Title of Program: Systems Engineering and Operations Research

Level (Masters/Ph.D.): Ph.D

Please Indicate: ___x___ Program ______ Certificate _______ Concentration _____ Track

Description of certificate, concentration or degree program: New degree program: PhD in Systems Engineering and Operations Research

Please attach a description of the new certificate or concentration. Attach Course Inventory Forms for each new or modified course included in the program. For new degree programs, please attach the SCHEV Program Proposal submission.

Please list the contact person for this new certificate, concentration, track or program for incoming students:
Ariela Sofer, Professor and Chair, SEOR Department,
703-993-1692. asofer@gmu.edu

Approval from other units:
Please list those units outside of your own who may be affected by this new program. Each of these units must approve this change prior to its being submitted to the Graduate Council for approval.

<table>
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<tr>
<th>Unit:</th>
<th>Head of Unit’s Signature:</th>
<th>Date:</th>
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Submitted by: ________________________________ Email: ____________
Graduate Council approval: ________________________________ Date: ____________
Graduate Council representative: ________________________________ Date: ____________
Provost Office representative: _________________________________ Date: _____________
<table>
<thead>
<tr>
<th>1. Institution</th>
<th>2. Program action (Check one):</th>
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<tr>
<td><strong>George Mason University</strong></td>
<td>Spin-off proposal</td>
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<tr>
<td></td>
<td>New program proposal</td>
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<tr>
<th>3. Title of proposed program</th>
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<tr>
<td>Systems Engineering and Operations Research</td>
<td>14.3501 (or 14.2701)</td>
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<tr>
<th>5. Degree designation</th>
<th>6. Term and year of initiation</th>
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<tr>
<td>Doctor of Philosophy</td>
<td>Fall 2008</td>
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<tr>
<th>7a. For a proposed spin-off, title and degree designation of existing degree program</th>
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<tr>
<th>8. Term and year of first graduates</th>
<th>9. Date approved by Board of Visitors</th>
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<tr>
<td>Spring 2011</td>
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<th>10. For community colleges: date approved by local board date approved by State Board for Community Colleges</th>
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<th>11. If collaborative or joint program, identify collaborating institution(s) and attach letter(s) of intent/support from corresponding chief academic officers(s)</th>
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<tr>
<th>12. Location of program within institution (complete for every level, as appropriate).</th>
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<tr>
<td>School(s) or college(s) of</td>
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<tr>
<td>Division(s) of</td>
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<tr>
<td>Campus (or off-campus site)</td>
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<tr>
<td>Distance Delivery (web-based, satellite, etc.)</td>
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<tr>
<th>13. Name, title, telephone number, and e-mail address of person(s) other than the institution’s chief academic officer who may be contacted by or may be expected to contact Council staff regarding this program proposal.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ariela Sofer, Professor and Chair of Systems Engineering &amp; Operations Research, 703-993-1692, <a href="mailto:asofer@gmu.edu">asofer@gmu.edu</a></td>
</tr>
</tbody>
</table>
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Description of the Proposed Program

Overview
The Department of Systems Engineering and Operations Research proposes a new PhD in Systems Engineering and Operations Research (SEOR). The department has participated in the Ph.D. in Information Technology (IT), administered by the Volgenau School since its inception in 1986. This interdisciplinary doctoral program allows students to choose a concentration in systems engineering and operations research, and SEOR faculty graduate on average 4 PhD students per year through this program. However, because of the IT degree title, many students seeking to pursue doctoral studies in systems engineering (SE) or operations research (OR) often overlook George Mason University because they are unaware that there are doctoral programs that cover these disciplines. In addition, many employers require a degree in the specific field. By creating this new degree program, SEOR could better recruit students into the program, assure that all students have a common core knowledge, and maintain control of the curriculum that is not possible in a degree program as broad as IT.

This is an elevation of an existing concentration into a standalone program. The proposed program uses existing courses, and we have all the faculty required for the program in place. If the program is approved, we will immediately discontinue recruiting for the old concentration. We will offer students the opportunity to transfer into the new program or complete the concentration. When all students have graduated from the concentration (or transferred into the new program), we will discontinue the concentration.

The PhD in SEOR curriculum offers a unique integration of systems engineering and operations research. This integration lends a strong analytical and computational component to our systems engineering and an overarching systems perspective that is well grounded in application to our operations research activities. No other department in the nation offers a Ph.D. degree program that covers SE and OR in this integrated manner.

Background
The Volgenau School of Information Technology and Engineering established the Ph.D. degree in Information Technology in 1986. The initial program was interdisciplinary in scope, and spanned the departments represented at that time in the School. The program has been successful and has attracted students in its interdisciplinary scope. As time went on, concentrations were added to the program to reflect the diversity of departments and curriculum in the School. The concentrations provided a useful measure to gauge interest in specific disciplines. As these specific disciplines grew in interest, three spinoff Ph.D. programs were created: Electrical and Computer Engineering, Computer Science, and Statistical Science.

The Department of Systems Engineering and Operation Research (SEOR) at George Mason University (Mason) was formed in 1998 by the merge of two independent units: the Department of Systems Engineering and the Department of Operations Research. Currently there are 16 full-time professors and 11 adjunct faculty members. SEOR offers
an M.S. degree in Systems Engineering, an M.S. degree in Operations Research as well as a B.S. degree in Systems Engineering. SEOR also offers several graduate certificates. Doctoral studies have been an integral part of SEOR through the Ph.D. in Information Technology (IT), administered at the Volgenau School-level. The purpose of this proposal is to create a Ph.D. degree in Systems Engineering and Operations Research that would be administered by SEOR. The academic requirements of the Systems Engineering and Operations Research Ph.D. program are derived from the requirements of the existing IT Ph.D. program, but tailored to the specific needs of a program in Systems Engineering and Operations Research.

Admissions Requirements

Candidates for the Ph.D. program must hold an MS degree from an accredited institution of higher education, in systems engineering, operations research or related areas in engineering mathematics and computer science, with a minimum graduate GPA of 3.5 on a 4.0 scale and a minimum undergraduate GPA of 3.0. In addition, well qualified candidates holding a BS degree in these areas may apply directly to the Ph.D.

All applicants should have a strong background in engineering mathematics including three semesters of calculus, differential equations, linear algebra, probability, and statistics. In addition, students entering the doctoral program must have a sound working knowledge in computing.

The admission process involves submitting the application for admission, undergraduate and graduate transcripts from previous colleges and universities attended, GRE test results, three letters of reference, a resume and a statement of career goals and aspirations, and a self-assessment of past background. Translations of international credentials must be provided, if they are not in English; in some cases, applicants will be required to have documents evaluated by an external agency. A satisfactory score on the TOEFL examination is required for non-native English speakers. All of an applicant's background is examined before an admission decision is made.

Curriculum

Coursework

Students entering with a masters degree in a related discipline will be required to complete 48 credit hours. In particular, students entering with a masters degree are required to complete the following:

- 24 credits of advanced emphasis coursework, including
  - STAT 554 *Applied Statistics* (3 credits)
  - SYST 763 *Research Methods in Systems Engineering and IT* (3 credits)
  - 18 credits of SYST/OR courses or IT courses with a SYST/OR designation; at least 15 of the 18 credits must be numbered 700 or higher, and the remaining 3 credits may be numbered 600 or
higher. No more than 3 credits are allowed for a directed reading course. Course substitutions must be approved by the dissertation committee chair and the SEOR department chair.

A GPA of 3.50 is required and no C grade is allowed in these 24 credits.

- A minimum of 24 research credits from among SEOR 998 and 999, with a minimum of 12 credits of SEOR 999.

Students entering without a masters degree are required to complete an additional 24 credits of masters level courses, including:

- 12 credits of fundamental Systems Engineering and Operations Research courses, including:
  - SYST 510 Systems Definition and Cost Modeling
  - SYST 520 Systems Engineering Design,
  - OR 541 Operations Research: Deterministic Models,

- 12 additional credits from one of the following two alternatives

<table>
<thead>
<tr>
<th>Alternative 1 (Systems Engineering)</th>
<th>Alternative 2 (Operations Research)</th>
</tr>
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<tbody>
<tr>
<td>SYST 530 System Management and Evaluation</td>
<td>STAT 544 Applied Probability</td>
</tr>
<tr>
<td>SYST 573 Decision and Risk Analysis</td>
<td>OR 635 Discrete System Simulation</td>
</tr>
<tr>
<td>SYST 611 System Methodology and Modeling</td>
<td>One OR “Deterministic Methods” course from among OR 641, 642, 643, 644</td>
</tr>
<tr>
<td>One approved SYST elective course numbered 600 or above.</td>
<td>One OR “Stochastic Methods” course from among OR 645, 647, 648, 675, 677</td>
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</table>

Qualifying Examinations

Each student must take four exams within two years of enrolling in the program:

- SYST 510 Systems Definition and Cost Modeling
- SYST 520 Systems Engineering Design,
- OR 541 Operations Research: Deterministic Models,

A student who passes three of the four exams in the first attempt must retake and pass the failed exam within one year. A student who passes fewer than three exams in the first attempt must retake and pass an entire set of four exams within one year. After two unsuccessful attempts, a student is dismissed from the Ph.D. program.

Dissertation Committee

Students should select a dissertation director and a doctoral supervisory committee as soon as possible. It is recommended that the committee be formed by the end of the
second or third semester of study. The dissertation director must be a member of the SEOR graduate faculty or a member of the Mason graduate faculty with approval from the SEOR Department Chair. The doctoral supervisory committee must include at least three members from the SEOR department-approved graduate faculty, and at least one non-SEOR member from the Mason faculty. The composition of the doctoral supervisory committee is to be approved by the doctoral coordinator. At least three members of the committee must be members of the Mason graduate faculty.

