Program Proposal
Cover Sheet

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<thead>
<tr>
<th>1. Name of institution</th>
<th>2. CHECK ONE:</th>
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<tbody>
<tr>
<td>GEORGE MASON UNIVERSITY</td>
<td>Spin-Off Proposal XXX</td>
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<td></td>
<td>New Program Proposal</td>
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<tr>
<th>3. Title of proposed program</th>
<th>4. CIP Code – xxx</th>
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<tr>
<td>SYSTEMS ENGINEERING MANAGEMENT</td>
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<tr>
<th>5. Degree title</th>
<th>6. Term and year of initiation</th>
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<tr>
<td>M.S. in SYSTEMS ENGINEERING MANAGEMENT</td>
<td>FALL 2005</td>
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<tr>
<th>7. Term and year of first graduates</th>
<th>8. For community colleges: date approved by local board</th>
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<tr>
<td>SPRING 2007</td>
<td>Not applicable</td>
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<tr>
<th>9. Date of approval by SEOR Dept.</th>
<th>10. For community colleges: date approved by State Board for Community Colleges</th>
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<td>April 30, 2004</td>
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<th>11. If collaborative program, name of other institution(s)</th>
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<th>12. Location of program within institution (please complete for every level, as appropriate). If any of these organizational units would be new, please so indicate and attach a revised organizational chart.</th>
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<tbody>
<tr>
<td>School(s) or college(s) of SCHOOL OF INFORMATION TECHNOLOGY AND ENGINEERING, GEORGE MASON UNIVERSITY.</td>
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<tr>
<td>Campus (or off-campus site) FAIRFAX</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 about the proposal.</th>
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Prof. Ariela Sofer, Chair
Department of Systems Engineering and Operations Research
SCHOOL OF INFORMATION TECHNOLOGY AND ENGINEERING
GEORGE MASON UNIVERSITY
703-993-1692
asofer@gmu.edu

Proposal for New Degree Program
Program Proposal
Master of Science in Systems Engineering Management

1. Introduction

Systems Engineering Management is concerned with managing the effective design, production, deployment, operation, maintenance, refinement, and retirement of reliable systems within cost and time constraints. The graduate program leading to the Master of Science in Systems Engineering Management (MS-SEM) provides students with the skills necessary to be successful in managing the progression of systems through these life cycle phases and to provide the expertise in architecting and integrating complex system of systems for government and commercial clients. Students in the program are introduced to the core competencies for systems of system, integration and management, the processes, the new technologies, and the disciplines needed for successful delivery of executable systems.

Students will progress through a series of classes that will build the foundation for the successful performance of systems engineering management tasks associated with all phases of the system lifecycle. The core courses will include study in requirements engineering, cost modeling, architecture design, and systems management.

The SEOR Department also offers a graduate program leading to the Master of Science in Systems Engineering (MS-SE). This program prepares students for a professional career in systems design, development, and management, associated with problem formulation, issue analysis, and the evaluation of alternative courses of action. The program emphasizes both analytical and practical aspects of engineering complex systems. Students are expected to demonstrate proficiency in several quantitative modeling disciplines. Students are also expected to master issues relevant to practical aspects of systems design, engineering and integration. The program also prepares students for careers in research and development and for pursuing advanced graduate study leading to the Ph.D. degree in Information Technology.

2. Justification for Program

Whereas the MS-SE degree includes also a strong focus on engineering of systems, the MS-SEM degree will focus primarily on the management of systems engineering. As such, it will not require the strong mathematical background required by the MS-SE degree. On the other hand it will require students to have substantial practical experience in systems engineering.

There are many highly qualified professionals in the Northern Virginia and Washington Metropolitan area, who have, through their hard work, experience, and strong capabilities attained the title of systems engineer or senior systems engineer. While these individuals come with extensive experience in systems engineering, they may not have the broad engineering mathematics background that trained engineers have, or alternatively, may have long forgotten their engineering math background. The SEOR department has received applications from many outstanding applicants with such background in the past. However all but those willing to learn
or relearn the extensive math requirements needed for the program were rejected. The MS-SEM
degree program offers this large pool of outstanding applicants an education which will enhance
the knowledge necessary for their professional career.

