• Tracking the number of students assigned to real analyst billets.

4. Our Environment

Our department faces a challenge in that it wants to maintain its reputation as a nationally and internationally recognized top-tier academic department in its discipline. At the same time, the department must also abide by various regulations, rules, and procedures enforced by the Department of Defense, which are at times counterproductive to the department’s success.

Vision for Success

Administration. A healthy environment that promotes the success of the department would include the following

• The faculty can focus on the Department’s core mission, namely education and research, and feels that the administrative staff—such as the research office, the travel office, the contracting office, and the legal office—are here to support it.

• To maintain a top research program, faculty members are able to travel regularly and without friction to academic conferences and peer institutions to share their research products.

• The staff has sufficient time to learn and provide administrative support to allow the faculty to focus on its core mission.

• The President and the Provost wield local authority to reduce administrative burden on the faculty, so that the faculty can focus on its core mission.

Assessment

The faculty feels that too much time is taken away to deal with administrative details, such as travel planning and execution, contracting, hosting visitors, participating in mandatory training programs, and managing external research grants.

The current process of getting travel approved is complicated and requires additional planning that is cumbersome and inefficient. The general feeling is that the Navy does not trust the faculty members to make prudent judgment, so it needs to enforce various rules and regulations to ensure that the faculty members do not step out of boundaries. The Defense Travel System imposes requirements as to which airlines and hotels to use, but often returns flights that cost more money and time, and hotels at inconvenient locations. It is also very complicated to accept invitations to travel to academic conferences or peer institutions to share research products, with extra work required for foreign travel. The department and NPS should work to ease the burdens on academic travel.
The contracting process has also been very complicated. Given the long-standing hiring freeze, it has become necessary to hire contractors to fulfill various teaching and research roles in order to maintain top-quality education and research programs. However, contracting remains a difficult and painful process.

Moreover, the ever-moving research and contracting rules are making it extremely difficult to run research centers. This, in turn, impacts on our ability to support thesis students in Navy-relevant research.

There is also an increasing burden in the form of mandatory annual training that each faculty and staff member has to complete. The benefit of this training is unclear. Perhaps the measure of success of a particular training should not be the percentage of the faculty and staff that complete a training module, but how many violations are cited. Many training modules could be administered more efficiently if people who are competent in an area do not have to repeat the same training each year. For example, ITACS could send phishing emails on a regular basis, and only those who fell into the phishing traps would need to take the training on phishing. Instead of requiring every Principal Investigator to complete the PI training each fiscal year, the training could be required only for those PIs who violate rules and regulations. Or a competency test could be administered, requiring training only for the portions that are deemed insufficient.

The hosting of outside visitors also entails a lot of paperwork, with additional work if the visitor is a foreign national. In addition, each year the department needs to financial uncertainty associated with the federal budget, most recently in the form of continuing resolutions, which often result in additional administrative friction, lost opportunities, and/or additional costs. Although the department has been successful in attracting external research grants, these funds are often slow to become available due to slow and cumbersome administrative processes both within the Navy and locally at NPS.

The department recognizes that many of these issues are brought about by requirements from the Department of the Navy, but it is also important to recognize that these issues have contributed to loss of faculty members, low morale, and difficulty in attracting top talent to the school.

The physical location of the school is an asset. The location and climate of Monterey offers an incentive for people to want to live or visit here. However, salaries for junior-level faculty members have become less competitive than in years past, while the salaries for senior-level faculty members have not remained competitive compared with those of peer institutions.
The goal of this Strategic Plan is to provide a framework for decision-making in the Department. Success for this document will be measured in terms of the extent to which it is used to guide decisions. We intend that this document be subject to periodic review for applicability and compliance.

GOALS and ACTIONS

1.  Retention and recruitment of the highest caliber faculty.

   Goal: Increase the size of tenure track faculty to the currently authorized end-strength level (via both recruiting and retention).

   The Department should develop a multi-year hiring plan that looks at immediate and longer-term hiring needs. Execution of this hiring plan should fall to the Recruiting Committee, which should be renamed the Recruiting and Retention Committee. This hiring plan should be reviewed and updated on an annual basis.

   The Department should support the creation of a career development plan for each junior faculty member, to include formal plans for mentoring. These plans should be reviewed periodically in conjunction with Faculty Activity Reports that describe the progress toward these goals.

2.  Maintain and grow top-tier educational programs

   Goal: Be recognized as the premier academic department in the nation for educating military officers in the application of operations research to Defense problems.

   We recommend that the department establish a standing committee for Educational Programs, whose members include the AC for Instruction, the AAs for the various curricula in the OR department, the program officers, and the department’s Academic Council representative, as well as any at-large members, as needed. The committee’s charter would be to coordinate the planning and revision of curricula and special programs, including certificates and concentration areas within the curricula, with the primary goal being maintaining transparency of the process for modifying curricula and adding new courses, and avoiding the creation of conflicts within and between curricula as a result of such changes. This would involve clear communication between the committee and representatives from affected communities, including sponsors, service representatives, and other curricula across campus.

   In addition, the Department should consider how it can meet the following goals:

   - Increase percentage of sections taught by tenure-track faculty.
   - Adapt to changing needs of sponsors, as well as help guide them, on emerging topics of interest (e.g., data analytics, energy, cyber) with new courses, certificates, or degree programs as appropriate.
• Better course coordination, both vertical and horizontal.
• Maintain an appropriate and healthy number of high-quality masters students.
• Improve learning assessment.
• Increase the number of PhD (or DSc --- Doctor of Science) students.
• Actively pursue new sponsors of students (e.g., USCG).
• Participate with others at NPS in interdisciplinary education and research programs focused on the analysis of warfare.
• Maintain a healthy balance of DL offerings.

3. **Maintain and grow research programs of high quality and relevance**

Goal: Produce highly impactful, award-winning research.

While continuing to cover the traditional techniques of military operations research, we will pursue any technique that offers the possibility of effective ways to study, analyze, or evaluate warfare. Our criterion will not be “Is it operations research?” but rather whether it supports our vision that we are the discipline that applies science to the study of warfare.

For each OR faculty member, achieve a publication rate of at least 2 technical reports or journal articles per year.

4. **Increase visibility and image of the Department**

Goal: Be recognized as the undisputed home of military operations research. In both education and research, be recognized as the premier academic department in the nation for applying operations research to Defense problems.

To this end, the Department should seek to achieve the following:

• Improve documentation and dissemination of department accomplishments, via the web and in-person briefs.
• Designate individual members of the Department to serve as liaison with sponsors and potential sponsors. Responsibility of the liaison include includes visits, knowing their client’s current issues and problems, directing relevant NPS technical reports and theses to them, getting them involved in seeing that residential education student input quotas are met, and brokering other educational services and reimbursable research for them.
• Revisit the notions of the “pillars of OR” in terms of modern challenges and opportunities.
• Actively seek and host visiting faculty from civilian institutions and the Department of Defense.
• Increase our collaborative efforts with other programs and faculty on campus engaged in education or analysis focused on warfare.
• Assist and participate in related programs, especially interdisciplinary programs, on campus. We will include in Departmental activities faculty from other departments who have interests in warfare analysis.

• Encourage and reward outreach by faculty (especially tenure-track faculty) to key professional societies, such as the Institute for Operations Research and the Management Sciences (INFORMS) and the Military Operations Research Society (MORS).

5. Ease administrative burdens

Goal: Establish and maintain a highly productive, supportive, and low overhead work environment

To this end, the Department should work to obtain the support staff, research assistants, and physical space to support growing programs.

Conclusion

The NPS Operations Research Department is poised to continue in its role as a leading academic institution within the military analytic community, however it faces considerable uncertainties in the coming years. This document articulates some of the ways that the Department can proactively manage the associated risks.

However, the ideas presented in this Strategic Assessment and Plan require ongoing discussion and possible debate, as well as a lot of hard work by its faculty members. Implementation of the proposed recommendations in this document requires also an Operating Plan that identifies metrics to be used to see whether the Department is marching toward its goals.

As a first step in this direction, it is recommended that the Department hold one or more strategic offsite meetings for the faculty to clarify and focus these efforts.
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Appendix A: Committee Membership and Schedule of Meetings

The following individuals led the OR 2015-2016 Academic Program Review.

- David Alderson, Associate Professor, Chair
- Sam Buttrey, Associate Professor
- CAPT Jeff Hyink, U.S. Navy, Program Officer
- Kyle Lin, Associate Professor
- Greg Mislick, Senior Lecturer
- Johannes Royset, Associate Professor
- Roberto Szechtman, Associate Professor
- Matt Carlyle, Professor, Academic Associate (ex officio)

The Committee was formally established by Chair Jacobs at a Department faculty meeting on 29 July 2015.

As a primary means of engaging the entire OR Department Faculty, the Committee used the weekly faculty seminar to review details of its academic programs. The dates and topics of these seminars were as follows:

- 18 Sep 2015: Curriculum 360 overview and review (Matt Carlyle)
- 01 Oct 2015: ESR 2 (Koyak), ESR 4 (Lin), ESR 5 Sim (S Sanchez)
- 08 Oct 2015: ESR 1 (Alderson), ESR 3 (Dell)
- 29 Oct 2015: ESR 6 (Atkinson, Mislick), ESR 7 (McLemore)
- 19 Nov 2015: DL Programs (Mislick)

In addition, the Committee held regular working meetings on the following dates: 13 July, 25 August, 8 September, 21 September, 5 October, and 26 October.

A draft of the report was circulated to the faculty on 25 January 2016.