Comprehensive Examination
The comprehensive examination is taken after the student has satisfactorily completed all the advanced emphasis course work requirements in the approved plan of study filed by the student. The examiners will include SEOR faculty and the supervisory committee plus any outside examiners considered appropriate. However, the supervisory committee determines whether the student passes or not. The comprehensive examination will consist of a written examination of 8 hours in length and an oral examination. The committee will determine if the student has a mastery of the advanced emphasis coursework. If a student fails the comprehensive exam, the student may request a re-examination within 60 days of receiving notice of the exam result. The request should be made in writing to the doctoral coordinator. If the student fails the re-examination, or does not request a re-examination within 60 days, the student will be dismissed from the Ph.D. program.

Dissertation Proposal
After passing the comprehensive examination, each doctoral student prepares a written dissertation proposal, which is presented to the doctoral supervisory committee. After successfully completing this requirement, the student is formally admitted as a candidate for the Ph.D. degree.

Dissertation Defense
When the central portions of the research have been completed to the point that the student is able to describe the original contributions of the dissertation effort, a candidate submits the written dissertation to the supervisory committee and schedules an oral predefense with the committee. This predefense is attended by the supervisory committee. The supervisory committee approves the work or the student must schedule a second predefense.

Once the committee believes the student is ready, a final public oral defense may be scheduled no sooner than one month after the conclusion of the predefense in order to have an announcement posted for at least two weeks. Following a satisfactory evaluation of the oral defense of the dissertation by the supervisory committee, the student must prepare, with supervision from the dissertation director, a final publishable dissertation that represents a definitive contribution to knowledge in systems engineering and operations research. This document must meet format guidelines specified by the Guide for Preparing Graduate Theses, Dissertations, and Projects. If the student fails to successfully defend the dissertation, the student may request a second defense, following the same procedures as for the initial defense. There is no time limit for this request, other
than the general time limits for the doctoral degree. An additional predefense is not required, but the student is strongly advised to consult with the committee before scheduling a second defense. If the student fails on the second attempt to defend the dissertation, the student will be dismissed from the Ph.D. program.

A sample schedule for completion of the Ph.D. degree in Systems Engineering and Operations Research is given in Appendix 1.

New Courses
The following two new “courses” were added to our program. These are dissertation research credits directly associated with the PhD in SEOR. The courses are equivalent to the courses IT 998 and IT 998 used for research credit in the PhD in IT. Neither course requires additional resources

SEOR 998 Doctoral Dissertation Proposal (1-12:0:0)  Work on research proposal that forms basis for doctoral dissertation. May be repeated. No more than 24 credits of SEOR 998 and 999 may be applied to doctoral degree requirements.

SEOR 999 Doctoral Dissertation (1-12) Prerequisite: admission to candidacy. Formal record of commitment to doctoral dissertation research under direction of faculty member in SEOR. May be repeated as needed.

Faculty
Our faculty is world renowned in the fields of systems engineering and operations research. For example, Professor Andy Sage is among the founders of the field of the field of systems engineering and has been inducted into the National Academy of Engineering for his contributions to the theory and practice of systems engineering and systems management. Dr. Donohue is former Associate Administrator of the FAA for Research and Acquisition, and a leading authority in air transportation research. Dr. Alex Levis of the Electrical and Computer Engineering Department (and a key participant in our systems engineering program) is former Chief Scientist of the Air Force and a renowned expert on systems architectures.

Three members of our faculty have served as President of the Institute for Operations Research and the Management Sciences, another has served as President of the Military Operations Research Society, and another has served as President of the International Council of Systems and Engineering. Collectively, our faculty has written more than 35 books that are used in classrooms worldwide.

SEOR currently has 16 tenured and tenure-track faculty, and full-time research professors. Combined they have supervised 57 Ph.D. graduates and are currently supervising 48 Ph.D. students. This number does not include students of former members of the SEOR department who have retired, passed away, or have left George Mason University to other academic institutions.
Key faculty who will participate in the program are

- Leonard Adelman, Professor  
  Human Factor, Decision Support Systems,
- Peggy S. Brouse, Associate Professor  
  Requirements Engineering
- Kuo-Chu Chang, Professor  
  Multisensor Data Fusion, Bayesian Networks
- Chun-Hung Chen, Professor  
  Discrete Event Systems Simulation and Optimization
- George L. Donohue, Professor  
  Air Transportation Technology and Systems Engineering
- Rajesh Ganesan, Assistant Professor  
  Stochastic Control, Control of Nanoscale Processes
- Karla L. Hoffman, Professor  
  Combinatorial Optimization, Auction Theory and Design
- Kathryn B. Laskey, Associate Professor  
  Bayesian Inference and Decision Theory, Uncertainty in Artificial Intelligence
- Alex Levis Professor (Department of Electrical and Computer Engineering)  
  Systems Architecture, Architecture Design and Evaluation
- Yifan Liu, Assistant Professor  
  Biodefense, Mathematical Models in Homeland Security
- Andrew G. Loerch, Associate Professor  
  Military Operations Research, Multi-Year Capital Budgeting
- Stephen G. Nash, Professor  
  Nonlinear Programming, Numerical Analysis
- Roman Polyak, Professor  
  Nonlinear and Linear Optimization, Game Theory,
- Andrew P. Sage, Professor  
  Systems Integration and Architecting, Complex Adaptive Systems
- David A. Schum, Professor  
  Probabilistic Reasoning, Marshaling of Evidence
- Lance Sherry, Research Associate Professor  
  Director, Center for Air Transportation Research
- John Shortle, Associate Professor  
  Queueing Theory, Simulation
- Ariela Sofer, Professor and Chair  
  Linear and Nonlinear Optimization. Optimization in Medicine

**Learning Outcomes**

The primary objective of the program is to prepare students for careers in the research and practice of systems engineering or operations research. Potential employers include government agencies, the defense and transportation industry, local government contractors and businesses. Graduates of the program will be prepared for professional
practice, research, or teaching, or a combination of these. As such, each of our Ph.D.
graduates should have a deep understanding of the Systems Engineering and Operations
Research methods. Every graduate should be able to:

- model and analyze complex systems for the purpose of supporting decision making
- develop new and innovative Systems Engineering or Operations Research methodologies
- apply their research skills to challenging system problems in the private and public sectors
- present research at national and international conferences
- publish research in respected journals

Assessment

As with all academic programs at George Mason University, assessment of student learning in the proposed program in systems engineering and operations research will take place at the levels of the student, the course, and the program. Faculty evaluate students every term in each course in which they are enrolled, through papers, oral presentations, projects, examinations, and other means. As is typical in doctoral programs, students in the Ph.D. in Systems Engineering and Operations Research will also be evaluated through qualifying examinations, a comprehensive examination, final dissertation defense, and publication and dissemination of research results.

The proposed program will be reviewed on the seven-year cycle typical of programs within the Volgenau School of Information Technology and Engineering. Program review takes place under the guidance of the Office of Institutional Assessment and requires three semesters to complete. The outcomes of the process are a series of deliverables—a self-assessment report and academic plan written by program faculty and a report by a review team external to the program—and changes made to enhance the program. The Department of Systems Engineering and Operations Research is scheduled for review of its programs in 2008-9.

The students’ attainment of the program’s learning goals will be assessed by the following milestones: qualifying examinations, approval of plan of study, comprehensive examination, dissertation proposal defense, dissertation pre-defense, dissertation final defense, and publication and dissemination of research results.

Benchmarks of Success

The success of the program will be assessed against the following benchmarks:

a. Ability to recruit talented graduate students and meeting of enrollment targets.
b. Incorporation of students in faculty research and publication of research results.
c. Satisfaction of students with the program, measured by course evaluations and interviews with graduates, both upon graduation and five years after graduation.
d. Quality and quantity of research publications by program graduates.
e. The success of graduates in obtaining high quality employment or advancing to higher positions within their organization.
f. The long-term professional success of the graduates, including their local and national/international impact.

Having a Ph.D. program in system engineering and operations research enables us to recruit high quality students from these fields as well as the following related fields: mathematics, industrial engineering, economics, computer science, and other engineering fields. We will implement a major recruitment effort to attract both domestic and international students. This new program allows us to recruit and fully fund undergraduate students from first-tier universities directly into our Ph.D. program. We also will be able to recruit top-quality students under the Presidential Scholar Program, which allots each Ph.D. program a three-year graduate research assistantship each year for recruiting purposes.

Expansion of an Existing Program?

This is an elevation of the existing PhD in IT with concentration in Systems Engineering and PhD in IT with concentration in Operations Research into a standalone program. The proposed program uses existing courses, and we have all the faculty members required for the program in place. If the program is approved, we will immediately discontinue recruiting for the old concentration. We will offer students the opportunity to transfer into the new program or complete the concentration. When all students have graduated from the concentration (or transferred into the new program), we will discontinue the concentration.

Collaborative or Standalone Program?

The proposed degree is a standalone program. No other institution of higher education, nor any business or industry, is involved in its development or operation.

Justification for the Proposed Program

Response to Current Needs
The systems engineering and operations research methodologies have become more and more important for government and industry, as the scale and the complexity of the problems they are facing have grown dramatically. The demand for expertise in systems engineering and operations research is particularly strong in Northern Virginia and the Washington metropolitan area. While SEOR has thriving M.S. programs in Systems Engineering and Operations, many graduates of these programs are wishing to pursue doctoral studies in systems engineering or operations research.
This proposal is designed to respond to current needs. As mentioned earlier, changing the name of the degree program and allowing SEOR to administer it are critical to our success in recruiting students to the program.