3. Foundation & Admission Requirements

Applicants for the MS-SEM program should meet the following entrance requirements:

- One of the following:
  - A bachelor’s degree from an accredited institution in engineering, mathematics, computer science, physical sciences, economics, or a related technical field; and must have a minimum of two years of appropriate full-time work experience in that field;
  - Applicants with a bachelor’s degree in a non-technical discipline must have completed a college level calculus course (MATH 113), a probability course (STAT 250), and have a minimum of five years of appropriate full-time work experience in a systems engineering related field;
  - A grade-point average (GPA) of 3.000 as an undergraduate. Other indicators such as a satisfactory score on the Graduate Record Exam (GRE), or a strong grade-point average in graduate courses may strengthen the application
  - Satisfactory performance on the TOEFL examination for non-native English speakers.

The MS/SEM program is not intended for students who wish to continue and pursue the Ph.D. degree in Information Technology. Applicants who wish to pursue doctoral studies in the future are encouraged to consider the Master of Science in Systems Engineering. Students who graduate from the MS-SEM who wish to continue for the Ph.D in Information Technology with Specialization in Systems Engineering will have to satisfy all the math foundation courses for the MS/SE. This includes calculus for engineers (MATH 113, MATH 114, MATH 213), matrix algebra (MATH 203), elementary differential equations (MATH 214), applied probability and statistics (STAT 344), and a scientific programming language (CS 112). Students must also pass the SYST 500 waiver exam to be considered as candidates for the program. If accepted into the program, they will need to take the course SYST 611 System Modeling and Methodology as part of their doctoral curriculum.

4. Degree Requirements

To obtain a Master of Science degree in the Systems Engineering Management program students must complete a plan of study with a minimum of 30 semester hours of graduate level courses. The plan of study must be approved by the student's faculty adviser, in writing, before the end of the student's first semester.

More detailed information about the Systems Engineering Management curriculum can be found in Section 6 below.

Cooperative Graduate Engineering
Students may take courses through the Cooperative Graduate Engineering Program in affiliation with the University of Virginia and Virginia Tech. With departmental approval, appropriate courses may be transferred to the MS-SEM program.

5. Advising

All entering systems engineering students must attend an orientation meeting that will culminate in the completion of a plan of study for the MS-SEM degree. All MS-SEM students are required to have an approved plan of study on file with the department. Each student is assigned a faculty advisor; students are encouraged to seek out their advisor when questions arise and when their plan of study needs to be revised. The assigned advisor can also help each student identify the appropriate faculty member for supervising her or his project or thesis.

6. Curriculum

To earn the Master of Science degree, students must complete an approved plan of study. This plan of study must include three core courses, two methods courses, four electives, and a management systems engineering project. The plan of study must include 30 semester hours of graduate-level course work. A research project (3 semester hours) is required for the degree.

**Core Courses** - Students must complete the following three core courses (9 semester hours):

- SYST 510: System Definition and Cost Modeling
- SYST 520: System Design and Integration
- SYST 530: System Management and Evaluation

**Basic Methods Courses** - Students must complete

- SYST 573: Decision and Risk Analysis

and one of the following:

- SYST 563: Research Methods in Systems Engineering and Information Technology
- OR 540: Management Science

**Elective Courses** - A set of approved elective courses is given below. Basic methods courses above the two required methods courses may also be counted as elective courses. At least three of the courses must come from the SEOR Department offerings.

- SYST 512: Systems Engineering for Design and Development
- SYST 513: Total Systems Engineering, Re-engineering and Enterprise Integration
- SYST 542: Decision Support Systems Engineering
- SYST 560: Introduction to Air Traffic Control
- SYST 571: Systems Engineering Management
- SYST 619: Introduction to Architecture-based Systems Engineering
- SYST 671: Judgment and Choice Processing and Decision Making
- SYST 691/PUBP: Introduction to Enterprise Engineering: Engineering and policy
- SYST 692/PUBP: Decision Support for Enterprise Integration
- SYST 694/PUBP: E-Commerce Architecture
- SYST 697/PUBP: Critical Information Technology Infrastructure
CEIE 610       Construction Systems and Management
SWSE 625       Software Project Management
TCOM 500       Modern Telecommunications

Project - Students must complete a project, SYST798 (3 credit hours), under the direction of a Systems Engineering faculty member. A project objective is selected with the approval of the faculty project advisor. A project report is submitted at the end of the semester, and must be approved by the faculty project advisor. Although a student may register for more than three semester hours of project work, only three hours will be applied toward the degree.