The final report was submitted to the Chair on July 6, 2016.
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<td>Senior Lecturer</td>
</tr>
<tr>
<td>Hamrick, Tom</td>
<td></td>
<td>G-272</td>
<td><a href="mailto:thamrick@nps.edu">thamrick@nps.edu</a></td>
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<tr>
<td>Hoivik, Thomas H.</td>
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<td><a href="mailto:thhoivik@nps.edu">thhoivik@nps.edu</a></td>
<td>Senior Lecturer</td>
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<td>House, Jeffrey</td>
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<td>G-263</td>
<td><a href="mailto:jbhousell@nps.edu">jbhousell@nps.edu</a></td>
<td>Military Assistant Professor, LTC/USA</td>
</tr>
<tr>
<td>Hughes, Wayne P., Jr.</td>
<td></td>
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<td><a href="mailto:whughes@nps.edu">whughes@nps.edu</a></td>
<td>Professor of Practice of Military OR</td>
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<tr>
<td>Kennedy, Quinn</td>
<td></td>
<td>G-228</td>
<td><a href="mailto:mkenned@nps.edu">mkenned@nps.edu</a></td>
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<td>Kline, Jeffrey</td>
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<td><a href="mailto:jkline@nps.edu">jkline@nps.edu</a></td>
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<tr>
<td>Kojak, Robert A.</td>
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<td>G-289</td>
<td><a href="mailto:rakoyak@nps.edu">rakoyak@nps.edu</a></td>
<td>Associate Professor</td>
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<td>Kress, Moshe</td>
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<td><a href="mailto:mkress@nps.edu">mkress@nps.edu</a></td>
<td>Professor</td>
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<td>Littrell, Keith</td>
<td></td>
<td>G-283</td>
<td><a href="mailto:wkittrell@nps.edu">wkittrell@nps.edu</a></td>
<td>Military Instructor/LCDR/USN</td>
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<tr>
<td>Lucas, Tom</td>
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<td><a href="mailto:twluc@nps.edu">twluc@nps.edu</a></td>
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<td>Maher, Kevin</td>
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<td><a href="mailto:kjmaher@nps.edu">kjmaher@nps.edu</a></td>
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<td>Mclemore, Connor</td>
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<td>Misslick, Gregory K.</td>
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<td>Nuussbaum, Daniel</td>
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<td>O'Neal, Carol</td>
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<td><a href="mailto:cjoaneal@nps.edu">cjoaneal@nps.edu</a></td>
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<td>Purdue, Peter</td>
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<td>Raffetto, Mark</td>
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<td>Singham, Dash</td>
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<td>Smith, Christian (Kip)</td>
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<td><a href="mailto:awashburn@nps.edu">awashburn@nps.edu</a></td>
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<tr>
<td>Dean’s Secretary</td>
<td>IT Specialist</td>
<td>Technical Editor</td>
<td>Sponsored Programs Financial Analyst</td>
<td>Educational Technician</td>
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<tr>
<td>Dear Secretary</td>
<td>Office Management Assistant</td>
<td>3861 Rumi (Academic Planning)</td>
<td>2616 PW/C 2526</td>
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**Appendix B: Faculty List**

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<thead>
<tr>
<th>Name</th>
<th>Office Management Assistant</th>
<th>3861 Rumi (Academic Planning)</th>
<th>2616 PW/C 2526</th>
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<tbody>
<tr>
<td>Provost Henninger</td>
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<tr>
<td>Danielle (Research)</td>
<td>2098/9</td>
<td>1046 SCSL (War Lab)</td>
<td>3011/2 Quarterdeck</td>
</tr>
<tr>
<td>Classroom IT Support</td>
<td>6911</td>
<td>TAC (IT Help Desk)</td>
<td>2441 Gate Access</td>
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<tr>
<td></td>
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<td>Conf. Rm. Coordinator</td>
<td>372-5232</td>
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<td></td>
<td>SATO/PSD</td>
<td>2393</td>
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<tr>
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<td></td>
<td>Classroom Scheduler (Cheryl Wilson-Roston, G-117)</td>
<td>3090 Teal Room</td>
</tr>
</tbody>
</table>
Appendix C: Faculty Publications and Presentations in 2014

Publications


Brown, G. (committee member), 2014, Force Multiplying Technologies for Logistics Support to Military Operations, Division on Engineering and Physical Sciences, National Research Council,
Committee on Force Multiplying Technologies for Logistics Support to Military Operations, National Academies Press, Washington, DC.


Duan, W., B. E. Ankenman, P. J. Sanchez, and S. M. Sanchez (2014). “Sliced full factorial-based Latin hypercube designs as a framework for a batch sequential design algorithm.” Accepted subject to minor revision, Technometrics.


Lin, K.Y. 2014. New results on a stochastic duel game with each force consisting of heterogeneous units, Naval Research Logistics 61(1) 56-65.


Seagren, Chad, “A Replication and Analysis of Tiebout Competition Using an Agent-Based Computational Model” Social Science Computer Review. Published online before print July 3, 2014, doi: 10.1177/0894439314534810.

Seagren, Chad, "Would Conscription Reduce Support for War?" (with David R. Henderson) Defense & Security Analysis, 30 (2) 2014: 133-147.


Presentations


Dell, R., “Planning Intra-Theater Airlift,” NATO System Analysis and Studies 103 Technical Course (Executive Seminar for Decision Makers in the Application of Operational Analysis): Den Helder, Netherlands on 1 December 2014; Bydgoszcz, Poland on 3 December 2014; and Rome, Italy on 4-5 December 2014.


Kline, J. “Communicating Analytical Results to Senior Leaders: Owls learn to speak Lion”, keynote address to the Australian Department of Defence Operations Research Symposium, Sydney, Australia, 21 October 2014


Kline, J., “Distributed Air Wing and Surface Capabilities,” Presentation to OPNAV N9I, Alexandria , VA, 23 July 2014

Kline, J., “Distributed Air Wing and Surface Capabilities,” Presentation to OPNAV N9I, Alexandria , VA, 23 July 2014


Szechtman, R., “New Approaches to intelligence collection and processing.” Brief to the Sponsor, NPS, Monterey, November 2014.


Appendix D: Sponsored Research Projects in 2014

This is the Department’s annual Faculty Activity Report, Part D, for calendar year 2014.
THE HUMAN SOCIAL CULTURAL BEHAVIOR (HSCB) MODELING INTIATIVE AT THE NAVAL POSTGRADUATE SCHOOL

Jeffrey A. Appleget, Senior Lecturer
Ronald D. Fricker, Jr., Associate Professor
Operations Research Department
Sponsor: Office of Naval Research

OBJECTIVE: The primary objective of the NPS Human Social Cultural Behavior (HSCB) Modeling Initiative program of research is to advance the state of the practice in Human, Social, Culture and Behavior modeling through a coherent, integrated approach leveraging basic and applied research. Two critical elements of the IW definition focus the FY 13 NPS program. The first is acquiring the understanding of how to model the relevant populations’ beliefs, attitudes, intentions and behaviors. The second is modeling those indirect and asymmetric approaches designed to erode an adversary’s power, influence, and will that are outlined in US doctrine. The FY14 effort was focused on developing methods, tools, and models for use with survey data.

SUMMARY: This effort has developed new tools, methods, and models to summarize, analyze, and visualize complex social survey data in order to provide useful information and actionable insights for COCOMs. This research was based on six years of detailed surveys of various North African countries: 2007—2012. The data through 2012 is maintained in-house at NPS, along with other meta-data from the contractor who supervised the execution of the surveys. We continued to recruit top quality thesis students. We graduated four thesis students again this year, with another student delayed due to his selection and participation in the SSG.

PRESENTATIONS (all at AHFE 2014, Krakow, Poland):

- Exploring the integrative model of organizational trust as a framework for understanding trust in government, R. Fricker, Jr., W. Kulzy, and D. Combs, USA
- Assessing threats to peace in the autonomous region of Muslim Mindanao in the Philippines, K. Johnsen, R. Fricker, Jr. and T. Deveans, USA
- Modeling trust in Mideastern governments, R. Fricker and D. Combs, USA
- Modeling the elements of stability for societies in conflict, J. Appleget, USA
- Applying factor analysis to Afghanistan survey analysis, J. Maddux, USA
- Modeling the effects of modern conflict on populations, M. Powers and D. Heerlein, USA

THESES DIRECTED:

- MODELING THREATS TO PEACE IN THE SOUTHERN PHILIPPINES, Krysta N. Johnsen, Captain, United States Marine Corps, MS in Operations Research, June 2014.
- COMPARISON OF SAHEL AFRICA POPULATION PERCEPTIONS TOWARDS THE UNITED STATES AND CHINA, David J. Risius, Major, United States Army, MS in Operations Research, June
2014.

- MODELING TRUST IN YEMEN’S GOVERNMENT, Matthew Murray, Major, United States Marine Corps, Master of Science in Operations Research, December 2014.

KEYWORDS: Statistics; survey analysis; data visualization; statistical modeling and analysis.
RESEARCH AND DEVELOPMENT OF TOOLS TO ASSESS THE VALUE OF ASSURED COMMUNICATIONS AND QUALITY OF SERVICES

Jeffrey A. Appleget, Senior Lecturer
Operations Research Department

Kurt Nielsen, Research Associate
Meteorology Department
Sponsor: Lockheed Martin

OBJECTIVE: Assist Lockheed Martin in the research and development of a wargame to investigate the effects on US forces of attacks on satellite-provided Position Navigation and Timing (PNT) capabilities. Research updated to include meteorological and oceanographic capabilities.

SUMMARY: This CRADA morphed from the PNT focus to examining the decaying constellation of weather satellites that DoD depends on, yet are not projected to replace. LM is developing seminar wargame events for junior and senior US military officers, and we used the Wargaming Applications class to provide Focus Group feedback for LM seminar wargaming products that they developed. The student participation and feedback was very well received. In addition, Kurt Nielsen has been able to provide DoD subject matter expertise from himself and other DoN and DoD experts to LM, who have been very grateful for the help. This initiative may continue in FY15.

PRESENTATIONS: Two presentations at MORS Symposium by Ms. Rebecca Dougherty of LM.

KEYWORDS: Wargaming; satellite attack; Position Navigation and Timing, weather, meteorology, oceanography.
OBJECTIVES:

- Develop and chair a mutual NPS/JWAC yearly research submission/review process to screen and review potential projects for possible funding from JWAC.

- Establish technical assessment and review process to transition prototype tools, software, and/or models to mature “cutting edge” capabilities.

- Oversee NPS Research conducted on behalf of JWAC.

- Link up JWAC personnel with NPS SMEs.

- Bring JWAC Thesis topics to the NPS students.

SUMMARY: A very successful site visit for Dr. Steve Hall and Dr. Appleget was conducted in November 2014 ICW AORS. The first NPS—JWAC research project, FOCUS (Flow of Communication upon Society) model, continued in FY14 and was successfully demonstrated in November 2014, garnering funding for FY15. Coordinated a very successful visit to NPS from senior JWAC members in April, showing them several different areas of NPS research for future leverage.


KEYWORDS: Research chair, agent-based modeling, modeling human behavior, social media, Twitter.
STRATCOM
INTRODUCTION TO WARGAMING

Jeffrey A. Appleget, Senior Lecturer
Operations Research Department

Sponsor: USSTRATCOM

OBJECTIVE: Co-developed and taught this introduction to wargaming course with Mr. Fred Cameron for a selection of 20 students from various staff sections at STRATCOM. This course was requested by their J-94, newly stood up wargaming directorate.

SUMMARY: Course was well received, with possible follow-on courses discussed.