The rationale for these changes is compelling:

1) The SEOR curriculum offers a unique integration of Systems Engineering and Operations Research. There is no other department in the nation offering a Ph.D. degree program that covers both the disciplines of Systems Engineering and Operation Research. The integration of Systems Engineering and Operations Research has been a hallmark of our academic programs and also our research. This integration lends a strong analytical and computational component to our Systems Engineering activities and a systems perspective to our Operations Research activities, stressing the optimization of entire systems rather than the evaluation of any specific component. All students in this Ph.D. program will have to demonstrate an understanding of the system lifecycle, from the requirements stage, to the costing, development, systems integration, systems architecture, continual testing and process improvement, enhancements and, finally, retirement of the system. They will also have to demonstrate an understanding of modeling, the fundamentals of optimization theory, decision analysis and simulation and be able to apply such methods to the development and testing of large-scale systems. The Center for Air Transportation Research at Mason exemplifies the approach of applying both the Systems Engineering and the Operations Research tools and technologies to a complex adaptive system. The research in this center is concerned with how airlines, airports, passengers, and regulators interact and impact the overall efficiency of the airspace (rather than being concerned with the optimization of a single airport or airline schedule). This unique approach is valued by policy makers within the government who use these techniques to evaluate how their decisions impact the country as-a-whole rather than only one component of the regulated system. Similarly, our work for the telecommunications industry has stressed the overall impact of new technologies on this industry that has transformed from primarily telephony to a broad purveyor of information through satellite, cellular, internet, and wired networks that must all interact.

2) Both Systems Engineering and Operations Research have become highly-valued disciplines where the demand for our graduates far exceeds those obtaining the graduate training required. The demand is particularly strong in Northern Virginia and the Washington metropolitan area, where government agencies and private industry (primarily in transportation services, logistics, telecommunications, and military consulting) require the analysis of complex interactive systems. The research in our department has impacted such diverse decisions as those regarding the development and deployment of complex weapon systems, the efficient allocation of resources at highly-congested airports, effective response to bioterrorism threats and the treatment planning of radiation therapy for cancer. Given the wealth of employment opportunities in these highly-specialized disciplines,
many of our students desire degrees that specifically identify their education in the fields of Systems Engineering and Operations Research rather than the broader term “Information Technology”. Currently, our students receiving masters degrees in either Systems Engineering or Operations Research must choose either to elect a Ph.D. in Information Technology or attend another university that offers the specialized Ph.D. of Systems Engineering, Operations Research or Industrial Engineering. We note that there is no Ph.D. program anywhere in Virginia offering such a Ph.D. although most large universities offer Ph.D.s in either operations research or in Systems Engineering; e.g., MIT, Yale, Princeton, Penn, Stanford, Berkeley, U. Va, Georgia Tech, U. Mich. We believe that the demand for this new degree program is very strong.

3) The lack of a specific Systems Engineering and Operations Research designation in a Ph.D. program at Mason is a hindering factor in the development of the university’s reputation. Although many of the faculty in the SEOR program are recognized world leaders, the department is not ranked by such entities as U.S. News and World Report because it is not identified as having a Ph.D. program in any of the disciplines that are ranked. Thus, when students are deciding where to do graduate work, they often overlook Mason. Similarly, recruitment of new faculty is more difficult because new faculty candidates consider it important for their professional development to choose a university that offers a Ph.D. in their specific field.

4) By creating this new degree program, the SEOR academic unit could better recruit students into the program, assure that all students have a core knowledge of these disciplines and maintain a quality assurance program that is impossible in a degree program as broad as Information Technology. As this degree evolves, it will help recruit new talent into the Northern Virginia region and will therefore assist business and government in obtaining the skilled labor they need.

5) Mason is the only civilian university recognized by DOD for its expertise in military operations research (as well as and systems engineering as it applies to defense applications), and we regularly have a number of full-time military students in our program. The US Military Academy at West Point sends some of their future SE and OR faculty to obtain their PhD degree at Mason. Often these students require special justification for taking the PhD in IT, because the military specifically requires expertise in SE and OR.

**Comparison to the PhD in IT with Concentration in SE or OR**

The following chart shows the comparison of the existing IT Ph.D. program with concentration in Systems Engineering or Operations Research and our proposed Ph.D. program in Systems Engineering and Operations Research.
<table>
<thead>
<tr>
<th><strong>Ph.D. in IT conc. SE or OR</strong></th>
<th><strong>Ph.D. in SE&amp;OR</strong></th>
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<tbody>
<tr>
<td><strong>Basic Course Requirements</strong></td>
<td><strong>Basic Requirements</strong></td>
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<tr>
<td>Credit Hours: 24</td>
<td>Credit hours: 24</td>
</tr>
<tr>
<td>At least 18 credits must either be in SYST courses numbered 600 or higher or in IT courses with a SYST designation, and at least 12 credit hours must be in courses numbered 700 or higher. GPA 3.5</td>
<td>STAT 554 &amp; SYST 763, remaining 18 credits must either be in SYST/OR courses numbered 600 or higher or in IT courses with a SYST/OR designation, and at least 15 of the 18 credits must be numbered 700 or higher. GPA 3.5, no C is allowed</td>
</tr>
<tr>
<td><strong>Additional Course Requirements for Students without an MS</strong></td>
<td><strong>Additional Course Requirements for Students without an MS</strong></td>
</tr>
<tr>
<td>24 graduate credits satisfying general requirements</td>
<td>24 graduate Credit hours including SYST 510, SYST 520, OR 541, OR 542, and four elective SE or OR courses</td>
</tr>
<tr>
<td><strong>Qualifying Exams</strong> Pass four exams from the following subjects in two consecutive offerings:**</td>
<td><strong>Qualifying Exams</strong> Each student must take all the following four subjects:**</td>
</tr>
<tr>
<td>• SYST 520 System Design and Integration</td>
<td>• Systems Definition and Cost Modeling (SYST 510)</td>
</tr>
<tr>
<td>• SYST 573 Decision and Risk Analysis</td>
<td>• System Design and Integration (SYST 520)</td>
</tr>
<tr>
<td>• OR 541 Deterministic Operations Research</td>
<td>• Deterministic Operations Research (OR 541)</td>
</tr>
<tr>
<td>• OR 542 Stochastic Operations Research</td>
<td>• Stochastic Operations Research (OR 542)</td>
</tr>
<tr>
<td>• STAT 544 Applied Probability</td>
<td>Tighter pass conditions:</td>
</tr>
<tr>
<td>• STAT 554 Applied Statistics</td>
<td>• Passes all four exams in the first attempt.</td>
</tr>
<tr>
<td><strong>Comprehensive Examination</strong> An oral examination</td>
<td><strong>Comprehensive Examination</strong> Both written and oral examinations</td>
</tr>
<tr>
<td><strong>Doctoral Dissertation Research</strong> 24 credits from IT 998/999</td>
<td><strong>Doctoral Dissertation Research</strong> 24 credits from SEOR 998/999, any portion of SEOR 998 requirement can be replaced by courses numbered 600 or higher with approval of the supervisory committee.</td>
</tr>
<tr>
<td><strong>Dissertation Proposal Presentation</strong></td>
<td><strong>Dissertation Proposal Presentation</strong></td>
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<tr>
<td><strong>Dissertation Defense</strong></td>
<td><strong>Dissertation Defense</strong></td>
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</tbody>
</table>
Employment Demand

Northern Virginia and the Washington metropolitan area provide a large and expanding market for graduates with a Ph.D. in Systems Engineering and Operations Research. The proximity to the federal government and the high-technology industries in the region make it easy for us to place our graduates.


For this field, BLS states

- “Employers generally prefer applicants with at least a master’s degree in operations research or management science, or a closely related field such as computer science, engineering, business, mathematics, or information systems.

- Individuals with a master’s or Ph.D. degree in management science, operations research, or equivalent should have good job opportunities as operations research analysts or in closely related occupations, such as systems analysts, computer scientists, or management analysts.

- Individuals who hold a master’s or Ph.D. degree in operations research, management science, or a closely related field should find good job opportunities because the number of openings generated by employment growth and the need to replace those leaving the occupation is expected to exceed the number of persons graduating with these credentials.

According to BLS, the District of Columbia and Virginia are number 1 and 2 in the list of States with the highest published employment concentrations and wages for operations research. Furthermore the Washington Metropolitan area (DC, VA, MD, WV) is the metropolitan area with the highest concentration of operations researchers in the country.

A search in monster.com under the key words “operations research analyst” conducted September 22, 2007, yielded 2147 open positions nation wide. The same search, when restricted to positions in Virginia yielded 233 positions. Of these, 188 positions were in a radius of 20 miles from 22030 (Fairfax, VA). See [A search on DICE](http://www.dice.com) gave 49 jobs listed for PhD’s in Operations Research (or had the words, PhD, operations, and engineering in the listing).

A search at the Virginia Employment Commission conducted September 22, 2007 yielded 18 positions under the heading “operations research,” with all 18 of these at an annual salary above $100,000; 16 of these had been posted within the preceding 14 days.
It is hard to obtain future demand predictions for systems engineering because the BLS does not yet analyze this job classification. Yet systems engineering is very much in demand, and many large corporations define their core competencies in terms of systems engineering and integration. SAIC for example describes itself as a leading systems, solutions and technical services company. Northrop Grumman describes itself as “designer, systems integrator and manufacturer of...” Noblis defines itself as a nonprofit science, technology and strategy organization that helps clients solve complex systems, process and infrastructure problems.” Mitre describes its mission as “Applying Systems Engineering and Advanced Technology to Critical National Problems.” BAE defines itself as a global leader in systems, defense and aerospace... SPARTA advertises itself as a “systems engineering and advanced technology company.”

To determine demand, a search in www.monster.com under the key words “systems engineer, integration” conducted September 22, 2007, yielded over 5000 open positions nation wide. (The word “integration” was added because it rules out positions that are systems engineer in title but are not strictly technical). The same search, when restricted to positions in Virginia yielded 2681 positions. Of these, 2159 positions were in a radius of 20 miles from 22030 (Fairfax, VA). See Appendix C for References


A search at the Washington Post on line showed 2571 positions for systems engineers, with numerous positions posted at local companies in Northern Virginia such as Booz Allen Hamilton, Sparta, BAE, General Dynamics, Mitre, and more.