Certificate Programs. George Mason University offers a number of certificate programs to students who hold bachelor’s degrees in engineering or scientific disciplines or who are currently in graduate status in such programs. The following certificate program may be combined with the MS-SEM degree:

• Certificate in Systems Engineering for Computer, Information, and Software Intensive Systems

7. Course Descriptions

Descriptions of SYST graduate courses offered by the Department of Systems Engineering and applicable to the MS-SEM degree follow.

510: Systems Definition and Cost Modeling (3:3:0)
Prerequisite: Graduate standing
Comprehensive examination of the methods and processes for the identification and representation of system requirements. Investigation of the systems acquisition life cycle with emphasis on requirements definition, including functional problem analysis. Examination of the systems engineering definition phase including requirements, problem analysis, definition, and functional economics. Specification of functional and nonfunctional requirements, and associated requirements prototyping. Functional economic analysis, including the use of prevailing cost estimation models, and planning and control of common operating environments. Lecture and group project including creation of requirements and use of cost estimation models.

512: Systems Engineering for Design and Development (3:3:0)
Prerequisite: SYST 510 or equivalent

513: Total Systems Engineering, Reengineering and Enterprise Integration (3:3:0)
Prerequisite: SYST 510 or SYST 520
Principles of strategic quality, including TQM. Quality standards including ISO9000 and 14000. Organizational leadership, cultures, and process maturity, reengineering. Quality, organization learning and reengineering approaches to enable information integration and management and environment and framework integration in the systems engineering of knowledge intensive
systems. Emphasis is placed on the role of integrated product and process design teams, standard
and commercial off the shelf products in enterprise integration. Architecture driven system
characteristics are studied as is transition management of legacy systems.

520: System Design and Integration (formerly SYST 612) (3:3:0)
Prerequisite: graduate standing
System design and integration methods are studied and practiced, including both structured
analysis and object-oriented based techniques. The course includes the development process of
functional, physical, and operational architectures for the allocation and derivation of
component-level requirements for the purpose of specification production; examination of
interfaces and development of interface architectures. Life cycle of systems is addressed;
generation and analysis of life cycle requirements. Software tools are introduced and used for
portions of the systems engineering cycle. Students are expected to develop a system design for a
system of their choice using both the structured analysis and object-oriented techniques
presented in class, and they will make presentations on these designs.

530: System Management and Evaluation (formerly SYST 613) (3:3:0)
Prerequisite: graduate standing
This course provides the necessary techniques for evaluating the cost and operational
effectiveness of system designs and systems management strategies. Performance measurement,
work breakdown structures, cost estimating, quality management are discussed. Configuration
management, and standards are discussed. Case studies of systems from different application
areas are discussed.

542/EEP 602: Decision Support Systems Engineering (3:3:0)
Prerequisite: SYST 301 or graduate standing
This course studies the design of computerized systems to support individual or organizational
decisions. The course teaches a systems engineering approach to decision support system (DSS)
development. A DSS is the end product of a development process, and it is this process that is
key to successful integration of a DSS into an organization. Any DSS is built on a theory
(usually implicit) of what makes for successful decision support in the given context. Empirical
evaluation of the specific DSS and the underlying theory should be carried on throughout the
development process. The course examines some prevailing theories of decision support,
considers the issues involved in obtaining empirical validation for a theory, and discusses what if
any empirical support exists for the theories considered. Students design a decision support
system for a semester project.

560: Introduction To Air Traffic Control (3:3:0)
Prerequisite: Graduate standing. This course is intended as an introduction to Air Traffic
Control (ATC) for those who plan professions in the aviation industry. It is a necessary
introduction for students who will later specialize and take more in-depth courses. The course
will survey the entire field, presenting the history of ATC and how it came to be as it is, the
technology on which the system is based, the procedures used by controllers to meet the safety
and efficiency goals of the system, the organizational structure of the FAA, challenges facing the
system and means under investigation to meet these challenges. This course will involve some
field work for data collection and analysis. A class project requiring a system simulation will be
required.