KEYWORDS: Wargaming
CONCEPT DEVELOPMENT AND ASSESSING MILITARY VALUE OF THE UNDERSEA CONSTELLATION

Jeffrey A. Appleget, Senior Lecturer

Jeffrey Kline, Professor-of-Practice

Operations Research Department

Sponsor: PEO C4I/PMW-770

OBJECTIVE: This proposed research work requested by PMW-770 will provide concept development and mid-grade officer quantitative assessment of the Undersea Constellation (UC) through campaign analysis and wargaming.

SUMMARY: This research leveraged two courses taught at the Naval Postgraduate School (NPS) to conduct concept of operations development and a military assessment of the Undersea Constellation. The Joint Campaign Analysis (JCA) course is an upper level applied course for operations research, modeling and simulation, systems engineering analysis, and joint operations logistics students. Within the context of a near-peer competitor scenario with U.S. forces facing robust anti-access area denial challenges, summer 2014 JCA students developed and evaluated concepts to achieve mission objectives without the benefit of the capabilities provided by the Undersea Constellation. They then selected the metrics for mission evaluation and analytical models to assess their concept by providing a quantitative assessment of risk using those metrics. Students were then be provided the capabilities envisioned for the Undersea Constellation. They were asked to evaluate how their concept of operations and risk assessment would change given employment of this system. Select deliverables for this course, briefings and papers addressing the military value of the Undersea Constellation in this scenario, were submitted under separate cover to PMW-770. The second course this research leverages is the Wargaming Applications class composed of operations research, national security affairs, and defense analysis students. In this class, students work with a DoD sponsor to design, develop, conduct and analyze an analytical wargame to address a sponsor’s objectives and issues. For example, a wargame may be designed to provide an employment concept for the Undersea Constellation, to advance work conducted in the JCA class, or to develop a red team response to the existence of the constellation. PMW-770 has a choice of one of three alternatives for a deliverable from this course. The first is a wargame that will be designed, developed, executed and analyzed by the class members at NPS. The second is a designed and developed wargame conducted with NPS Undersea Warfare faculty and students as the players. This wargame would be conducted and analyzed outside of the regular quarter. The third is a designed and developed wargame to be conducted and analyzed in San Diego with fleet participants as invited by PEO C4I. The third choice was selected, and the wargame was conducted in San Diego in early December.

KEYWORDS: Undersea Warfare, Joint Campaign Analysis, Wargaming, C4I
MAKE GOAL: A TRAINING SYSTEM FOR NAVAL RECRUITING DISTRICT LEADERS

LTC Jonathan K. Alt, Assistant Professor
Samuel E. Buttrey, Associate Professor
LT Lee Sciarini, Assistant Professor
Quinn Kennedy, Senior Lecturer
Jeffrey A. Appleget, Senior Lecturer
Operations Research Department

Sponsor: OPNAV N1 and Commander, Naval Recruiting Command

OBJECTIVE: Recruiting individuals to serve in the military continues to be a challenging and resource-intensive effort. As budgets are reduced, Naval Recruiting Districts (NRD) need to produce quality recruits at prescribed levels in order for the Navy to maintain the force. The Make Goal game is intended to assist NRD leaders in learning to efficiently allocate resources to accomplish this task. This research will: 1) assess the current Make Goal game as an instructional system in order to develop a set of recommended improvements, 2) analyze data available from the sponsor to develop an empirical model to use within the game to determine player outcomes, 3) implement a browser-based version of the improved game, and 4) conduct pilot testing of the improved game using students at the Naval Postgraduate School.

SUMMARY: Research began in July 2014 and continues through June 2015. The first three objectives of the research have been completed, with interim deliverables provided to the research sponsor. The final objective is ongoing with expected completion prior to April 1, 2015.

THESES DIRECTED:

KEYWORDS: Recruiting; statistical modeling; game-based training.
DEVELOPMENT OF OPERATIONAL DECISION AIDS FOR THE MARITIME OPERATIONS CENTER

Jeff Kline, Professor of Practice, PI
Gerald Brown, Distinguished Professor, NAE
Javier Salmerón, Associate Professor
Emily Craparo, Assistant Professor
LCDR Connor McLemore, USN, Military Associate Professor
Anton Rowe, Research Associate
Carol O’Neal, Research Associate
Department of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: To 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 planning staff. Maritime operational missions to be planned include 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 CY 2014 this program further advanced the following prototypic decision aids: modified a Mix-Mode Fuel Minimization Tool (Transit Fuel Planner (TFP)) for LCS-3 (FT WORTH) and COMPHIBRON 5; continuing development of Vertical launch load out Planner for C7F/CPF; continuing development of the Continuous Maintenance Availability Scheduler (CMAV-S) for COMSUBPAC staff; continuing work for a USMC Amphibious Assault Event Test and Evaluation Scheduler; provided support to LCSRON to assess squadron staff requirements for the LCS 3-2-1 Rotation Planner; provided a classified study to OSD CAPE to support an Air Refueling Network Assessment tool; supported inclusion of the Mission Planning Service (MPS) and Oceanic Routing Service (ORS) in PMW 150’s Maritime Tactical Command and Control (MTC2) Next Generation MOQ, and the ORS into ONR’s Submarine Mission and Navigation tool; employed the Replenishment at Sea Planner (RASP) to evaluate blue and red fueling networks, and began transition to a service contractor initiated a Campaign Model Planner (CMP).

PRESENTATIONS:

TECHNICAL REPORTS:


THESES SPONSORED:

Capt Christopher Wood, “What Friends Are For: Collaborative Intelligence Analysis and Search”

LT Brennan Kemper, “Maximizing Weapon System Availability with a Multi-Echelon Supply Network”


LT Dustin K. Crawford, “Alternative Practices to Improve Surface Fleet Fuel Efficiency”

MAJ Ryan D. Colton, USMC, “Aerial Refueling Network Analysis”

HONORS/AWARDS/PRIZES


2014 Military Operations Research Tisdale Award for best thesis: Captain Christopher Wood, USMC.

Inventory Optimization for NAVSUP Enterprise Resource Planning

Javier Salmerón, Associate Professor

Emily Craparo, Assistant Professor

Department of Operations Research

Sponsor: Naval Supply Systems Command, Weapons Systems Support

**OBJECTIVE:** To develop mathematical optimization models to guide tactical, retail, and wholesale inventory level decisions at Naval Supply Systems Command, Weapons Systems Support (NAVSUP WSS). The ultimate goal is to enhance operational readiness and increase fiscal efficiency by establishing optimal stocking levels for all echelons of supply that NAVSUP WSS manages. We will prioritize our model development in three distinct areas of NAVSUP WSS support: (a) wholesale, (b) readiness-based sparing, and (c) retail, multi-echelon.

**SUMMARY:** During FY 2014 the PIs developed models for wholesale inventory which are currently undergoing testing at NAVSUP WSS. During FY 15 the PIs are developing similar models at site demand base level. In addition, they are coordinating the development of a user interface (effort led by A. Rowe), and a simulation model (led by Dr. A. Buss).

**CONFERENCE PRESENTATIONS:**

**THESES SPONSORED:**
LCDR Geoffrey Roth, graduation expected March 2016. (Advisor: A. Buss; Second reader: J. Salmeron.)
Optimally Locating MARFORRES Units

Javier Salmerón, Associate Professor
Rob Dell, Professor
Department of Operations Research
Sponsor: Naval Research Program (Chief of Naval Operations)

OBJECTIVE: Marine Forces Reserve (MARFORRES) is realigning its subordinate units in accordance with the Force Structure Review Group’s (FSRG’s) requirements. MARFORRES anticipates further realignment studies in the near future, where discretionary changes may be guided by and/or benefit from formal mathematical optimization. Specifically, adherence to demographics targets (for areas where the units are located) and minimization of cost are driving factors. This study develops and computationally implements optimization models which can provide recommendations and insights into future MARFORRES realignment studies.

SUMMARY: With our thesis student, Capt. Bisker, we created “Marine Corps Reserve Optimizer” (MCRO), a framework for optimization of unit relocation based on demographic targets. MCROsituates MARFORRES subordinate units with respect to demographics. It selects optimal locations for all candidate moving units based on the projected availability of qualified recruits in candidate areas. MCRO optimizes to (a) minimize a penalty function that measures stress with respect to demographics, and (b) minimize unit movement. We find that (i) the relocation of 10 units reduces the number of areas experiencing the highest geographical stress from nine to three, and (ii) all stress can be relieved in 56 movements. Current efforts are geared towards extending MCRO to incorporate the consolidation of Recruit Training Centers from both an economic and a readiness point of view. That is, basing realignment decisions on four main pillars: existence of adequate facilities; access to training areas; how realignment affects the people in each unit; and cost effectiveness.

THESES SPONSORED:
"Optimal Location of Marine Forces Reserve Units by Demographics," Paul M. Brisker (June 2014) (co-advised by R. Dell and J. Salmeron)
Assistance with Unit Assignment Optimization Model

Javier Salmerón, Associate Professor (Department of Operations Research)

William Fox, Professor (Department of Defense Analysis)

Sponsor: TRADOC Analysis Center (Ft. Leavenworth)

OBJECTIVE: The principal investigators goal was to assist Training and Doctrine Command Analysis Center – Fort Leavenworth (TRAC-FLVN) on the development of a prototypic mathematical optimization model, whose goal is to prescribe the best assignment of Army units to missions over time.

SUMMARY: Three members of the TRAC-FLVN team travelled to the Naval Postgraduate School during one week in August 2014 in order to specify the problem and work with the PIs on the development of the mathematical model. During that time we developed the System for Modeling the Allocation Capabilities (SMAC). Given a series of units (or systems, such as unmanned air and ground vehicles), capabilities (such as sensor types) and missions, SMAC is an optimization model that seeks to minimize the number of unmet missions over time. It accounts for readiness states of the systems, set up costs for the capabilities (limited to a given budget), mission fulfillment rates by the different capabilities, and other technical and logistic considerations. The PIs continued to assist the TRAC-FLVN team on the computational implementation of the model in the General Algebraic Modeling System and delivered a final version in September of 2014.
Plant Utilization at Marine Corps Logistics Command

Javier Salmerón, Associate Professor
Moshe Kress, Professor

Department of Operations Research

Sponsor: Naval Research Program (Chief of Naval Operations)

OBJECTIVE: The MCLC operates the production plants in Barstow, CA (PPB) and Albany, GA (PPA). These plants provide depot-level maintenance, rebuild, repairs, and manufacturing of platforms. PPB and PPA recently consolidated their headquarters and a series of related activities into a unique maintenance depot now known as Marine Depot Maintenance Command. MCLC approached the Naval Postgraduate School (NPS) in March 2013 soliciting proposals for research on plant capacity and their effect on various logistical capabilities.