A search at the Virginia Employment Commission conducted September 22, 2007 yielded 309 positions under the heading “systems engineer,” with 293 of those at an annual salary above $100,000; 245 of these had been posted within the preceding 14 days.

A search on DICE (the career announcements for engineering www.dice.com), yielded 138 positions for PhD’s with Systems Engineering background (i.e. had the requirement of a PhD and the term systems and engineering in the requirements).

Appendix C gives sample job announcements with URL addresses. Appendix D shows letters of support from local industries in the Washington metropolitan area that demonstrate the need for doctoral-level experts in operations research and systems engineering.

Finally, some of our PhD graduates will choose to go to academia. Several of our graduates have gone to academic institutions nationwide such as Princeton, and Cal Tech, as well as in Virginia (in George Mason, University of Mary Washington, Marymount University, Bridgewater College), to teach future generations of engineers.
Evidence of Student Demand

To assess student demand we conducted a survey of our graduate students. The survey was sent to 55 doctoral students we have identified as “SEOR” students. It was also sent to close to 200 Masters students, as well as about 15 former graduates of the PHD in IT program. A copy of the survey is given in Appendix E.

Of particular interest was the students’ view of the new program. A summary of the survey results is given below.

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Undecided</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 a. FOR STUDENTS CURRENTLY IN MASON PHD PROGRAMS: If this program had been available when you initially applied to Mason, would you have applied for admission to it?</td>
<td>30</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5 b. FOR STUDENTS WHO ARE INTERESTED IN APPLYING FOR A PHD PROGRAM IN THE FUTURE: If this program becomes available when you apply to Mason, will you apply for admission to it?</td>
<td>54</td>
<td>5</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>5 c. FOR STUDENTS WHO LEFT MASON TO PURSUE EDUCATION ELSEWHERE: If this program had been available when you completed your current program, would you have applied for admission?</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5 d. FOR STUDENTS WHO LEFT MASON BUT HAVE NOT PURSUED FURTHER EDUCATION: If this program had been available when you completed your current program, would you have applied for admission?</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Thus of 35 doctoral students who responded to the survey, 30 students (86%) stated that they would have applied to the program had it been available at the time of application. Furthermore 54 of the masters level students were sufficiently interested that they thought they would apply to the program if it becomes available.

The written comments in the survey were overwhelmingly positive. For a summary see Appendix F.

Give this, the estimated headcount and FTE Students is given in the following table.
Assumptions:
90% retention
40% full-time students/60% part-time students
Full-time students taking 12 credit hours
Part-time students taking 6 credit hours
Full-time students graduate in 3-4 years

<table>
<thead>
<tr>
<th>Year</th>
<th>2008-09</th>
<th>2009-10</th>
<th>2010-11</th>
<th>2011-12</th>
<th>2012-2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HDC</td>
<td>FTE</td>
<td>HDC</td>
<td>FTE</td>
<td>HDC</td>
</tr>
<tr>
<td>New</td>
<td>8</td>
<td>4</td>
<td>8</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Returning</td>
<td>35</td>
<td>21</td>
<td>39</td>
<td>23</td>
<td>39</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>25</td>
<td>47</td>
<td>27</td>
<td>47</td>
</tr>
</tbody>
</table>

Table 1. Projected enrollments in Proposed Program

Duplication
The SEOR curriculum offers a unique integration of systems engineering and operations. There is no other department in the nation offering a Ph.D. degree program in systems engineering and operation research.

Institutions in the Commonwealth Offering Similar Programs
The University of Virginia offers a PhD program in Systems Engineering, Virginia Polytechnic Institute offers a Ph.D. program in Industrial and Systems Engineering, and Old Dominion University offers a PhD program in Engineering with concentration in Modeling and Simulation. Enrollment statistics for the University of Virginia and Virginia Polytechnic Programs are follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>University of Virginia</th>
<th>Virginia Polytechnic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FTE</td>
<td>Graduates</td>
</tr>
<tr>
<td>2000-01</td>
<td>31.7</td>
<td>4</td>
</tr>
<tr>
<td>2001-02</td>
<td>41.2</td>
<td>2</td>
</tr>
<tr>
<td>2002-03</td>
<td>42.3</td>
<td>6</td>
</tr>
<tr>
<td>2003-04</td>
<td>42.7</td>
<td>13</td>
</tr>
<tr>
<td>2004-05</td>
<td>35.1</td>
<td>3</td>
</tr>
<tr>
<td>2005-06</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>2006-07</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
Table 1. FTE and Graduate Totals for Comparable Degree Programs in the Commonwealth

We could not discern from the SCHEV data, what proportion of the doctoral graduates in Old Dominion University graduated with the concentration in Modeling and simulation, but the total FTE figures for years 2000-01 through 2004-05 are 92.0, 93.6, 97.8, 220.5 and 105.4, and the total number of graduates was 12, 9, 19, 21, and 14.

Our proposed program is unique in that it serves the Northern Virginia/Washington metropolitan area and offers students the opportunity to complete the degree part-time, as all courses are offered after 4:30 p.m. The largest employers of Ph.D.'s in Systems Engineering and Operations Research are located in Northern Virginia, e.g. Lockheed Martin, SAIC, Raytheon, U.S. Government. Indeed, of the 34 doctoral students who replied to our survey 20 are part time students, 10 are full time students (4 students did not respond to that question).

Projected Resource Needs

Full-time Faculty
The Department of Systems Engineering and Operation Research has faculty with subject-matter expertise sufficient to teach the full range of classes offered in the program. Because all of the courses offered are currently taught within the Ph.D. in Information Technology program, we anticipate adding no new full-time faculty to launch the program. By the target year of 2012-13, we project that total FTE will have increased to the point that we will need to add a new full-time tenure line.

Part-time Faculty from Other Academic Units
The proposed program does not require any significant resource of part-time faculty from outside the academic unit.

Adjunct Faculty
The proposed program does not require the use of adjunct faculty.

Graduate Assistants
Support to graduate students in the form of graduate assistantships is an essential component of successful Ph.D. programs. Graduate research assistants provide the additional support faculty need to expand research efforts. Graduate teaching assistants free faculty time to devote to research and doctoral supervision committees. Research assistantships and teaching assistantships also directly benefit doctoral students, who receive financial support, contribute to research, and gain teaching experience.

Graduate assistantships for the proposed Ph.D. in Systems Engineering and Operations Research will have four components:
• Graduate research assistantships funded by sponsored research. The SEOR faculty have brought in significant research funding to support our graduate students. The sponsored research by SEOR faculty will support an additional three research assistantships by 2013-14.

• Graduate teaching assistantships. Support from the school is available for teaching assistantships that will be given to talented full-time graduate students. Three doctoral students will be awarded teaching assistantships in the program’s first year, increasing to a total of 8 by the target year.

• Presidential Scholar’s Award. The Office of the Provost will provide one new three-year Presidential Scholar’s Award to the program to recruit highly qualified students. By the target year of 2013-14, the Presidential Scholar’s Award will support three students in the proposed program.

• Graduate research assistantships funded by the school. The Volgenau School of Information Technology and Engineering also provides a new two-year GRA position to each new tenured faculty member, generating a total of two such positions by the target year.

By the target year, then, we anticipate that full-time students in the Ph.D. in Systems Engineering and Operations Research will be supported by a total of 12 GRA positions and 8 GTA positions.

Classified Positions
The Department of Systems Engineering and Operations Research currently employs two classified staff member. We anticipate that less than 10% of one classified staff member’s time will be devoted to operation of the proposed program.

Targeted Financial Aid
No targeted financial aid will be offered for the proposed program.

Equipment
New full-time faculty will require a computer and office furniture.

Library
Current journal subscriptions are adequate to support the proposed program.

Telecommunications
Any new full-time faculty will require phone hardware and services.

Space
No new space is required to initiate and operate the program.

Other Resources
New full-time faculty receive two years of start-up funds.
PROJECTED RESOURCE NEEDS FOR PROPOSED PROGRAM

Part A: Answer the following questions about general budget information.

- Has or will the institution submit an addendum budget request to cover one-time costs?  
  Yes [_________]  No [x]

- Has or will the institution submit an addendum budget request to cover operating costs?  
  Yes [_________]  No [x]

- Will there be any operating budget requests for this program that would exceed normal operating budget guidelines (for example, unusual faculty mix, faculty salaries, or resources)?  
  Yes [_________]  No [x]

- Will each type of space for the proposed program be within projected guidelines?  
  Yes [x]  No [_________]

- Will a capital outlay request in support of this program be forthcoming?  
  Yes [_________]  No [x]

Part B: Fill in the number of FTE positions needed for the program

<table>
<thead>
<tr>
<th></th>
<th>Program initiation year 2008 - 2009</th>
<th>Total expected by target enrollment year 2012 - 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ongoing and reallocated</td>
<td>Added (new)</td>
</tr>
<tr>
<td>Full-time faculty</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Part-time faculty [faculty FTE split with other unit(s)]</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Adjunct faculty</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Graduate assistants</td>
<td>5.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Classified positions</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*Added after program initiation year
<table>
<thead>
<tr>
<th></th>
<th>Program initiation year</th>
<th>Total expected by target enrollment year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008 - 2009</td>
<td>2012 - 2013</td>
</tr>
<tr>
<td></td>
<td>Ongoing and reallocated</td>
<td>Added (new)</td>
</tr>
<tr>
<td>Full-time faculty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>fringe benefits</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Part-time faculty [faculty FTE split with other unit(s)]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>fringe benefits</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Adjunct faculty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>fringe benefits</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Graduate assistants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$135,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>fringe benefits</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Classified positions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>fringe benefits</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Total personnel costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>$135,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>fringe benefits</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>TOTAL personnel costs</td>
<td>$135,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Library</td>
<td>$4,000</td>
<td>$0</td>
</tr>
<tr>
<td>Telecommunication costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Other costs (specify)</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$139,000</td>
<td>$30,000</td>
</tr>
</tbody>
</table>

*Added after program initiation year

**Part D: Certification Statement(s)**

The institution will require additional state funding to initiate and sustain this program.

