Department of Systems Engineering and Operations Research
Volgenau School of Engineering

seor.gmu.edu
seor@gmu.edu

(703) 993-1670

Industry and Government Sponsored Projects in Systems Engineering and Operations Research Undergraduate Senior Design Projects

Background

The senior design courses consist of a two semester (6 credit hour) capstone experience for Systems Engineering majors. Students typically work in teams of four or five on the same problem for their entire senior year. The results of the design formulation, project management and trade-off evaluations are presented to the Systems Engineering and Operations Research (SEOR) faculty, alumni and the project sponsors at the end of the each semester, and in professional and inter-collegiate competitions at in late spring each year. These competitions include the General Donald R. Keith Memorial Capstone Conference held annually at the United States Military Academy at West Point, and the IEEE Systems and Information Engineering Design Symposium held annually at the University of Virginia.

Purpose of the Capstone Program

The two courses, together, provide the capstone experience to the Systems Engineering undergraduate program. The capstone provides the students with the opportunity to put all of the course material that they have covered in their curriculum into practice. It also provides the faculty with the opportunity to test the students' ability to have assimilated the course material and certify that they are ready to receive the Bachelor of Science degree in Systems Engineering. In addition to providing the opportunity to utilize the systems engineering processes (e.g. problem formulation, preparation of a Statement-of-Need, requirements determination, work-breakdown structures, Pert/Critical Path Charts, Test and Evaluation Plans, life cycle cost estimation, etc.) it requires the student to use analytical skills in system modeling, optimization, simulation and decision making. Emphasis in the courses is also placed on written and verbal communication skill development and the creative process of engineering design. At the point of capstone project initiation, the students should have the basic skills to allow them to create new systems that are technically sound, affordable, environmentally compatible and safe. The students are required to manage a complex, unstructured project using the management and teamwork skills that they have studied. The students submit a weekly time sheet to their team timekeeper to be submitted at all major program reviews to practice using Earned Value Management schedule and cost variance control.

Properties of a Good Industry- or Government-Sponsored Design Problem

A good problem for a senior design team is one which is stated as a specific NEED with a general amount of information that supports and explains the nature of the customer's need. The student design team must use systems engineering processes to structure the need into a formal Statement of Need (SON) that is possible to address within the time and resources available to the design effort. Defining the project scope and formulating the problem is an important part of the design experience. The customers must have a designated point-of-contact or a Contracting Officer's Technical Representative available to the student design team for technical consultation. Based upon an agreed SON, a Requirements Definition stage will be conducted leading to a formal Statement of Work (SOW) which will be approved by the sponsoring organization. This SOW will be used to construct a customer value hierarchy and a House of Quality to produce several design alternatives that will be presented to the faculty and detailed Work Breakdown Structure (WBS), Critical Path (CP) and Earned Value Management (EVM) time and budget estimate will

be presented at that time. The spring semester emphasizes trade-off analysis (using modeling and simulation), of design alternatives identified in the fall. The final report and presentation of the preferred design recommendation is given to the customer in late April or early May.

A good project will have a real problem with interested and active customer involvement. A good project will be data-rich and loosely defined, to allow the student teams to exercise statistical data analysis and problem formulation/design creativity. A good project will address a real-life, unstructured, complex problem that will typically need to be scoped down by the students so that it is still difficult but doable within the 28 weeks allotted for the effort. The customer should expect that approximately 2000 person-hours will be invested in the design and analysis work within this 28 week period of performance. The problems should ideally be submitted to the SEOR Dept. in the spring or early of the year preceding the design activity to allow student teams to be formed at the conclusion of their junior year. The student teams can then use the summer to conduct background research on their design problem

Projects should not involve classified or company proprietary data and should be presentable and publishable in professional journals and competitions.

Sample Senior Design Projects

The titles of recent senior design projects are found at http://seor.gmu.edu/projects/capstones.html. Sample titles of 2015 projects include:

- Design of a Sediment Removal and Processing System to Reduce Sediment Scouring Potential from the Lower Susquehanna River Dams
- Analysis of the Impact of Enhanced Foreign Object Debris Inspection on the Aircraft Assembly Process
- A Decision Support Tool for Designing Niche Small Package Delivery Aerial Vehicles
- Design of a Procedure Analysis Tool for the FAA Human Factors Certification Process
- Design of a Primary Flight School Decision Support System
- Design of an Agricultural Runoff Monitoring and Reward System for the Upper Chesapeake Bay
- Design of a Low-Cost General Aviation Flight Data Recording and Analysis System
- Life-Cycle-Cost Model for the Design of a Bridge Vibration Monitoring System

The full student paper, student report, presentation and poster of recent projects can be found at http://catsr.vse.gmu.edu/SYST495_Spring2015.html and earlier projects at http://catsr.ite.gmu.edu/SYST495_Spring2014.htm.

Cost for a Project Sponsor to Participate

In general, the majority of the costs are borne by the university and the student's themselves. In order to ensure an adequate sponsor involvement, however, sponsors are asked to provide a donation to the Systems Engineering Senior Design Fund to cover equipment, specialized software, and student travel expenses to the two design competitions. This tax-free donation, made to the SEOR Senior Design Fund can be made in two installments (one at the end of each semester) or in a single installment at the end of the Spring Semester. In the unlikely event that the student work does not meet the faculty or sponsor's expectation we will waive the donation. All published work will acknowledge the sponsor's financial and technical support.

Contact Information

For further information contact the capstone course director and instructor, Professor Lance Sherry at lsherry@gmu.edu or SEOR Department Chair at asofer@gmu.edu

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Recent BS/SE Capstone Project Awards

US Military Academy Capstone Conference

- 2015 1st Place, Decision Analysis
- 2015 1st Place, Process Improvement
- 2015 1st Place, Engineering Analysis
- 2015 2nd Place, Best Conference Paper
- 2015 Best Conference Poster Award
- 2014 1st Place, Project Management
- 2014 Best Conference Poster Award
- 2013 1st Place, Modeling and Simulation
- 2013 1st Place, Decision Analysis and Support
- 2012 Best Conference Poster Award
- 2012 1st Place, Decision Analysis and Support
- 2012 1st Place, Process Modeling
- 2012 1st Place, Environmental Design
- 2011 Best Conference Poster Award
- 2010 1st Place Modeling and Simulation
- 2010 1st Place Decision Analysis:
- 2010 1st Place Modeling and Analysis:
- 2006 1st Place, Modeling and Simulation
- 2006 1st Place, Project Management
- 2005 1st Place, Process Modeling and Analysis
- 2005 1st Place, Reengineering
- 2004 1st Place, Process Modeling and Analysis
- 2004 1st Place, Decision Analysis

IEEE Systems & Information Engineering Design Symposium, UVA

- 2014 1st Place, Environment and Social Systems
- 2014 1st Place. Modeling and Optimization
- 2014 1st Place Decision Analysis and Risk
- 2013 1st Place, Environment and Human Health
- 2012 1st Place, Modeling and Simulation
- 2012 1st Place, Decision Analysis and Support
- 2012 Best Conference Poster Award
- 2011 1st Place, Systems Engineering Applications
- 2010 1st Place, Data Mining Integration & Security
- 2009 1st Place, Environmental and Economic Systems
- 2009 1st Place, Optimization and Systems Analysis
- 2006 1st Place, Logistics and Transportation
- 2006 1st Place, Risk Analysis

INCOSE/JHU-JPL Samuel Kossiakoff Systems Engineering Scholarship

- 2012 Gabriel Lewis
- 2011 Colin Mullery