SUMMARY: The initial thrust of the research was to develop scientific methods to examine utilization levels of the different plant resources. The PIs’ proposal included the development of mathematical models to guide plant design and utilization at MCLC, including optimal levels of physical capacity, equipment, manning and operations. However, during the PIs’ travel to PPB in April 2014, and after meeting with multiple branch and division heads, PPB identified and expressed more interest in investigating the management of critical platform parts. As a consequence, the focus of the study has become to optimize the inventory control of these parts. Our research goal has been to develop mathematical optimization and simulation models that can help MCLC analyze the inventory problem of platform-parts – each identified by a National Identification Number (NIN) – availability. We have sought approaches that find acceptable trade-offs between fill rates for critical NINs, and safety stock costs. To that end, we have developed: (a) the Critical Part Inventory Optimization Model, a mathematical tool that can help guide inventory decisions by prescribing order quantities for a given set of “critical” NIN items; and (b) the Inventory Simulation Model, which complements the optimization with additional, detailed results.

THESES SPONSORED:
Major Tim Curling (MOVES), graduation expected June 2015. (co-advisors: A. Buss and J. Salmeron.)
SUMMARY AND OBJECTIVE: Renewable energy options are currently being explored as methods of complementing traditional energy sources for military installations. A number of installations currently use wind power to satisfy a portion of their demand. Wind power is clean, cost effective, and does not depend on a steady supply of incoming fuel. However, it is not reliable enough to be the sole power source for military purposes where constant readiness is necessary. Backup generators are required, but these generators are inefficient when utilized intermittently. Thus, direct timing of use with the availability of wind power is not cost effective. In this research, we develop optimization and simulation models for optimally dispatching diesel generators based on ensemble predictions of wind power output. Specifically, we design optimal day-ahead policies for joint operation of wind turbines and backup generators. We also consider storage of energy generated during high-wind periods, and we account for the cost of storage as well as production costs of all forms of power. Building on this model for optimal deployment of existing power generation assets, we will also construct a long-term capital planning model to determine optimal procurements of energy generation and storage assets.

PUBLICATIONS:

THESES DIRECTED:

KEYWORDS: Energy, microgrids, optimization, simulation, renewable energy, capital planning.
Analysis Support for Comprehensive Soldier Fitness
Sam Buttrey, Associate Professor
Operations Research Department

SPONSOR: TRAC-Monterey

OBJECTIVE: Examine responses to the GAT survey with emphasis on the effect of resilience trainers

SUMMARY: The Global Assessment Tool (GAT) is a survey administered at least yearly to every uniformed member of the Army, including Guard and Reserves. The current method of "scoring" the GAT is simplistic. We will consider more data-driven ways to score the GAT, acquire and analyze GAT data for Guard and Reserve soldiers, and consider ways to adjust for individual soldiers' scoring predilections and time trends.

PUBLICATIONS:

Felts, S. Analysis of Army Reserve and Army National Guard Responses to the US Army Global Assessment Tool, Masters Thesis, Department of Operations Research


Final project report.
OBJECTIVE: Duplicate the statistical analysis performed by the STARRS research team.

SUMMARY: The Concentration of Risk Model (CORM) describes a collaboration by a number of groups, including the National Institutes of Mental Health, the Department of Health Care Policy at Harvard University, the University of Michigan and others, to identify Army soldiers at risk for suicide. This project continued an ongoing effort to duplicate the CORM collaborators' results, both in constructing the database and also in implementing a specific set of models that had already been proposed by the Harvard group.

PUBLICATIONS: Final project report.
Navy Recruit Attrition Prediction Modeling
Sam Buttrey, Associate Professor
Operations Research Department

SPONSOR: Naval Recruiting Command

OBJECTIVE: Use MEPS and other non-traditional data to improve the evaluation of new recruits regarding their probability of completion of the first term.

SUMMARY: This proposal describes the first phase of a two-phase project, with each phase occupying a one-year period. The primary objective of this first phase is to identify, collect and evaluate data that can be used to update and augment the existing quality matrix so that it can more precisely predict a sailor’s probability of completing his or her first term. These data might include information on, for example, ACT/SAT scores, adult education, or distance/virtual learning. Some of the data may be commercially available; other parts might need to be collected directly from recruits. The second phase, should it go forward in FY & 15, will involve building models using these additional sets of data; those models will be developed and to the existing Quality Matrix.

PUBLICATIONS:

Final Project Report
Nuclear Prototype Training Allocation

Robert F. Dell, Professor

Operations Research Department

Sponsor: Department of Energy, Knolls Atomic Power Laboratory

OBJECTIVE: The goal of this research is to develop and implement an integer linear program to prescribe how many students of each class and type to allocate to each Nuclear Power Training Unit site.

SUMMARY: A prescriptive optimization model has been developed and implemented. The model has been adopted by the sponsor and has completely replaced the sponsor’s legacy program.

THESSES DIRECTED:


KEYWORDS: Optimization, Manpower Planning
Optimized Naval Aircraft Capital Investment Planning

Robert Dell, Professor
Gerald Brown, Distinguished Professor
Javier Salmerón, Associate Professor
Anton Rowe, Research Associate
Operations Research Department

Sponsor: Naval Research Program (Chief of Naval Operations)

OBJECTIVE: This research effort continues development of an optimization model called the Capital Investment Planning Aid (CIPA) with a specific tailoring to Naval aircraft. CIPA prescribes aircraft procurement and retirement schedules over a 30-year planning horizon while adhering to annual budget constraints, industrial base requirements, business rules, and force structure requirements expressed in terms of supporting mission areas. CIPA considers multiple aircraft types, multiple mission areas, track average aircraft age for each aircraft type, and expected attrition for each aircraft type. As a result of this effort CIPA will become a fully functional decision support system. This effort started at the end of 2014 and has completion expected in 2015.

SUMMARY: CIPA was initially developed over a decade ago to assist Navy long-range force structure planners at the Chief of Naval Operations, Assessment Division (N81). At that time, N81 planners manually considered alternate future ship, submarine, and aircraft procurement and retirement schedules and evaluated these with a contractor-developed spreadsheet tool. This tool, the Extended Planning Annex/Total Obligated Authority (EPA/TOA) model, estimates the financial impact of any complete future plan over a 30-year horizon. While manually preparing such plans, N81 force structure planners must consider annual budget, industrial base, and force structure requirements expressed in terms of the number of platforms needed to support a mission. CIPA allowed for manual planning to be replaced with optimized planning. This research updates CIPA and specifically tailors it for aircraft and use by N98 planners. In the decade since CIPA was originally developed and implemented, there have been substantial improvements in both available desktop computing power and the underlying algorithms used to solve CIPA. Such improvements enable improved solution time and only add to CIPA’s usefulness as a decision support tool. In addition, we are looking to fully implement improvements such as increasing Operation and Maintenance Navy costs as aircraft age increases and model an age-dependent aircraft effectiveness of an aircraft type for a mission.

THESES SPONSORED:
“Optimizing Naval Aircraft Procurement, Upgrades, and Retirements” Holly M. Zabinski (expected June 2015) (co-advised by R. Dell and J. Salmeron)
Design of Experiments for Follow-on Operational Test of the Aegis Modernization Program

P. A. Jacobs, Distinguished 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.

SUMMARY: Data from at-sea events have been summarized.

OTHER:


DOD KEY TECHNOLOGY AREA: Human-System Interface; Modeling and Simulation

KEYWORDS: military test and evaluation, stochastic models, kill chain, design of experiments; statistics.
OBJECTIVE: The Secretary of the Army directed Capability Portfolio Reviews (CPR) as a pilot process to holistically examine the requirements that drive capability development, acquisition and sustainment to determine if current and proposed programs are aligned to meet key national and defense strategies and Army plans. A CPR includes the scoring on a categorical scale by subject matter experts (SMEs) of the contribution of future capabilities to the successful conduct of military tasks. Statistical techniques including Bayesian methods are explored to summarize such data to assist decision-makers in resource allocation decisions.

SUMMARY: The Dirichlet/multinomial model is proposed and studied to summarize survey data.

OTHER:


DOD KEY TECHNOLOGY AREA: Surveys; Modeling and Simulation

KEYWORDS: Analysis of survey results; Dirichlet/multinomial model; Bayesian analysis; allocation of resources.
**Understanding optimal decision making in wargaming**

Quinn Kennedy, Senior Lecturer  
Operations Research Department  
Sponsor: Army Research Office

**Objective:** To objectively and quantitatively define and measure optimal decision making in wargaming through the use real time measurements of decision performance, visual scan patterns and brain activity.

**Summary:** The work described in this section was conducted in year 2 of a three year effort. The researchers attempt to identify the transition from exploring the environment as a naive decision maker to exploiting the environment as an experienced decision maker via statistical and neurological measures. Two cognitive abilities required for optimal decision making in wargaming are reinforcement learning, the ability to learn from trial and error; and cognitive flexibility, the ability to recognize when the rules have changed or that the current strategy no longer works. Therefore, the researchers developed two wargames (tasks) that tap these abilities. While 34 volunteer warfighters completed each wargame, their decisions, visual scan patterns and brain activity were tracked in real time. Preliminary results indicate that the wargames successfully elicit these abilities and also suggest that each subject's decision behavior can be modeled by two simple behavioral measures -- variability in latency time and regret. Two student theses are connected to this project. Major Patton's thesis examined wargaming decision making in a dynamic and complex environment. Captain Critz's thesis attempts to validate a training intervention model that is based on variability in latency time and regret.

**Technical report:**


**Conference paper:**


**Theses directed:**


Other:

Nesbitt, P., Kennedy, Q., & Alt., J. Iowa gambling task modified for military domain. Under review at Military Psychology.


Keywords: Optimal decision making, wargaming, neurophysiological predictors,
OPTIMIZATION OF SENSOR OPERATION FOR SEARCH, SURVEILLANCE, AND RAPID ACCURATE DECISION MAKING IN MARITIME, LITTORAL AND URBAN ENVIRONMENTS

Michael Atkinson, Assistant Professor
Moshe Kress, Professor
Johannes O. Royset, Associate Professor
Department of Operations Research
Sponsor: Office of Naval Research

OBJECTIVE: To 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.

SUMMARY: This project contributes to the development 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 Joint Inter-Agency Task Force (JIATF) South. The TDA will supply the commander of counter-drug operations with a situational awareness picture, predict future locations of targets, recommend optimal allocation of search assets and effective courses of actions, and help the commander effectively utilize intelligence. The development of the TDA requires two mathematical models. A probability model takes intelligence and environmental factors as inputs and outputs a spatio-temporal probability map. The probability map specifies the likely locations of targets in the present and the future. The optimization model takes target dynamics (e.g., a probability map) and operational constraints as inputs and produces a search plan for available assets.