_______ Yes ____________________________________________

Signature of Chief Academic Officer

X____ No ____________________________________________

Signature of Chief Academic Officer

If “no,” please complete Items 1, 2, and 3 below.
1. Estimated $$ and funding source to initiate and operate the program.

<table>
<thead>
<tr>
<th>Funding Source</th>
<th>Program initiation year</th>
<th>Target enrollment year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007- 2008</td>
<td>2011 - 2012</td>
</tr>
<tr>
<td>Reallocations within the department or school (Note below the impact this will have within the school or department.)</td>
<td>$109,000</td>
<td>$350,000</td>
</tr>
<tr>
<td>Reallocations within the institution (Note below the impact this will have within the school or department.)</td>
<td>$30,000</td>
<td>$90,000</td>
</tr>
<tr>
<td>Other funding sources (Please specify and note if these are currently available or anticipated.)</td>
<td>0</td>
<td>$139,875</td>
</tr>
</tbody>
</table>

2. Statement of Impact/Other Funding Sources.

The Office of the Provost will fund one new, three-year Presidential Scholar’s award (worth $30,000) each year. The remainder of the funding necessary to initiate the program will be reallocated from existing resources in the Department of Systems Engineering and Operations Research or the Volgenau School of Information Technology and Engineering.

By the target year 2011-12, the provost’s commitment of Presidential Scholar’s awards will be $90,000 per year. The costs associated with the new faculty line will be funded through a combination of increases in enrollment and anticipated revenues from increased sponsored research. The remainder of funding necessary to maintain the program will be reallocated from existing resources in the Department of Systems Engineering and Operations Research and the Volgenau School of Information Technology and Engineering.

No additional resources will be sought from the Commonwealth of Virginia.


If resources are reallocated from another unit to support this proposal, the institution will not subsequently request additional state funding to restore those resources for their original purpose.

____ x Agree

Signature of Chief Academic Officer

_____ Disagree

Signature of Chief Academic Officer
Appendices
**Appendix A. Sample Schedules**

**Example 1.** Student enters Ph.D. degree with B.S. in engineering or mathematics and is interested in specializing in operations research. We assume that the student takes 18 credits per year (except for the last year). The total program would take 4 and a half years, if the dissertation research goes well:

<table>
<thead>
<tr>
<th>Year</th>
<th>Semester</th>
<th>Course No.</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>Fall</td>
<td>STAT 544</td>
<td>Applied Probability</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 541</td>
<td>Deterministic Operations Research</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SYST 510</td>
<td>Systems Definition and Cost Modeling</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>SYST 520</td>
<td>System Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STAT 554</td>
<td>Applied Statistics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 542</td>
<td>Stochastic Operations Research</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>Qualifying Examinations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 2</td>
<td>Fall</td>
<td>OR 635</td>
<td>Discrete Systems Modeling and Simulation</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 641</td>
<td>Linear Programming</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 645</td>
<td>Stochastic Processes</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>OR 644</td>
<td>Nonlinear Programming</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 735</td>
<td>Advanced Stochastic Simulation</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 741</td>
<td>Advanced Linear Programming</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Selection of advisor/creation of doctoral committee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 3</td>
<td>Fall</td>
<td>SYST 763</td>
<td>Research Methods in SE and IT</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 784</td>
<td>Advanced Nonlinear Programming</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 750</td>
<td>Advanced Topics in OR</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>SYST 780</td>
<td>Queuing Modeling of Computer-Communication Networks</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SEOR 998</td>
<td>Doctoral Dissertation Proposal</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comprehensive Exams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 4</td>
<td>Fall</td>
<td>SEOR 998</td>
<td>Doctoral Dissertation Proposal</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissertation Proposal Presentation</td>
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<tr>
<td></td>
<td>Spring</td>
<td>SEOR 999</td>
<td>Doctoral Dissertation</td>
<td>9</td>
</tr>
<tr>
<td>Year 5</td>
<td>Fall</td>
<td>SEOR 999</td>
<td>Doctoral Dissertation</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissertation Defense</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Example 2.** Student enters Ph.D. degree with M.S. in systems engineering. We assume that the student takes 18 credits per year. It is possible to finish the program in 3 years if the dissertation research goes well, and the student has all prerequisites.

<table>
<thead>
<tr>
<th>Year</th>
<th>Semester</th>
<th>Course No.</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>Fall</td>
<td>STAT 554</td>
<td>Applied Statistics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 719</td>
<td>Computational Models of Probabilistic Reasoning</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SYST 680</td>
<td>Principles of C4I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Qualifying Examinations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>SYST 763</td>
<td>Research Methods in Systems Engineering and IT</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SYST 760</td>
<td>Special Topics in C4I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SYST 850</td>
<td>Systems Integration Engineering</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Selection of advisor/creation of doctoral committee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 2</td>
<td>Fall</td>
<td>SYST 888</td>
<td>Distributed Estimation and Multisensor Tracking and Fusion</td>
<td>3</td>
</tr>
<tr>
<td></td>
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<td>SYST 842</td>
<td>Models of Probabilistic Reasoning</td>
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<td>SEOR 998</td>
<td>Doctoral Dissertation Proposal</td>
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<td>Comprehensive exams (middle of 2nd year)</td>
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<td>Dissertation proposal presentation</td>
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<td>Year 3</td>
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<td>Doctoral Dissertation defense</td>
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Appendix B. Faculty

Adelman, Leonard
Professor
Ph.D., University of Colorado, 1976
M.A., University of Colorado, 1973
B.A., Florida State University, 1971

Brouse, Peggy S.
Associate Professor
Requirements Engineering, Decision Support, Process Improvement, Cost Modeling
Ph.D., George Mason University, 1992
M.BA., Marymount University 1986
M.S., American University 1978

Chang, Kuo-Chu
Professor
Multisensor Data Fusion, Multitarget Tracking, Situation, Assessment, Bayesian Networks, Artificial Neural Networks
Ph.D. Electrical Engineering, the University of Connecticut, 1986.
M.S. Electrical Engineering, the University of Connecticut, 1983.
B.S. Communication Engineering, National Chiao-Tung University, Taiwan, 1979.

Chen, Chun-Hung
Professor
Discrete Event Systems Simulation and Optimization, Air Traffic Network Simulation and Management.
Ph.D., Harvard University, 1994
M.S., National Taiwan University, Taiwan, 1989
B.S. National Chiao-Tung University, Taiwan, 1987

Donohue, George L.
Professor
Air Transportation Technology and Systems Engineering
Ph.D., Oklahoma State University, 1973
M.S., Oklahoma State University, 1968
B.S.M.E., University of Houston, 1967

Ganesan, Rajesh
Assistant Professor
Stochastic Control, Control of Nanoscale Processes, Wavelet Based SPC, Translational Bioinformatics.
Ph.D., Industrial Engineering, University of South Florida, 2005
M.A., Mathematics (Statistics), University of South Florida, 2005
M.S., Industrial Engineering, University of South Florida, 2002
B.S., Mechanical Engineering, National Institute of Technology, Calicut, India, 1996

Hoffman, Karla L.
Professor
M.BA., The George Washington University, 1971
B.A., Mathematics Rutgers University, 1969

Laskey, Kathryn B.
Associate Professor
Bayesian Inference and Decision Theory; Multi-Source Fusion, Uncertainty in Artificial Intelligence; Situation Assessment
Ph.D, Carnegie-Mellon University, 1985
M.S., University of Michigan
B.S., University of Pittsburgh

Liu, Yifan, Ph.D.
Assistant Professor
Biodefense, Mathematical Models in Homeland Security
Ph.D, Stanford University, 2006

Loerch, Andrew G.
Associate Professor
Military Operations Research, Multi-Year Capital Budgeting
Ph.D, Operations Research, Cornell University, 1990
M.S., Operations Research, Naval Postgraduate School, 1980
B.S., Mechanical Engineering, Polytechnic Institute of Brooklyn, 1974

Nash, Stephen G.
Professor
Nonlinear Programming, Numerical Analysis, Computer Science.
Ph.D., Stanford University, 1982
B.S., University of Alberta, 1977

Polyak, Roman
Professor
Nonlinear and Linear Optimization (Exterior-Interior Point Methods), Game Theory, Mathematical Economics.
Ph.D, Mathematics, USSR Academy of Sciences, Moscow.
M Sc., Mathematics and Physics (honors), Zhitomir University, Ukraine

Sage, Andrew P.
Founding Dean Emeritus
University Professor and First American Bank Professor
Systems Integration and Architcting, Complex Adaptive Systems and Knowledge Management, Economic Systems Analysis
D. Engr. Dalhousie University, 1997 (Honoris Causa)
D. Engr. University of Waterloo, 1987 (Honoris Causa)
Ph. D. Purdue University, 1960
S. M. E. E. Massachusetts Institute of Technology, 1956
B. S. E. E. The Citadel, 1955

Schum, David A.
Professor
Probabilistic Reasoning, Marshaling of Evidence, Study of Discovery-Related Processes
Ph.D, Ohio State University, 1985
M.A., Southern Methodist University
B.A., Southern Methodist University

Shortle, John
Associate Professor
Queueing Theory, Simulation, Telecommunications, Air Transportation
Ph.D., Operations Research, University of California, Berkeley, 1996.
M.S., Operations Research, University of California, Berkeley, 1993
B.S., Mathematics, Harvey Mudd College, Claremont, CA, 1992

Sofer, Ariela
Professor and Chair
Optimization; Nonlinear Programming, Optimization in Medical Applications
D.Sc., The George Washington University
M.Sc., Technion, Israel
B.Sc., Technion, Israel
Appendix C. Sample Job Announcements


A search in monster.com under the key words “systems engineer, integration” conducted September 22, 2007, yielded over 5000 open positions nation wide. (The word “integration” was added because it rules out positions that are systems engineer in title but are not strictly in our domain).