563: Research Methods in Systems Engineering and Information Technology (3:3:0)
Prerequisite: STAT 344 and STAT 354 or equivalent
This course provides the foundation for one of the most important activities in systems engineering: information gathering to support drawing conclusions and making decisions about design options and process improvements. The course begins by developing an understanding of the scientific process, the use of empirical evidence to support and refute scientific hypotheses, and the use of scientific information in decision making. The course covers different sources of scientific evidence: designed experiments, quasi-experiments, field studies, surveys and case studies. The process of formulating testable hypotheses is discussed. Methods of measurement are discussed, including approaches to measuring soft, hard-to-quantify factors. Students apply statistical data analysis methods to draw conclusions from empirical data. Presentation of results is discussed. Students do a project involving empirical research.

571: Systems Engineering Management (3:3:0)
Prerequisite: SYST 471 or SYST 530
This course is a study of more advanced topics in management. This is a seminar style course, and students are expected to read a number of selections from the current literature as well as make presentations and produce papers on engineering management topics. A number of issues in systems engineering management, such as multi-project management, quality programs, and the impacts of process change on the organization will be examined. The course focuses strongly on the practical impacts of various system engineering management techniques and practices on projects, organizations, and personnel.

573: Decision and Risk Analysis (3:3:0)
Prerequisite: STAT 344 or equivalent
This course is a study of analytic techniques for rational decision making that address uncertainty, conflicting objectives and risk attitudes. This course will cover modeling uncertainty; rational decision making principles; representing decision problems with value trees, decision trees and influence diagrams; solving value hierarchies, decision trees and influence diagrams; defining and calculating the value of information; incorporating risk attitudes into the analysis; and conducting sensitivity analysis. (Offered concurrently with SYST 473. Students may not receive credit for both SYST 473 and SYST 573.)

619/ECE 672 Introduction to Architecture Based Systems engineering (3:3:0).
Prerequisite: SYST 510 or SYST 520 or equivalent or equivalent.
Lifecycles in systems engineering and the role of systems integration and architecting in these. Conceptual frameworks for systems architecting. Structure, function, and purpose of systems architecting and integration. Risk management and systems architecting and integration. User requirements and functional specifications in systems architecting

659: Topics in Systems Engineering (3:3:0)
Prerequisite: Permission of instructor.
Topics not covered in the department's regular systems engineering offerings. Course content may vary each semester depending on instructor and the perception of students' needs. Course may be repeated once for credit.

671/OR 671: Judgment and Choice Processing and Decision Making (3:3:0)
Prerequisite: STAT 510 or STAT 544 or permission of the instructor. People do not typically make judgments and decisions in a manner consistent with decision theory. So, how do people typically make judgments and decisions? This course presents an initial review of the scientific
literature directed toward answering this question, and emphasizes its importance when performing decision analysis and designing systems to support judgment and decision processes.

691/PUBP 771 Introduction to Enterprise Engineering: Engineering and Policy. (4:3:1) Prerequisite: INFS 614, or equivalent. This course provides an overview of Extended Enterprise Integration. Lectures focus on the SAP architecture and the R/3 standard software solution. Laboratory requires students to complete an end-to-end implementation project with the Great Plains Software midrange ERP solution, Dynamics C/S +. For modeling, students must demonstrate complete proficiency in the Architecture of Information Systems (ARIS) methodology, and the supporting ARIS Toolset.

692/PUBP 772 Decision Support for Enterprise Integration. (3:3:0) Prerequisite: SYST 542 and SYST 691. Lectures focus on the use of "Business Intelligence" to enhance competitive advantage; developing an information driven set of controls to improve profitability; and emphasize the creation of a balanced business with aligned corporate direction and strategic intent. Solutions provided within ERP systems are examined.