PUBLICATIONS:


PRESENTATIONS:


THESES DIRECTED:


KEYWORDS: Optimization; probability; tactical decision aid; information fusion; sensor allocation
DEVELOPING SYNTHETIC THEATER OPERATIONS RESEARCH MODEL (STORM) ANALYTIC UTILITY

Pl: Thomas W. Lucas, Professor

Department of Operations Research

Sponsor: OPNAV N81

OBJECTIVE: To develop tools and processes that reduce the amount of manpower and time required to complete STORM output post-processing.

SUMMARY: A modeling environment that underpins many important N81 and joint studies is the Synthetic Theater Operations Research Model (STORM). The Navy and other Services use STORM as a tool to evaluate campaign risk and assess the utility of operational and acquisition decisions. STORM is a large, stochastic, campaign-level simulation that requires extensive detail for both system parameters and operational concepts and generates a huge amount of output data. Because STORM is stochastic, multiple replications are made for given inputs. A current impediment to fast and efficient use of STORM is the volume of data it generates. This research developed tools and processes that reduce the amount of manpower and time required to complete STORM output post-processing. The new capabilities include an algorithm to dynamically determine the number of scenario replications needed for a specified level of precision. All together, the new capabilities enable analysts to gather timelier and deeper insights than what was previously possible.

PUBLICATIONS:


PRESENTATIONS:


THESES DIRECTED:


The objective is to 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. 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).

PUBLICATIONS:


D-28
Efficient Intelligence Collection
Assistant Professor Ned Dimitrov
Professor Moshe Kress,
Sponsor: USMC

OBJECTIVE: Combining Markov random fields, graphical models, Bayesian learning models and exploration/exploitation techniques, the objective is to develop theory and methodology for sequencing forensic activities on the edges of a social network in the presence of interdependencies among network nodes and capacity constraints. This research provides better knowledge and understanding regarding the efficiency of the process of screening network-generated intelligence data for detecting rare malicious activities.

PUBLICATIONS:

PRESENTATIONS:
“Finding the Needles in the Haystack”, Technical University of Vienna and Technion
OBJECTIVE: The USMC is pivoting to the Pacific region. In doing so, the USMC faces strategic challenges, such as establishing optimal levels of infrastructure capacity at USMC bases, and operational ones, such as determining efficient deployments of logistical assets and optimal assignment of personnel to those bases and to the missions they must conduct. Building upon prior logistics organizational studies, and using state-of-the-art optimization techniques, the proposed project will develop a network model – implemented in an optimization tool – that will address the aforementioned strategic and operational issues. The general approach will follow the modeling principles described in chapters 7 and 10 of (Kress, M., Operational Logistics: The Art and Science of Sustaining Military Operations, Kluwer, 2002). The main contribution of this project is a decision support tool that will help logistics planners to evaluate the responsiveness, efficiency and robustness of a given logistics structure in the Pacific region to demands derived from current and future possible scenarios.

PRESENTATIONS:
To sponsor 24 July 2014 (VTC)

THESIS:

LCDR Thomas Walker
**OBJECTIVE:** The Marine Corps Logistics Command has limited situational awareness regarding plant capacities and their effect on various logistical capabilities such as supply availability of certain commodities and maintenance responsiveness for various types of equipment. This shortcoming is manifested e.g., in the plants at the Blount Island Command. Plant capacity is determined by three main factors: 1. the physical size of the plant, 2. the number and mix of facilities and equipment supporting that plant, and 3. the quantity and qualifications of personnel assigned to the plant. Each of these factors constitutes a constraint limiting the capacity of the plant. Moreover, the actual realizations of these factors determine the flexibility of the plant and its ability to properly respond to uncertain demand. The problem we intend to address is: *how to design MC logistical plants such that they can operate efficiently while providing maximum response to changing demand.*
FUTURE NAVY RECRUITING STRATEGIES: DEVELOPMENT OF CONCEPTS, PRACTICES, PROCESSES AND PROCEDURES TO RECRUIT GENERATION Z AND ALPHA

Ronald D. Fricker, Jr., Professor
Samuel E. Buttrey, Associate Professor
LTC Jonathan K. Alt, Military Assistant Professor
Operations Research Department

Sponsor: OPNAV N1 and Commander, Naval Recruiting Command

OBJECTIVE: This research project will identify and evaluate past alternative recruiting efforts with an emphasis on assessing the quantitative evidence (if any) of performance. It will also assess the literature on trends in the Millennial and post-Millennial generations with a focus on how well current and previous recruiting efforts align with how these generations are likely to want to interact with Navy recruiting. Finally, this research will pose possible future recruiting strategies for the Navy along with rigorous quantitative methods for evaluating the performance of the various strategies and their components.

SUMMARY: The research started in late 2013 and continued through 2014. Extensive travel was undertaken in 2014 which focused on collecting data and information from other Services’ recruiting commands, the Royal Navy, and the Australian Defence Force. Upon completion of the travel, the research and findings were documented in a draft NPS technical report that was reviewed by all of the organizations visited and, at the end of 2014, was under review at the Naval Recruiting Command. In 2015, the technical report will be published and results briefed to Commander, Naval Recruiting Command and the Chief of Naval Personnel.

PRESENTATIONS: In-process reviews conducted with Naval Recruiting Command in February, April, and June 2014. In-process review conducted with OPNAV N1B in September 2014.

KEYWORDS: Navy recruiting; millennial generation; generations Z and alpha.
Improved Forecasting Methods for Naval Manpower Studies

Robert A. Koyak, Associate Professor

Lyn R. Whitaker, Associate Professor

Department of Operations Research

Sponsor: Navy Total Force, N15 (Chief of Naval Operations)

OBJECTIVE: The purpose of this project is to conduct an investigation into the statistical properties of recently-developed forecasting methods, and other emerging methods that may be identified as having desirable attributes, using data provided by NPRST that encompass recent events in the U.S. economy (e.g. the 2008 housing market debacle), and changes that affect the mission and budget of the Navy.

SUMMARY: This project is part of the Naval Studies Program. Initial funding was received in late November 2013. Most of the research activity was conducted in CY 2014, ending on November 30, 2014. The Master’s thesis research of LCDR Sean McCrink (USN) on modeling promotion probabilities for enlisted Sailors, completed in June 2014, also was sponsored under this project. The investigators examined the use of nonparametric classification techniques (CART, Random Forests) for prediction of loss rates in the U.S. Navy Hospital Corpsman enlisted community.


KEYWORDS: Manpower, forecasting
OBJECTIVE: This project develops an application of the approach used in Brown, Grose, and Koyak (2006) to FA-XX or other components of the Navy’s Thirty Year Aviation Plan. Depending on the availability of suitable data during FY 2014, development of the approach on a smaller-scale application may be considered in consultation with the sponsor. Upon finalization of the optimization model it will be simulated in order to exercise its stochastic elements. The number of simulations will be chosen so that attributes of cost and timeliness are estimated with acceptable accuracy, and to produce prediction intervals of desired quantities. A software version of the optimization model will be developed using Visual Basic for execution in Microsoft Excel.

SUMMARY: This project is part of the Naval Studies Program. Initial funding was received in late November 2013. Receiving information from the sponsor to support optimization modeling was the primary activity in CY 2014. The project has been continued to June 2015.

KEYWORDS: Acquisition, optimization, cost estimation
What Are the Optimal Maintenance Intervals for PMCS On Marine Corps Equipment?

Robert A. Koyak, Associate Professor
Michael Atkinson, Assistant Professor

Department of Operations Research

Sponsor: Marine Corps Logistics Command (Chief of Naval Operations)

OBJECTIVE: This project investigates development of preventative maintenance schedules for U.S. Marine Corps (USMC) land vehicles based on condition and usage information. Current schedules rely on chronological time, which is an inadequate substitute for condition and usage. Information to be considered includes, but is not limited to: mileage, cumulative engine cycles, operating environment (e.g. climate, terrain), and past repair history. The class of vehicles to which this effort will be applied includes MTVRs and MRAPs, particularly those equipped with engines (e.g. Caterpillar) that have automatic data-capture capabilities.

SUMMARY: This project is part of the Naval Studies Program. Initial funding was received in late November 2013. In CY 2014 the investigators examined automatic data collections from USMC land vehicles (MTVRs, MRAPs, and Cougar trucks) and compared them to maintenance data (MIMMS, GCSS) to assess the potential value of the former for setting maintenance policies.


KEYWORDS: Maintenance, maintenance scheduling
A New Mathematical Framework for Design Under Uncertainty

Johannes O. Royset, Associate Professor
Department of Operations Research
Sponsor: Air Force Office of Scientific Research

OBJECTIVE: We develop a new mathematical framework for design under uncertainty with application to a high-speed navy vessel.

SUMMARY: In this Phase I of the project, we will develop the theoretical foundations towards a general framework on design under uncertainty (DUU), with important contributions to stochastic optimization algorithms, representation of high-dimensional stochastic response surfaces, and stochastic low-dimensional modeling. On the application side, we will develop a fully parametric multiobjective hull form optimization framework for SWATH vessels in waves, integrating multi-fidelity wave and CFD models with multi-information sources. This framework will be demonstrated in the specific case of an ultra high speed vessel in hull-borne mode. We will also develop and verify the capability of a multi-fidelity optimization framework for unconventional super-cavitating hydrofoils for ultra-high speeds applications. Moreover, we will establish the theoretical foundations for an optimal path planing of the vessel in high seas to avoid big waves. Theoretical developments in these areas will lead to DUU of the full vessel in Phase II.

JOURNAL PAPERS:

KEYWORDS: Nonlinear optimization, stochastic programming, decision making under uncertainty
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. We have 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 part (iii) control problems.

JOURNAL PAPERS:


THESES AND DISSERTATIONS DIRECTED:

KEYWORDS: Nonlinear optimization, stochastic programming, semi-infinite optimization, optimal control
Estimation and Uncertainty Quantification of Uncertain Systems

Johannes O. Royset, Associate Professor
Department of Operations Research
Sponsor: Army Research Office

OBJECTIVE: We will carry out a fundamental study of statistical estimation and function approximation and the use of such estimates in uncertainty quantification, rare-event prediction, and information fusion for a broad range of stochastic systems.

SUMMARY: We propose to develop a flexible framework for estimation of density functions, regression curves, and other quantities that systematically incorporates hard information derived from physics-based sensors, field test data, and computer simulations as well as soft information from human sources and experiences. The project focuses on two main areas: (i) We will consider complex systems subject to random input parameters and will develop epi-spline-based procedures for constructing functional models of the system as well as for estimating probability density functions, moments, quantiles, and rare events of the resulting random system performance. (ii) In the context of target detection, tracking, and situational awareness, we will construct epi-spline-based procedures for information fusion of hard data from physics-based sensors with soft contextual information and predictions from human sources pertaining to past, current, and future time periods.