See http://jobsearch.monster.com/Search.aspx?q=systems+engineer%2C+integration&fn=&lid=&re=130&cy=us&brd=1&JSNONREG=1

The same search, when restricted to positions in Virginia yielded 2681 positions. See http://jobsearch.monster.com/Search.aspx?q=systems%20engineer%2C%20integration&fn=&re=137&cy=us&brd=1&jsnonreg=1&pg=1&sid=99

Of these, 2159 positions were in a radius of 20 miles from 22030 (Fairfax, VA). See http://jobsearch.monster.com/Search.aspx?q=systems%20engineer%2C%20integration&fn=&re=100&cy=us&brd=1&jsnonreg=1&pg=1&zip=22030&rad=20


The same search, when restricted to positions in Virginia yielded 233 positions. See http://jobsearch.monster.com/Search.aspx?q=operations%20research%20%20analyst&fn=&re=137&cy=us&brd=1&jsnonreg=1&pg=1&sid=99

Of these, 188 positions were in a radius of 20 miles from 22030 (Fairfax, VA). See http://jobsearch.monster.com/Search.aspx?q=operations%20research%20%20analyst&fn=&re=100&cy=us&brd=1&jsnonreg=1&pg=1&zip=22030&rad=20
The Magazine OR/MS Today has numerous OR positions listed on their online publication:

From http://www.lionhrtpub.com/orms/classifieds/ORMS-classifieds.html

Posted September 14, 2007

**Head Scientist, Sabre Research Group**
**Sabre-Holdings**

Sabre-Holdings invites applicants for the position of Head Scientist, Sabre Research Group

The Sabre Head Scientist leads the Sabre Research Group and reports directly to the Chief Information Officer. Sabre Research is a group of employees with advanced degrees in Operations Research, Industrial Engineering and Computer Science. The group’s expertise includes optimization, forecasting, algorithms, statistics, data analysis, simulation, system development and prototyping. The Sabre Research Group supports all of Sabre’s businesses units with primary focus on Travel Network, Travelocity, Airline Solutions and Sabre Studios. The Research Group conducts proof-of-concept projects and develops prototypes for new business processes and applications in the areas of merchandising, retail marketing, revenue management, pricing, airline planning and operations. The Research Group supports the migration of new models, algorithms and processes into production usage after successfully demonstrating value, feasibility and scalability in the prototype phase.

**Requirements:** PhD in Industrial Engineering, Operations Research, Systems Engineering, Computer Science or related field is preferred. Successful applicants will have a significant record of leading industrial and academic research with a consistent history of success and benefits. This position requires experience dealing with senior executives across a variety of departmental areas often with conflicting objectives and priorities.

Sabre Holdings connects people with the world’s greatest travel possibilities by retailing travel products and providing distribution and technology solutions for the travel industry through our three companies: Travelocity, Sabre Travel Network and Sabre Airline Solutions. Headquartered in Southlake, Texas, Sabre Holdings has approximately 9,000 employees in 45 countries. Our teams around the world work together to support travelers, travel agents, corporations, government agencies and travel suppliers. Our team members are people who take initiative, are resourceful and innovative, and are passionate about what they do. In return for their hard work and dedication, Sabre Holdings provides our employees with countless learning and growth opportunities, a healthy work-life balance and a fun, yet productive, work environment.

If interested, please rush your resumes to:
vanilla.bhasin.ctr@sabre.com
McCormick School of Engineering and Applied Sciences  
Department of Industrial Engineering and Management Sciences  
APPLICATIONS INVITED FOR A FACULTY POSITION

We invite applications for a full-time professorial appointment at any level: assistant, associate, or full to begin September 2008. Applicants should hold an earned Ph.D. (or should be near completion of their doctoral studies in case of assistant professor applicants) with a demonstrated research potential in industrial engineering and operations research. Individuals with application interests in stochastic modeling of production and service operations systems, and supply chain management are especially encouraged to apply. Industrial experience is desirable.

The Department offers an undergraduate program, an MS/PhD program and a part-time professional master's degree program in engineering management. The Department is also a key partner in a full-time master's degree program in management and manufacturing jointly with the Kellogg School of Management. Both the undergraduate and graduate programs have been consistently ranked among the top ten by *US News & World Report*.

Applicants should send a cover letter along with a curriculum vitae detailing educational background, research and work experience, and copies of up to five selected publications. Letters of recommendation from three references should be mailed to us directly. To receive full consideration, all materials should be received by us by December 31, 2007:

Chairman, Faculty Recruiting Committee  
*Department of Industrial Engineering and Management Sciences*  
Northwestern University  
2145 Sheridan Road, Room C210  
Evanston, IL 60208-3119

*Northwestern University is an Affirmative Action/Equal Opportunity employer.*  
*Women and minorities are encouraged to apply.*  
*Hiring is contingent upon eligibility to work in the United States.*
Marriott International

Operations Research Analyst

At Marriott, you define what success means to you, then we help make it happen. With opportunities for building your skills, colleagues who share your enthusiasm, and a clear career path with challenging work that provides direction for growth and promotion. If you're the kind of person who wants to be challenged, supported, and applauded, this is where you belong.

Marriott currently has exciting opportunities available in Operations Research, specifically, applications of Operations Research in Pricing and Revenue Management applications.

We are seeking talented researchers for the position of Operations Research Analyst at our corporate office in Bethesda, MD. The Operations Research team at Marriott develops and applies mathematical models to Marriott's business problems. Our areas of expertise include optimization, forecasting, pricing, and statistical and probabilistic modeling.

The main responsibilities of this position are to perform mathematical modeling, analytical interpretation of data, and programming assistance for Marriott's Revenue Management Systems, which help Marriott sell its perishable product. Analysts will develop and maintain research models with the Operations Research team and provide assistance to professional programmers that implement them in Marriott's business-critical systems. In addition, Analysts may lead small teams to accomplish individual projects by providing direction and assistance to other associates (employees).

The following characteristics are required in applicants:

- At least 1 year of experience in industrial or academic research, applying analytical and programming skills toward complex mathematical modeling and/or systems development. In particular, experience with statistical models related to pricing and forecasting is desired.
- Experience with statistical analysis/modeling software (e.g., SAS, S-PLUS, Matlab)
- Familiarity with a Unix environment
- Good communication skills and facility for working in teams

Desired skills:

- SAS Enterprise Data Miner and SAS High Performance Forecasting experience
- Java, C/C++, and/or CPLEX experience
- Knowledge of relational databases and object-oriented development environments
• **Mainframe computing environment experience**

We offer an excellent benefits package that includes: matching 401(k) profit sharing plan, tuition reimbursement and an employee discount on most Marriott brand properties.

Please submit your resume to [http://www.marriott.com/careers](http://www.marriott.com/careers) and include the code at the end of the address line: 462834

Visit our website: [www.marriott.com](http://www.marriott.com)


Join us. We're Marriott.

*EOE.M/F/D/V*
A search at the Washington Post online at
http://www.washingtonpost.com/wl/jobs/JS_JobSearchResult?ResumeId=&action=undoFacet&TS=1190697211681 showed 2571 positions for systems engineers, with numerous positions posted at local companies such as Booz Allen Hamilton, Sparta, BAE, General Dynamics, Mitre, and more. One example is below.

From WashingtonPost.com

Position in Fort Belvoir

http://www.washingtonpost.com/wl/jobs/JS_JobSearchDetail?jobid=24358096&jobSummaryIndex=2&agentID=&QUICK_SEARCH=1

Principle Systems Engineer - IWMDT (Requisition # 94157)

ORIGINAL JOB LISTING

The FEDCOM BU/IWMDT Program currently has an opening for a Principle Systems Engineer.

REQUIRED EDUCATION/SKILLS: Possession of a Master's degree or PhD from an accredited university. SYSTEMS ENGINEERING EXPERIENCE: Minimum 12 years experience, or 10 years with SE degree or certification. OVERALL ENGINEERING EXPERIENCE INCLUDING SYSTEMS ENGINEERING EXPERIENCE: Minimum 18 years general engineering experience, 15 with a PhD.

Desired Skills: Must be able to take high level DOD net-centric concepts and adapt them to fit CBRNE operations. Ensure the programs is compatible with DOD SOA efforts such as NCES and NECC. Work with customer's lead engineers to develop road map for implementing new capabilities. Broad understanding of various CBRNE modeling and simulation applications and an understanding of how various end users could adapt their current CONOPS to take advantage of net-centric operations. Tasks include developing DODAF compliant architecture views, developing system level requirements, review software requirements to ensure compliance with system level requirements, working with end users to help define new requirements. Working with external systems to develop interfaces and CONOPs for how those system can best take advantage of net-centric CBRNE M&S. Recognized expert in one or more systems engineering areas. Defines, documents, and teaches engineering processes to SAIC staff. Principal contributor to systems engineering activities which include any of the following: Concept of Operations Formulation, Requirements Definition, Analysis and Engineering, System Architecting, System analysis and design, Interface and Data Architectures, Validation and Verification, System Integration, System & Op. Performance Analysis, Lifecycle Cost Analysis & Estimation, Decision Analysis and Resolution. Capable of providing solutions to a variety of problems that may arise in a expeditious, efficient, and timely manner. May support business development and proposal activities.