693/PUBP 773 Supply Chain Integration and Management (Business-to-Business Electronic Commerce). (3:3:0) Prerequisite: SYST 691. Lectures focus on two issues: Supply chain integration from an information technology perspective, and supply chain management from a decision support perspective. The motivation for the course is the merging of enterprise computing with operations research, primarily through customer/supply chain management systems. Topics include ERP/Web integration, advanced planning, and customer relationship management.

694/PUBP 774 E-Commerce Architectures (Business-to-Consumer Electronic Commerce). (3:3:0) Prerequisite: SYST 691. Introduction to the network and system architectures that support high volume business to consumer web sites and portals. Course provides insight into the structure of the modern web enabled storefront. Critical business and technology issues include Storage Area Networks (SANs), server clustering, load balancing techniques at the server and network level, fault tolerance, and recovery of database and application servers.

695/PUBP 775 Economics of Electronic Commerce. (3:3:0) Prerequisite: SYST 691. Focuses on gaining competitive advantage through Electronic Commerce implementation; the identification and growing of new market opportunities, as well as the electronic enabling of existing business relationships; business-to-consumer relationships, as well as the economics of strategic procurement, ERP hosting, customer relationship management, catalog hosting, portal operations, and supplier management.

696/PUBP 776 Customer Relationship Management. (3:3:0) Prerequisite: SYST 691. Focuses on the "front office" and its integration with the "back office." The modern world of eCommerce extends intra-enterprise integration [as implemented in Enterprise Resource Planning (ERP) systems] to include external constituents, such as customers, partners, and suppliers. Course is focused on modern system support for the Demand Chain, and the value creation process that results from integrating the front office systems (e.g., CRM) with the back office systems (ERP).

697/PUBP 777 Critical Information Technology Infrastructures (3:3:0) Prerequisite: SYST 694. Design and implementation of high-speed network and application services in support of
modern Enterprise Resource Planning (ERP) systems. Critical technologies include high-speed data communication, switched vs. routed data flow, workflow engines, business rule and web application servers, and load balancing technologies. A large-scale web enabled ERP system architecture will be examined in detail.

**798: Research Project (3:0:0)**

*Prerequisite:* 21 graduate credits.

Capstone research project. Key activity is completion of a major applied project resulting in an acceptable technical report and oral briefing.
8. Systems Engineering and Operations Research Faculty

Adelman, Leonard, Ph.D., University of Colorado; Professor

Brouse, S. Peggy, Ph.D., George Mason University, Associate Professor

Chang, Kuo-Chu, Ph.D., University of Connecticut, Associate Professor

Chen, Chun-Hung, Ph.D., Harvard University, Associate Professor

Donohue, George, Ph.D., Oklahoma State University, Professor

Falk James, Ph.D., University of Michigan, Affiliated Professor

Gross, Donald, PhD., Cornell University, Research Professor

Gulledge, Thomas, Ph.D., Clemson University, Associate Professor of Public Policy

Hoffman, Karla L., Sc.D., The George Washington University; Professor

Laskey, Kathryn B., Ph.D., Carnegie Mellon University, Associate Professor

Loerch, Andrew, Ph.D., Cornell University, Associate Professor

Nash, Stephen G., Ph.D., Stanford University, Professor and Associate Dean

Polyak, Roman, Ph.D., Russian Academy of Sciences, Professor

Sage, Andrew, Ph.D., Purdue University, D.Engr., University of Waterloo; University Professor, First American Bank Professor, Founding Dean Emeritus of School of Information Technology and Engineering

Schum, David A., Ph.D., Ohio State University, Professor

Shortle, John, Ph.D., University of California, Berkeley, Assistant Professor

Sivaraman, Eswar, Ph.D., Oklahoma State University, Visiting Assistant Professor

Sofer, Ariela, Sc.D., The George Washington University, Professor and Chair

Wagner, Donald. Ph.D., Northwestern University, Research and Visiting Professor

White, Bernard E., Ph.D., University of Virginia, Associate Professor, Assistant Dean for Undergraduate Affairs

Wolman, Eric Ph.D., Harvard University, Research and Visiting Professor

Adjunct Professors: Adams, Alexander, Barry, Carley, Killam, Masi, McDevitt, Patel, Wagenhals, Wells, Wieland, York, Youngren.