BOOK CHAPTER:

KEYWORDS: Nonparametric estimation, function approximation, stochastic programming
New Approaches to Intelligence Collection and Processing

Assoc. Professor Roberto Szechtman

Sponsor: National Reconnaissance Office

OBJECTIVE: To design collection and processing policies that make more efficient the intelligence process.

SUMMARY: This work is motivated by the massive amount of information available to intelligence agencies in response to a request for information. While the intelligence process consists of collection, processing, and analysis stages, this part of the project is concerned with the collection phase, where a bottleneck of data occurs. Since the impact of each source of intelligence is by and large not known in advance, we take a Bayesian learning approach that takes into account the past performance of each intelligence source to evaluate which source is the most promising. Every situation requires an exploration of the available options, which eventually converges on the most appropriate information providers.

PRESENTATION(S):

Szechtman, R., “New Approaches to intelligence collection and processing.” Brief to the Sponsor, NPS, Monterey, November 2014.

KEYWORDS: Efficient learning, large scale inference, intelligence collection, intelligence processing
A New Perspective on Feasibility Determination

Assoc. Professor Roberto Szechtm, Prof. Enver Yücesan (INSEAD)

Sponsor: GEE

OBJECTIVE: To develop new approaches for determining the feasibility of stochastic systems.

SUMMARY: We address the problem of feasibility determination for linearly constrained sets. We characterize the optimal budget allocation scheme using the large deviations theory, and state an algorithm rooted in stochastic approximation ideas.

PUBLICATIONS:


PRESENTATION(S):


KEYWORDS: Large Deviations, Simulation, Feasibility Determination.
Models of Intelligence Operations

Prof. Kevin Glazebrook (Lancaster U.) and Assoc. Prof. Roberto Szechtm

Sponsor: GEE

OBJECTIVE: To formulate tractable models of intelligence operations that yield insights about the efficient collection of intelligence items.

SUMMARY: We use a Bayesian learning framework to analyze several collection approaches, including knowledge gradient, a perturbed index policy, and Lagrangian relaxation.

KEYWORDS: Intelligence operations, Bayesian learning, multi-armed bandits.
OBJECTIVE: To formulate tractable models of intelligence operations that yield insights about the efficient collection of intelligence items.

SUMMARY: We design a prototype of a decision support tool that can be used by squadron, wing, and airfield operational planners. The objective of the planning is to optimize aircraft slot management and post-flight processes to minimize the time to disengage an aircraft. The decision support tool assists in evaluating alternate options, developing recommendations and allowing explicit focus on fuel savings in decision making. The simulation model is rooted in discrete event simulation and is implemented in the Simio programming language, which is well suited for our operational setting. Our goal is to develop a model that can be employed by any analyst with some basic training in simulation modeling.

KEYWORDS: Simulation, scheduling, ground operations.
A Robust Design Approach to E^2O Cost Benefit Analyses
Susan M. Sanchez, Professor
Operations Research Department
Sponsor: U.S. Marine Corps Expeditionary Energy Office

OBJECTIVE: The objective of this project is to provide a better understanding of the uncertainty associated with energy costs for Marine Corps expeditionary operations.

SUMMARY: The U.S. Marine Corps has launched a multidisciplinary energy studies program with NPS, in order to assist the USMC Expeditionary Energy Office as it seeks to analyze, develop, and direct the Marine Corps’ energy strategy in order to optimize expeditionary capabilities across all Warfighting functions. Clearly, these assessments involve costs that must be estimated from a variety of different types of models. When these many disparate models are put together to obtain an overall cost model, many of these individual sources of uncertainty end up being aggregated or ignored. As a result, assessing the overall uncertainty associated with a particular estimate is problematic—looking at individual uncertainties at the micro level may not provide a good picture of the macro level uncertainty. We adapt manufacturing’s “robust design” approach and apply the result to cost estimation models, as a proof-of-concept for use in E2O initiatives. The end result is a method suitable for assessing the overall uncertainty associated with a particular cost estimate, taking into account a broad set of environmental noise conditions. A second but equally important result is the ability to identify any decision factors combinations that result in both low costs and low cost variability. This may provide guidance on which of the many potential uncertainty sources require close monitoring, and which can safely be disregarded.

PUBLICATIONS:

KEYWORDS: Expeditionary energy, solar energy, design of experiments.
Data Farming at USMA in support of Engineered Resilient System (ERS) Architectures
Susan M. Sanchez, Professor
Operations Research Department
Sponsor: U.S. Army Engineering Research Development Center

OBJECTIVE: Support the development of data farming capability at the Operations Research Center (ORCEN) in the Systems Engineering Department at the United States Military Academy (USMA).

SUMMARY: The United States Department of Defense (DoD) is sponsoring research aimed at improving the system acquisition process. One such effort is known as the Engineered Resilient System (ERS) Architecture. Some important goals of this effort include: (1) producing more complete and robust requirements pre-Milestone A, (2) considering many more design concepts in much less time, and (3) affecting feedback between manufacturability and capability. A key focus of the ERS architecture project is the effective use of modeling and simulation (M&S) to enable extensive trade-space analysis early in the conceptual design of future systems.

A West Point Cadet Capstone Team is planning to construct simulations of potential future systems in an agent-based modeling environment. NPS’s SEED Center will team with the ORCEN at USMA to build these models and then data farm them using the SEED Center’s X-Study and OldMcData data farming tools.

KEYWORDS: Design of experiments, data farming, resilient systems, simulation
OBJECTIVE: The E2O was formed to address energy efficiency in the Marine Corps. The objective of this analysis was to determine Marines’ attitudes and behaviors regarding energy use and conservation.

SUMMARY: Four site-visits were conducted to observe Marine operational exercises at 29 Palms and other locations. Ethnographic methods were used to observe and interview nearly 60 Marines, usually in teams or small groups. They were asked about their knowledge, attitudes, and decisions pertaining to energy use. Examples of energy-related topics or opportunities include Forward Operating Base (FOB) computers and generators, battalion aid stations, air combat elements, tactical convoys, logistics and maintenance. Recommendations were made regarding procedures, policies, technology, training, and organizational culture.

Final Report:

OBJECTIVE: The primary objective of the 2014 effort was to explore the impact of alternative circadian-based watchstanding schedules on Sailors’ work/rest patterns and alertness levels onboard U.S. Navy combatants and shore installations. We focused on the analysis of sleep, performance, training and manning data collected on 150 Sailors aboard the USS NIMITZ in 2014. The before-after study design and large sample size has allowed us to explore the differences between traditional and alternative watch schedules within the same population of sailors. Based on the analysis, we will continue to make recommendations (to include potential USN Policy changes) regarding use of the alternative circadian-based watchstanding schedules for USN operations.

SUMMARY: FY14 efforts have focused on two areas: the implementation of circadian-based watchstanding schedules into operational commands; and factoring individual fatigue into operational readiness models. For these efforts, we have collected survey, actigraphy and cognitive performance data onboard the USS NIMITZ, the USS INDEPENDENCE, and the President’s Emergency Operations Center of the White House Military Office. Notional schedules and recommendations have been prepared for two additional shore-based installation commands with 24/7 watchstanding requirements, and a follow-on study to include a full data collection from the Marine Corps Embassy Security Guard program will commence in 2015.

I. Accomplishments. Alternative Circadian Watch Schedule. The alternative watch schedule experiments are ongoing studies aboard maritime platforms. They represent an attempt to find an ideal shiftwork system to apply across the Surface Fleet that will improve crew performance by maximizing each watch section’s sleep opportunities during nighttime sleeping periods, aligning them with their body’s natural circadian rhythms.
II. Circadian Watchbill Controlled Study. In addition to the 3/9 operational study, we designed and conducted a controlled laboratory study investigating and quantifying the effects of the alternative, circadian based watch schedule on sleep quality and performance as compared to the traditional watch schedules in a controlled environment. This study was conducted at the sleep laboratory of Dr. Hans Van Dongen at Washington State University, Spokane WA. Results are still being analyzed and will be published upon completion.

III. Installation Command (24/7) Watchstanding. Multiple installation commands have asked for assistance in their schedule creation for 24/7 operations. The primary focus of this effort was to assess effectiveness of alternative, 24-hour on/72-hours off watch schedule at the President’s Emergency Operations Center (PEOC) in the White House Military Office. Historically, personnel assigned to the PEOC worked a 12-hour “Panama” watch schedule. Personnel reported chronic insufficient and disrupted sleep patterns. Data was collected regarding mood-state and actigraphy before and after switching to a new alternative schedule with a 5-hour sleep period built into a 24 hour workday. Mood improved significantly on the new schedule and timing of sleep was more consistent resulting in better sleep hygiene. In addition, PEOC personnel overwhelmingly preferred the new schedule. These results are being published in the journal, Human Factors.

IV. LCS-2 Rough Water Trials. LCS-2 rough water trials were recently completed. Data analysis has been completed on the actigraphically-measured sleep data of 19 participants. The results have been submitted to a peer-reviewed journal for publication.

PUBLICATIONS:


PRESENTATIONS:


THESES DIRECTED:

ANALYSIS OF ALTERNATIVE WATCHSTANDING STUDIES

Nita Lewis Shattuck, Associate Professor
Panagiotis Matsangas, NRC Post Doctoral Fellow
Stephanie Brown, Research Associate
Department of Operations Research

Sponsor: ONR CODE 34

OBJECTIVE: The primary objective of this effort was to explore the impact of alternative watchstanding schedules and manning levels on Sailors' work/rest patterns, alertness levels and training and qualification rates. We focused on the analysis of sleep, performance, training and manning data collected on 122 Sailors aboard the USS JASON DUNHAM in December 2012. The large sample size and extensive supporting operational data collected from the ship allowed us to expand our analysis to examine the effects of watchstanding schedules and manning levels on training effectiveness and qualification rates. Based on the analysis, we will make recommendations (to include potential USN Policy changes) regarding use of the alternative circadian based watchstanding schedules for USN operations.

SUMMARY: Primary accomplishments partially funded by this project include the continuation of the 3/9 alternative watch schedule investigations onboard the USS Jason Dunham during operational settings (60% of FY14 analysis effort funded by ONR-Code34). Secondary accomplishment extended this investigation to a controlled laboratory environment for further analysis (53% FY14 effort funded by ONR-Code34).