Apply Online
The Aero Space Corporation had the following ad on September 22, 2007:

Architect Anal / Sys Modeler-hj

Chantilly, VA

Category: MTS Level 2/3 Positions  Requisition #: 551243
Group: Systems Engineering Division  Contact: M. Waddell, 703.633.5281
(ETG)

Responsibilities

Provide technical expertise and project leadership in the areas of space system architecture modeling and analysis. Perform system optimization and assess overall performance through use of in-house or custom-developed analysis tools. Compare performance of architecture variants and conduct trade studies. Provide independent assessments and/or lead studies of teams of more junior analysts. Apply broad and/or deep experience with customer space systems and technologies in one or more specific functional areas depending on background. Provide expert advice within a specific technology or functional area. Interact with program office and customer organizations. Creatively and effectively apply computer analysis to problems as needed. This position is in Chantilly, Virginia.

Qualifications

PhD or MS preferred in Aerospace Engineering, Operations Research or related field of science or engineering. Eight years previous experience for Engineering Specialist, twelve years experience for Senior Engineering Specialist. Substantial experience or background in one of the following areas: intelligence system analysis; orbit and/or attitude determination; optimization and/or covariance analysis techniques; communications systems analysis; powered trajectory analysis; guidance and control analysis; vehicle dynamics. Familiarity with orbital mechanics and mathematics related to space system analysis. Prior experience in system analysis and simulation desired. Technically adapt with the use and maintenance of PC or Unix platforms and associated software. Excellent written and verbal communication skills required. Dependability and good interpersonal skills required. Current SBI desired, ability to obtain SBI required.

Security Clearance

All job openings within divisions and departments in the Engineering and Technology Group (ETG), Space Systems Group (SSG), National Systems Group (NSG), Systems Planning & Engineering Group (SPE), and the Corporate Information Resources Division (CIRD) require that the employee obtain and maintain at least a secret clearance.
Appendix D. Letters of Support from Industry.

Letters from

- Dr. H. Gil Miller, Corporate Vice President and Chief Technology Officer of Noblis
- Mr. Norman T. Fujisaki, CEO, Metron Aviation
- Dr. Tim Cannon, Microsoft Corporation
Dr. Ariela Sofer  
Professor and Chair  
Systems Engineering and Operations Research  
George Mason University  
4400 University Drive, MS4A6  
Fairfax, VA 22030  

Dear Dr. Sofer:

Noblis is a non-profit, 501(c)3, science, technology, and systems engineering organization working with our public and private sector clients to address some of the most challenging problems faced by our nation. Our technological expertise spans networking and information technologies, sensors and signal processing, data and knowledge management, modeling, simulation and analytics, as well as the life and chemical sciences. The domain areas that we address include national and public safety, transportation, telecommunications, health care, environment, and energy.

The problems that our many clients face are linked by one common theme—at the center of our clients' problems are large, complex systems. In today's jargon, this theme may be discussed as system of systems, federation of systems, network-centric systems, network-based systems, even wicket systems. Staff addressing these large, complex systems problems require highly specialized, analytically sophisticated, and unique skills, education, and expertise, which are not simply add-ons to the more traditional engineering disciplines.

Noblis is a consumer of the high quality, capable, engineering and technology talent produced by US universities, especially in the mid-Atlantic region. The close proximity of the George Mason University campus makes for easy collaboration with their staff and students and the focus of the Systems Engineering and Operations Research Department is a natural for joint work—see for example the Center for Network-Based Systems at www.noblis.org/cnbs/. Over the last 10 years, Noblis has been a consumer of graduates of the Systems Engineering and Operations Research Department at all levels, though mostly at the Ph.D. level.

While the Systems Engineering and Operations Research Department Ph.D. graduates are able to immediately contribute to the Noblis work programs, they do present us one continuing problem. As we propose staff for possible programs and contracts, the designation Ph.D. in Information Technology is confusing at best; while we understand the designation of Ph.D. in Information Technology, current and potential clients do not. In this day and age of diverse and multi-
disciplined approaches and teams, there is an expectation of staff educated and expert in systems engineering and in quantitative analysis. And, while this causes confusion by our client base, we have no doubt that this is also causing confusion and avoidance by potential applicants to the Systems Engineering and Operations Research Ph.D. programs. Additionally, while information technology is a key component of any system today, we need expertise that is capable of addressing problems beyond information technology.

As a current and future employer of Systems Engineering and Operations Research graduates, as well as a collaborator with the department’s faculty and students, we urge the adoption of the Ph.D. in Systems Engineering and Operations Research to not only clarify the program’s core to applicants and external observers, but to also add focus to the program’s courses and research.

Sincerely,

[Signature]

H. Gilbert Miller

HGM/ sdm
Appendix E. Sample Survey Instrument

Survey of Student Demand of PhD Program in SEOR

Dear Student and Potential Applicant:

The Volgenau School of Information Technology and Engineering has offered a PhD degree in Information Technology since 1986. The initial program was interdisciplinary in scope, and spanned the departments represented at that time in the School. As time went on, specialized PhD programs were added, and the School now offers PhD degree programs in Computer Engineering, Computer Science, Electrical Engineering, and Statistics. The SEOR Department is now developing a new PhD Program in Systems Engineering and Operations Research.

The proposed PhD in SEOR program offers a unique integration of systems engineering and operations research. All students will have to demonstrate an understanding of the system perspective including the design and integration of complex systems. They will also have to demonstrate an understanding of operations research, including fundamentals of mathematical modeling of complex systems, optimization theory, risk analysis, and simulation.

Highlights of the program

- Students entering with an MS degree will be required to complete 48 credits. Of these 24 credits are in course work, and include STAT 554, SYST 763, and 18 credits from a list of SEOR-approved electives, of which 12 must be numbered 700 or higher. In addition, a student must complete a minimum of 24 research credits.
- Students entering without a master’s degree are required to complete additional 24 credits of masters level courses.

All students must also fulfill the following requirements

- Pass a qualifying examination covering the fundamentals of systems engineering and operations research (SYST 510, 520 and OR 541 and 542).
- Pass a comprehensive examination consisting of a written examination of 8 hours in length and an oral examination.
- Successfully complete a research dissertation

We have prepared the survey below to gauge interest in the program. Your answers to the following questions will be used in summary form only. No personally-identifiable information will be released. Please feel free to contact us at seor@gmu.edu if you would like more information about the proposed program.

You may

- Return a hard copy to your professor
- Return a hard copy to the department office in ST II room 111
- Return an electronic copy to seor@gmu.edu

Please return this survey by **Friday September 21, 2007**.

Thank you.

Ariela Sofer
Professor and Chair
Systems Engineering and Operations Research
Survey for PhD Program in *Systems Engineering and Operations Research*

1. Would you be interested in applying or enrolling in a program like this? (If no, then skip to question 3.)
   - Yes
   - No

2. If yes, would you prefer to attend the program on a full-time or part-time basis?
   - Full-time
   - Part-time
   - Not sure

3. Have you ever applied to an institution offering a similar program? If so, which program, at which school?
   - Yes
   - No

4. Are you currently attending George Mason University? If so, in what program?
   - Yes
   - No

5. a. FOR STUDENTS CURRENTLY IN MASON PHD PROGRAMS: If this program had been available when you initially applied to Mason, would you have applied for admission to it?
   - Yes
   - No

5. b. FOR STUDENTS WHO ARE INTERESTED IN APPLYING FOR A PHD PROGRAM IN THE FUTURE: If this program becomes available when you apply to Mason, will you apply for admission to it?
   - Yes
   - No

5. c. FOR STUDENTS WHO LEFT MASON TO PURSUE EDUCATION ELSEWHERE: If this program had been available when you completed your current program, would you have applied for admission?
   - Yes
   - No

5. d. FOR STUDENTS WHO LEFT MASON BUT HAVE NOT PURSUED FURTHER EDUCATION: If this program had been available when you completed your current program, would you have applied for admission?
   - Yes
   - No

6. In which state do you currently live?
   - Virginia
   - Maryland
   - DC
   - Other

7. Do you plan to live in this state for the next three or four years?
   - Yes
   - No

8. Are you currently employed? (If no, then skip to 14.)
   - Yes
   - No

9. If you are employed, please identify the state in which you work.
   - Virginia
   - Maryland
   - DC
   - Other

10. If you are employed, are you employed full-time or part-time?
    - Full-time
    - Part-time

11. If you are employed, would the proposed program help you in your work?
    - Yes
    - No

12. Please feel free to provide additional comments about the program.
Appendix F. Written Student Comments on the Proposed PhD Program in Systems Engineering and Operations Research

From Current PhD Students who voted yes on Question 5a

1. A PhD in SEOR makes much more sense. It was difficult to explain to managers and customers that I was in an IT program but I did not do IT. I could not answer IT questions that were put to me --- very embarrassing.


3. My PhD studies are entirely focused on Operations Research. I would find the name on my degree to be far more compelling if it said SEOR versus IT.

4. Separate PhD in OR or PhD in SE would be better.

5. I feel it is important for PhD degrees to be specialized. To that end each department should be able to offer PhDs for their respective discipline. The IT degree should be reserved for those individuals who truly want a multidisciplinary degree.

6. I am currently enrolled in the PhD/IT Program. Frankly, I consider it to be an SE degree, so this is a logical progression for GMU, which I fully support. If I could transfer to this program without a substantial requirement for new class work or exams, I would certainly consider it.

7. I have worked as the director for Systems Analysis and Assessment, leading a staff of 120 analysts within a 600 person Systems Engineering activity for the last six years in Northern Virginia. Here I have seen the value of the unique integration of Systems Engineering and Operations Research drive the 10 billion dollar annual investments of a Government Agency. Recognition of the contributions of recent graduates has identified George Mason as one of the preferred providers for agency sponsored Systems Engineering PhD studies.

8. I would have applied for this program instead of the general program. Systems Engineering is a struggle for most organizations. Having a PHD would be a great help. Also, too many people in practice call themselves systems engineers with no training. Specialized advanced degrees would help limit this.