PUBLICATION:


PRESENTATIONS:

LITTORAL COMBAT SHIP WATCHBILL INNOVATIONS

Nita Lewis Shattuck, Associate Professor
Panagiotis Matsangas, NRC Post Doctoral Fellow
Stephanie Brown, Research Associate
Department of Operations Research

Sponsor: OPNAV N135

OBJECTIVE: This study is focused on (1) the assessment of the optimal assignment of the Plus-10 crew members, determining the workload of each member of the crew for various scenarios and underway evolutions and (2) the development and validation of alternative watch bills that can be used on minimally manned crews to validate models of human performance and DoD-sanctioned modeling tools to determine predicted cognitive effectiveness levels of crewmembers in 40, 50, and 60 member core crew configurations.

SUMMARY: Data was collected onboard LCS-2 during rough water trials, Jan-Feb 2014. The data was applied in the IMPRINT modeling effort, used to create notional schedules, mission requirements and unplanned events onboard a LCS platform. The rate of mission failures during regular activities and unplanned events were analyzed across various reduced manning levels (SOW line item 4 and 5). Results indicated a reduction in failures as manning levels are increased. Risk and cost-benefit analysis will have to be accounted for when ultimately determining the optimal number of sailors for the platform. Analysis work has been accomplished by student thesis researchers and NPS summer interns, with PI guidance and oversight. This is the first application of the IMPRINT Pro Forces module in the US Navy. There are some software errors present but model validation continues. A baseline analysis without unplanned events is being conducted in order to better validate the model output results.

THESES DIRECTED:
INFORMING SHIPBOARD READINESS METRICS TO INCLUDE PHYSICAL AND COGNITIVE FATIGUE ESTIMATES

Nita Lewis Shattuck, Associate Professor
Panagiotis Matsangas, NRC Post Doctoral Fellow
Stephanie Brown, Research Associate
Department of Operations Research
Sponsor: OPNAV N173

OBJECTIVE: Based on a comprehensive review of the literature regarding the connections among physical fitness levels, health, obesity, shiftwork, and sleep, we first set out to determine the prevalence of physical injuries, physical complaints and physical and cognitive fatigue among USN crewmembers. Questionnaires were designed and administered to Sailors (n=767) aboard the USS NIMITZ in conjunction with the Spring 2014 Naval PRT to determine point prevalence estimates of physical fitness, physical injuries and fatigue issues in the fleet. Initial data were also collected on two shore-based USN populations (Naval Postgraduate School and Defense Language Institute students) to serve as a comparison. Command resilience of USN Sailors will also be collected and compared, showing averages and standard deviations along with their work/rest schedules. Our initial operational readiness model will then be updated to include adjustable manning levels and work/rest schedules based on the results of the data collected.

SUMMARY: Initial results of the shipboard questionnaire were briefed to the sponsor in September 2014 showing that over 50% of the population report experiencing at least one musculoskeletal symptom during the previous 12 months. Musculoskeletal symptoms were more common in older crewmembers, in females, in those consuming caffeinated beverages or taking sleep-promoting medications. Crewmembers reporting musculoskeletal symptoms also show elevated daytime sleepiness and higher levels of fatigue compared to those crewmembers without musculoskeletal symptoms. Watchstanding, body mass index (BMI), workout frequency, and consumption of energy drinks were not associated with musculoskeletal symptoms in this population. Additional findings and conclusions will be made upon completion of the second phase of data collection.
OBJECTIVE: The project will assess the effectiveness of alternative watchstanding schedules to determine their effects on operational readiness. The study will focus on cognitive performance, alertness levels and sleep of Marines stationed at Embassy/Consulate security posts. The initial investigation looked at the current state of the Marine Corps Embassy Security Guard (MCESG) program, providing notional alternative work-rest schedules to mitigate reported stress and fatigue. The continued work further evaluated the current work practices using interviews of instructors at MCESG schoolhouse. An additional follow-on study for CY15 is designed to collect sleep and performance data from Marines stationed at US Embassies to assess the impact of the existing schedules on their reaction times and alertness levels.

SUMMARY: The FY14 effort focused on current state of the operational work environment imposed upon Marines serving in the Marine Corps Embassy Security Guard (MCESG) program through notional work schedules. Estimates of the cognitive and psychological impact, on both individual Marine health and mission accomplishment, of various schedule configurations using the Fatigue Avoidance Scheduling Tool (FAST) interface were provided. Field-based monitoring of the sleep and performance at embassy/consulate detachments that are representative of the typical schedule configurations currently in use throughout the MCESG program will be conducted in FY15. Upon completion, optimal Embassy Schedule recommendations will be provided based on results of empirical studies.
FDA Analysis Support
P. Lee Ewing, Research Associate Professor
Operations Research Department
Sponsor: Army G-8, Forced Development Directorate, Warfare Analysis Division

OBJECTIVE: The NPS research team will research and develop improved optimization analysis capability, and will continue to sustain and maintain current analytical tools which support 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 will focus on:

(1) Research and develop a GAMS based optimization analysis tool which will maximize Army modernization levels through allocation of budget year equipment.

(2) Sustain and maintain existing ORAM and CPM optimization tools.

3) Review of the General Fleet Model developed by the MITRE corporation for FDA.

SUMMARY: In support of existing optimization tool sustainment, the PI with assistance from Rob Dell and Anton Rowe completed two short courses. Ewing and Dell developed and instructed a mathematical modeling course. Rowe developed and instructed a course in Visual Basic for Application. Work continues on this project into 2015.
OBJECTIVE: The research team will study and suggest alternative approaches to traditional large-scale campaign simulation models by demonstrating the utility of Scenario-Based Warfighting Analysis (SBWA) with traditional OR tools and methods and simple campaign modeling tools such as the Fast Theater Model (FATHM). In general, the study’s primary tasks are to:

(1) Develop an agile campaign analysis approach which emphasizes resource relationships between two or more of the Services and allows for rapid development and modeling of alternative CONOPs and scenarios.

(2) Demonstrate the approach by providing analytical products based on two scenarios and CONOPs.

(3) Summarize the campaign analysis approaches used and study results in a written report. Include strengths and weaknesses of the approaches used and any dependencies on traditional large scale campaign simulation models

SUMMARY: This work is conducted by two NPS teams. One team consisting of Dr. Brown and Dr. Washburn, on contract from IDA, has modified FATHM to demonstrate its use for campaign analysis. The other team, led by Mr. Kline, has produced a CAPE approved scenario to demonstrate Scenario-Based Warfighting Analysis. Mr. Kline’s project included a demonstration of obtaining quantitative insights using campaign analysis tools which did not include large combat model simulations. After agreement of the use of an unclassified South China Sea Scenario to draw logistic and tactical mission analyses, the NPS Joint Campaign Analysis class developed three decision aids to provide a risk assessment in three areas of interest by OSD CAPE: the resilience of the air refueling network (Air Tanker Logistics Model), Carrier Strike Group positioning under an anti-access area denial umbrella (Carrier Threat Model) and Air to Air Combat (Air Combat Markov model). These unclassified models were briefed to OSD CAPE and at their request the Air Tanker logistics Model and Carrier Threat Model further developed with classified data to provide SECRET level analyses. Thesis Students: Captain Ryan Colten, USMC “Air Refueling Network Analysis”, MSOR Thesis December 14. LT Evan Wolf, USN, “Risk versus effectiveness in Carrier Positioning”, MSSE Thesis December 14.
ASSESSING RISK AND IDENTIFYING HOW TO IMPROVE RESILIENCE OF THE ENERGY SUPPLY CHAIN IN THE PACIFIC THEATRE:

REFINERY CAPACITY ANALYSIS

David Alderson, Associate Professor
Gerald Brown, Distinguished Professor
Robert Dell, Professor
LCDR Connor McLemore, USN
Daniel Nussbaum, Visiting Professor
CDR Peter Ward, USN
Keenan Yoho, Assistant Professor
Department of Operations Research

Sponsor: Office of the Assistant Secretary of Defense for Operational Energy Plans and Programs

OBJECTIVE: The objective of this project is to provide an integrated view of risk and resilience associated with the supply and consumption of energy to support warfighting capability in the Pacific Theater.

SUMMARY: Building on several existing, but related, efforts, we focus on worst-case disruptions and their impact on operations in the US Pacific Command (USPACOM) Area of Operations (AOR), along with prioritization, evaluation, and cost of possible mitigations. The project includes the following subtopics: (1) an analysis of the refinery capacity in the Pacific theater; (2) the optimization of prepositioned fuel farm tanks; (3) an analysis of the impact of past and anticipated future market changes in the USPACOM Area of Responsibility.

THESES SPONSORED:
OBJECTIVE: The ultimate goal of this work is to help OPNAV N81 better understand the causes, risks and mitigations to campaign logistics for the Force.

SUMMARY: This project will first analyze the flow of fuels by type (i.e. JP-5, JP-8, DFM, etc) from worldwide sources to intheater demands as a multi-commodity scheduling problem, taking into account the distribution of both raw and refined product. This project will then use analytic methods (such as Attacker-Defender modeling) to explore the critical disruptions and corrective rerouting to the fuel flow, to include interdicting selected ports. Finally, this task will explore the tradeoffs between number of force protection packages for ports and transport ships and the success of the fuel flow, measured by delivery to theater.

This work builds upon analyses of bulk fuel distribution as presented in Technical Report NPS-OR-14-001R to analyze bulk fuel capability and risk in the 2028 CC-2 Campaign.

THESES SPONSORED:
**NEXT-GENERATION NETWORK SCIENCE**

David L. Alderson, Associate Professor  
Emily Craparo, Assistant Professor  
Department of Operations Research

Thomas Otani, Professor  
Department of Computer Science

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 (UPenn), California Institute of Technology, and University of California (Santa Barbara and San Diego campuses). This was a final (no-cost extension) year of a five-year award.

**SUMMARY:** The NPS part of the MURI team continues to focus 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. In collaboration with UCSB, we have conducted research involving behavioral social network experiments developed by the MURI team members at UPenn. This portion of the project focuses on gathering and prioritization of information from broadcast and social networks for evacuation decision-making. The first run of the experiment was deployed with civilian participants (undergraduates) at UCSB in spring 2012, with subsequent experiments at UCSB planned in the future.

**PUBLICATIONS:**


**PRESENTATIONS:**

OBJECTIVE: This project seeks to develop and test new theory for solving large-scale optimization and game-theoretic models; applications include military planning, critical infrastructure protection, and other defense-related problems. When appropriate, models and algorithms are implemented on request of US COCOMS, and as able, involve PhD or MS thesis research.

SUMMARY: In CY14, this research continued development and deployment of NMP (Navy Mission Planner). One surprise has been the quick deployment via MTC2, Maritime Tactical Command and Control (Naval Program Management, Warfare, Command and Control Program Office, PMW 150, Space and Naval Warfare Systems Command 4301 Pacific Hwy, San Diego, CA 92110) of a package we developed to find the shortest navigable path between any two “wet” points on the globe, a problem that turns out to be more mathematically complicated than one might expect. (A provisional U.S. Patent has been awarded.)