9. My customers are Not interested in someone with a PhD in IT. They care about systems engineering and operations research though. Therefore, once I complete the program, if I am conferred a degree in IT I will still call it a PHD in OR…because that is how my customers will look upon it and how I will practice it…

10. I would still want the flexibility to take a limited number of courses in Information Systems, Computer Science or Software Engineering.
11. A Ph.D. program in SEOR would be very appealing to me and keep GMU on the competitive edge for graduate students seeking advanced degrees in SEOR in the D.C. area.

From Current PhD Students who voted no

12. I am too far along in my program to consider switching. However the program sounds interesting
13. While this does not fit my own situation I believe it would be a beneficial addition

From Current MS Students who voted yes on Question 5b.

14. I am very interested in the proposed program. I intend to pursue a PhD in Operations Research (or as closely related to OR as available) on completion of my MS in OR (estimated completion Spring 09). GMU is my first choice for a PhD Program and I currently plan to apply for admission to the PhD in IT (concentration in OR) this spring. If a SEOR PhD Program was available I would definitely apply to it rather than the IT PhD Program.

15. Current available curriculum in the program is very good and more formalization would be to the benefit of all. It’s awkward professionally citing “IT degree” when SEOR discipline is very different.

16. OR is a large and growing field. The need for such a PHD program is growing rapidly., particularly for the DC Metro area.

17. I work for an organization that prefers OR degrees to IT degrees.

18. I’ve appreciated my experience here as a master’s student. George Mason has the benefit of many involved professionals. A PhD Is a great way to expand the program at George Mason and would be of interest to many in the Washington DC area.

19. Operations Research is a vital and high-demand field in the defense arena and in contractor support to defense studies. My company, which is headquartered in McLean and employs over 40,000 individuals, had 100 openings for “Operations Research” analysts and practitioners in mid-September 2007. Many of these require a degree in Operations Research. Somebody needs to educate the next generation of Operations Research Analysts.

20. I am currently enrolled in the Master of Science of Systems Engineering program. I would be interested in a Ph.D. in SEOR; however I would have to weigh my ambition for that undertaking against my commitment to my employer and family. I think establishing a Ph.D. in these two disciplines is a great idea.

21. George Mason is uniquely positioned to offer a quality and affordable means of obtaining a PhD in OR. The DC metro region, consisting of the military, Federal Government, IT companies, and venture capital firms, provides GMU with and
ample market of employers who need individuals with this level of training and
education and who have a demonstrated history of supplementing the educational
cost of such programs.

22. I plan to apply for the SEOR PhD program upon completing my MS in OR. I find
it highly encouraging that the program will now be listed as a PhD in SEOR
instead of IT since my field is OR not IT. The enhanced focus upon SEOR will be
greatly beneficial.

23. I think it is a great idea. It will definitely help for my future education, which
means I will consider Mason again for the PhD program.
Many consulting positions in Operations Research specifically require post-
graduate or PhD work in Mathematics, OR or Engineering. I will likely look
elsewhere for a PhD program if it remains under "IT", for the battle of funding
with my company will be a challenge.

From MS Students who were undecided

24. I am very interested in a PhD Program, but I would need more information to see
if it suits my needs. I would want to work on a nearly full-time basis while in the
Program. This is what made the MS program so lucrative.

25. Depends on structure of program

From MS Students who voted no

26. I am very interested in a PhD Program, but I would need more information to see
if it suits my needs. I would want to work on a nearly full-time basis while in the
Program. This is what made the MS program so lucrative.

27. Would be a great program and very useful in today's market. However, I am not
interested in continuing my education past the completion of my current Masters.

28. It sounds like a very good and attractive program. Unfortunately, I don't plan on
going on to do a PhD in this or any other program.

29. This appears to be a very appealing program, specially with our proximity to the
Washington DC area, Pentagon and other federal entities. I have had research
projects in this area and if I had not went another track a couple of years ago I
would have considered it.

From PhD Graduates who voted yes on Question 5d

30. Since I have already earned a PhD from GMU, I doubt I’d even pursue a second,
but the point I’m trying to make here is that if this combined program had been
available at the time I was pursuing my PhD, I would have seriously considered
applying to this program.

31. Systems Engineering is a hot discipline, as is evidenced by professional
recruitment sites. The combination of Systems Engineering, consistent with the
INCOSE Professional Society, combined with the rich analytical discipline of Operations Research, is a powerful Research Program offering. I am enthusiastic about such a program and strongly support it.

32. I completed the PhD in IT at GMU in 1994. My approach to the program was as a Systems Engineer as I also have an MS in Systems Engineering. The program at that time was well structured for someone interested in Systems Engineering. I think the subsequent specialization of the School and the realities of employment make a degree in SEOR highly desirable. I have checked yes on question # 1, because I would have enrolled in an SEOR doctoral program when I was at GMU had there been one available.
Appendix G. Letters of support from Current and Potential Students

Letters from

Kenneth Comer (signed letter available)
Fred Woodaman (signed letter available)
Dr. Ariela Sofer  
Chair, Department of Systems Engineering and Operations Research  
Volgenau School of Information Technology and Engineering  
George Mason University  
Fairfax, VA  

Dr. Sofer:  

I am a doctoral student in the Volgenau School’s Information Technology and Engineering PhD program. I must offer my most enthusiastic endorsement for the proposal to create a separate PhD track in systems engineering and operations research. If created, I will move quickly to convert my program to the SEOR degree.  

I received my MS degree in operations research in 1989, and have worked as an operations research analyst in the national security field for almost two decades. Since then, the value and versatility of operations research academic training has proven itself in numerous agencies, departments, and organizations in the federal government and, more recently, in private industry. In particular:  

- The quantitative methods of deterministic optimization assist government decision-makers every day to prioritize multi-billion dollar programs, evaluate utility, and properly distribute scarce resources  
- Stochastic modeling and applied statistics have been critical in creating a balanced risk assessment across the entire defense enterprise. The Department of Defense could not function without the systematic evaluation of uncertainty provided by OR methodologies.  
- All the military services have broad uses for modeling and simulation – a key component of the GMU curriculum – in training, acquisition, and strategic analysis. I am a senior officer in the Navy Modeling and Simulation Office. Modeling and simulation is a vital element of all defense decisions today, and its continued use is required by numerous instructions and directives.  

Operations research, however, is a constantly changing field. The US military is shifting to new patterns of warfare and non-traditional operations. Current events have forced us to prepare for a wide range of irregular, disruptive, and even catastrophic threats. Our ability to counter these threats will depend on the analytical methods and tools under development at universities today. What’s more, as defense systems have become more complex, we will need new tools and metrics to help us manage complex adaptive systems on a global scale. These new instruments will require research at the doctoral level.  

George Mason is uniquely positioned to become a center of excellence in this transformation. No other institution is close enough to allow students to work full time on real-world problems and attend classes at night. I have experience first-hand the synergy between working difficult but up-to-the-minute decision issues by day and interacting with Mason’s world-class faculty in the
evening. I know from my classmates that I’m not the only one who takes solutions straight from
the GMU classroom to the Pentagon.

Senior officers in the Department of Defense have established an energetic commitment to
reinvigorating systems engineering within the department. Led by the Undersecretary of Defense
for Acquisition, Technology, and Logistics, this program has a number of elements. Major
defense programs will require a “systems engineering plan” before they receive final funding.
There are nowhere near enough systems engineers to create, much less execute these plans. (A
recent search of the Washington Post shows that there are over 700 openings for ‘systems
engineers’.) Undersecretary Michael Wynn and his deputy for systems engineering, Mark
Shaeffer declared in an article in 2005 that they planned to use systems engineering as a key
acquisition management planning and oversight tool. To support this, they expressed a firm
commitment to reinvigorating systems engineering education. This commitment will establish a
broad and abiding market for GMU-produced talent—either as practitioners or as educators.

Finally, it’s important to recognize the unique national asset embodied in the GMU SEOR faculty.
I have experienced first-hand how the reputation of these top-notch educators and professionals
opens doors. These professors are well known throughout the national policy-making community
and, in fact, throughout the world. I have had the experience of learning from superb faculties,
including Nobel Prize winners, at Cornell, Georgetown, and George Washington Universities.
My best teachers, those who challenge, encourage, and inspire, have been at George Mason
University.

Sincerely,

Kenneth Comer
September 25, 2007

Ronald F. A. Woodaman  
17 Planters Place  
Stafford, VA  22554  
(540) 657-2975  
rwoodama@gmu.edu

Dr. Ariela Sofer  
Department Chairperson  
Systems Engineering and Operations Research (SEOR) Department  
Volgenau School of Information Technology and Engineering  
George Mason University  
Fairfax, VA  22030

Dear Madam:

I note with considerable interest that the SEOR Dept. is seeking to establish its own Doctorate Degree. As a current PhD student in IT with a Concentration in Operations Research, I am strongly in favor of this new degree and would desire this to be the eventual degree conferred upon me when I graduate.

My argument for the SEOR doctorate stems from the desire for a degree title that clearly conveys my area of research. My Bachelor of Science (United States Naval Academy ’87) was in Systems Engineering. My Masters degree was in Operations Research (Naval Postgraduate School ’00). That my doctorate would be titled “Information Technology with a Concentration in Operations Research” implies that there is some fundamental basis in my studies that started with IT and were narrowed to the study of Operations Research. But a closer examination of my PhD studies and preliminary dissertation research to date reveals that my studies have focused exclusively upon Operations Research. While admittedly one can define Information Technology in such a way to include Operations Research, it makes more sense for me and for my career goals - in government, industry, and academia - that my degree’s title and program of study capture the essence of my chosen field: Operations Research.

Please add my voice to what I hope is a chorus in support of this new program.

Sincerely,

Ronald F. A. Woodaman