We continue theoretical development of a game-theoretic, anti-submarine model for planning defenses around a “high-value unit,” typically the aircraft carrier in a carrier battle group, or a sea base supporting incursions over the shore. We have been corresponding with NATO analysts who have adopted our system. (See Monsuur, et al., 2014, “A Game-Theoretic Attacker-Defender Model for a Sea Base: Optimal Deployment at the Maritime Battleground,” in Optimal Deployment of Military Systems, Netherlands Annual Review of Military Studies.)

We have developed and are fielding the Replenishment at Sea Planner (RASP), with initial installation completed at 5-th Fleet, Bahrain, and 7-th Fleet, Singapore. RASP minimizes fuel consumption by Navy supply ships as they attend deployed combatants and has been certified by independent auditors to save a lot of fuel (U).

Our transit fuel planner has been deployed on Littoral Combat Ships LCS-1, 2 and 3, and can save as much as 20% fuel consumption. Last year the planner also deployed with CG 65 Chosin in the western Pacific.

We continue to develop and support the Combat Logistics Force (CLF) strategic and operational planning models, and have evaluated current war plans for the 7-th Fleet, among others, for logistic feasibility.
We continue to apply our missile-defense model, Joint Defender (JDEF) for EUCOM to reckon where to locate, and re-locate defensive radars and interceptor missile fields in Eastern Europe. Changes in political policy and diplomacy have necessitated plan revisions.

We have introduced a Vertical Launch System Planner (VLP) for guided-missile destroyers and cruisers that optimally allocates limited missile inventories among deployed combatants to best prepare for any of many war plans.

The distinguishing ability we bring to bear here is mathematical mastery and ownership of these optimization-based decision-support tools, combined with domain expertise in warfare modeling, with reach-back support offered via a phone call or email at any classification level. Some requests require exigent mathematical developments, and some just seasoned modeling advice.

**PUBLICATIONS:**


**TECHNICAL REPORTS:**


**CONFERENCE PRESENTATIONS:**


THESES SPONSORED:


DEFENDING INTERDEPENDENT INFRASTRUCTURE SYSTEMS

R. Kevin Wood, Distinguished Professor
Javier Salmerón, Associate Professor
David Alderson, Associate Professor
Department of Operations Research

Sponsor: Defense Threat Reduction Agency through the University of Texas at Austin

OBJECTIVE: This research, in collaboration with Professor Ross Baldick of the University of Texas at Austin, seeks to develop new theory, models and algorithms for optimal design or retrofit of interdependent infrastructure systems. The goal is to make such systems resilient to kinetic and other types of WMD attacks.

SUMMARY: We have developed new techniques for assessing the resilience to attack of interdependent infrastructure systems through attacker-defender (AD) models, and for optimizing that resilience through defender-attacker-defender (DAD) models. A general algorithm for solving DAD models was tested successfully on full-scale model of the traffic flow in the highway network in the San Francisco Bay Area. We have also finished theoretical and computational development of an AD model for analyzing a strategic spare-parts policy for an electric power grid. The second-stage of this model optimally allocates spare parts after an attack, and then operates the power grid optimally, over time, as standard repairs take place. Full-scale models solve in a few hours. We have also developed a new enumerative method for solving the mixed-integer problems that arise when solving AD and DAD problems using the preferred technique of “global Benders decomposition.” Initial testing indicates that order-of-magnitude computational speedups are possible over standard Benders decomposition, and even over the more modern technique of Benders branch-and-cut.

PUBLICATIONS:


TECHNICAL REPORTS:


CONFERENCE PRESENTATIONS:


THESES SPONSORED:


Replenishment at Sea Planner (RASP)

Gerald G. Brown, Distinguished Professor

Dan Nussbaum, visiting Professor

Department of Operations Research

Sponsor: Military Sealift Command (MSC)

**OBJECTIVE:** RASP is an optimization-based decision support tool to help Combat Logistic Force planners schedule replenishments at sea of our deployed combatant ships.

**SUMMARY:** After a successful rollout of RASP to 5th and 7th fleets in 2013, 2014 was spent continuing to support RASP and add functionality based on feedback from the surface routers and MSC. New versions of RASP have been released every few months, culminating in a version 1.5.3 released in August 2014. During the course of the year the RASP heuristic solver was improved to include more fleet business logic, especially in the area of port cost analysis. RASP's automated reports and performance metrics have also been improved, and the oceanic routing data made easier to manage. RASP continues to help save fuel and standardize practices, data, and reporting across fleets.

Improvements to RASP are planned to continue into 2015.

Appendix E: Student Theses Completed in 2015


Li, Hung-xin, 2015, "Improving the Taiwan military's disaster relief response to typhoons," Master of Science in Operations Research, NPS, June.


Miller, Matthew L., 2015, "Suicide Rate Analysis of the Regular Component Active Duty Enlisted Population (U)," Master of Science in Operations Research, NPS, June.


Rodgers, Brian, 2015, “USPACOM Bulk Fuel Supply Chain Under Multiple Production, Storage and Demand Scenarios (U),” Master of Science in Operations Research, NPS, September.


Struhs, Matt D., 2015, “Exploring the Effects of Social Media on Accepted Theories for Extremism in Yemen (U),” Master of Science in Operations Research, NPS, September.


Unlu, Salim, 2015, “Effectiveness of unmanned surface vehicles in anti-submarine warfare with the goal of protecting a high value unit” Master of Science in Operations Research, NPS, June.


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**Location:**

RES  Resident  
DL   Distance Learning

**Instructor Type:**

TT = tenure track
MF = military faculty
LT = lecture track (Lecturer, Senior Lecturer, Professor of Practice)
RT = research track (Research Assistant Professor, Research Associate Professor, Research Professor)
C = contractor
O = others (intermittent employee, other departments such as SE and CS, other DoD institutions such as AFIT)

**Instructor Academic Degree:**

M  Masters  
D  Doctorate
Appendix G: Additional References

Note: References 1-6 were included as part of the nomination package for the 2013 UPS George D. Smith Prize, and thus have their own internal numbering. Reference 7 was published as the sequel to winning that prize.

Introduction

The Operations Research (OR) Department conducted an Academic Program Review (APR) during the 2015-2016 Academic Year. The results of this APR are contained in two separate documents:

1. **An OR Department Self-Study.** This document provides an internal assessment of the department—who we are, what we do, and how we are doing—based largely from a historical perspective that reflects the tradition and past successes and challenges of the department.

2. **An OR Strategic Assessment and Plan.** This document considers the issues from the Department Self-Study in a forward-looking manner and specifically considers the future challenges and opportunities for the Department.

The remainder of this document summarizes the key findings and recommendations of the APR.

**Executive Summary**

The Operations Research (OR) Department at the Naval Postgraduate School (NPS) is committed to:

1. Educating analysts so that they are fully capable of conducting independent analytical studies of military problems, and providing an educational basis for continued learning and development;

2. Developing and maintaining a world class research program in operations research and related areas; and

3. Providing high-quality, objective, academically rigorous analysis and professional advice to the U.S. Navy and Department of Defense (DoD).

The strengths of the Department are its faculty, its students and alumni, and its focus on the military applications and related methodological areas of operations research.

- As of May 2016, we had a distinguished faculty that comprises 18 tenure-track faculty members, 22 non-tenure track faculty members, and 8 senior active duty military officers. (We have two additional tenure-track hires that are coming on board this year.) Several of our civilian faculty members are nationally and internationally known researchers and educators. Many non-tenure track faculty are former senior military officers. Overall, the military faculty members bring operational experience into the classroom and into thesis topics, and provide career counseling and positive role models for the students. They also provide an important link to decision makers inside the Pentagon and in operational commands. The synergy provided by civilian and military faculty is invaluable.

- The Department’s students are both mature and highly motivated, representing officers from diverse services and countries. With the current emphasis on joint and combined operations, a student body consisting of officers from all of the U.S. military services and a variety of other nations is a significant strength of the Department. Our alumni are very supportive and appreciative of the rigorous education that they received.

- The Department, and all of the Naval Postgraduate School, has a well-defined set of Navy and DoD clients and a corresponding strong sense of its mission. We are the oldest instructional
military OR program in existence. Our department has been a consistent leader nationally in its contribution to the theory and practice of military OR.

Our educational programs are designed from the ground up to strengthen the bridge between our students and the DoD. There are many unique attributes of NPS OR. Perhaps one of the most distinguishing, when compared to other universities, is that our faculty and students are all members of the defense industry we support.

The Department remains highly productive and relevant in its education and research programs. In fiscal year 2015 (FY15), the department taught 170 course sections and graduated 103 Masters students (59 resident and 54 non-resident) and 2 Ph.D. students. During FY14 (the most recent year for which data is available), the OR faculty executed over $5.5M of externally funded research encompassing 63 projects, and resulting in 81 peer-reviewed publications, technical reports, and other research reports.

Despite these ongoing successes, for more than 15 years we have recognized that the Department has been at risk due to an aging faculty—a significant number of senior faculty members have recently retired or are eligible for retirement. Several of them continue to work in an emeritus capacity. Due to administrative and/or budget restrictions, we did not hire any external tenure-track faculty between 2011-2015 (although one non-tenure track faculty member was hired onto the tenure track during this period). During the last few years we have suffered from attrition—two of our recent assistant professor hires (from 2009-2010) and our senior statistician have left NPS OR and moved to other universities. In Spring 2016, we hired two new tenure-track professors, but more faculty recruiting is urgently needed.

During this same period, NPS as a whole has been in a period of transition, following a 2012 Navy Inspector General report and subsequent change of NPS leadership. The net result of this has been an increased administrative burden on the department and its faculty, particularly as it pertains to travel to academic conferences and meetings, the process for proposing and securing research funds, contracting for outside services, and participation in academic and research-related activities that fall outside the teaching mission. In general, it has become harder for NPS faculty to succeed in their research mission.

The overall goal of the Strategic Assessment and Plan is to provide a framework for decision-making in the Department. The Committee evaluated potential long-term success of the Department in terms of its ability to manage risk in four dimensions: (1) People, (2) Products, (3) Market, and (4) Environment. Overall, the Committee identified five key actions for strategic effort in the Department:

1. Retain and recruit the highest caliber faculty
2. Maintain and grow top-tier educational programs
3. Maintain and grow research programs of high quality and relevance
4. Increase visibility and image of the Department
5. Ease administrative burdens.

Specific recommendations for how to achieve these actions are detailed in the Assessment and Plan.