GEORGE MASON UNIVERSITY

VOLGENEAU SCHOOL OF INFORMATION TECHNOLOGY AND ENGINEERING

SYST 490/495 Senior System Design Project (2009/2010)

1/17/2010

Instructor: Dr. George L. Donohue
Office: Rm. 2212 Engineering Bld.
Lecture: Rm. 2211 Engineering Bld.
Lab: Rm. 2211 Engineering Bld.
Time: TTh 12:00 – 13:15
Office Hours: Tuesday/Thursday 14:15 to 15:45, (lunch mtgs 13:15-14:15 by apt.)

Required Reading:

Derek Hitchins***, Systems Engineering: A 21st Century Systems Methodology,*** John Wiley & Sons, 2007.

Suggested Reading:

Thomas L. Friedman***, Hot, Flat, and Crowded,*** Farrar, Straus and Giroux Publishers, 2008;

William J. Palm III, ***System Dynamics***, McGraw Hill, 2005;

Norman R. Augustine, ***Augustine's Laws: A Top Executive Looks at the Complexities and Conundrums of Today's Business Management – and Offers Solutions***, American Institute of Aeronautics and Astronautics, 1997.

FE Review Manual, Michael Lindeburg, 2002

http://www.ncees.org/exams/study_materials/fe_handbook/ (17.5 Mbyte pdf file)

Objective: These two courses, together, provide the Capstone experience to the Systems Engineering undergraduate program. It provides the students with the opportunity to put all of the course material that you have covered in the last 3 to 4 years into practice. It also provides the faculty with the opportunity to test your ability to have assimilated the course material and certify that you are ready to receive the Bachelor of Science degree in Systems Engineering. In addition to providing you the opportunity to utilize the systems engineering processes (e.g. requirements determination, work-breakdown structures, Pert Charts, test and evaluation, life cycle costing, etc.) it will require you to use your analytical skills in system modeling, simulation and decision making. Emphasis in these courses will also be placed on written and verbal communication skill development and the creative process of engineering design. You now have the basic skills that should allow you to create new systems that are technically sound, affordable, environmentally compatible and safe. You were required to describe your problem definition, scope, value hierarchy, requirements analysis, modeling and simulation approach for your designs in the Program Proposal that you submited to your sponsors and the faculty last semester, in early December.

You are now required to manage this complex, unstructured project using the management and teamwork skills that you have developed. The class has been divided into four project teams, each working on a real problem. Each student MUST maintain a personal log of all design activity, to be inspected upon demand. You MUST submit a weekly time sheet to your team timekeeper to be used in your EVM project control and submitted at all major program reviews. Qualifying teams will be entered into inter-scholastic senior design competitions at the end of this Semester (SIEDS 2010, 23 April, 2010, USMA 29 April, 2010). Decide which Track in which you want to compete.

Each member of the class will give a substantial presentation at some point in the project to faculty and outside project sponsors. Each student will be graded upon his/her presentation ability. The Project IEEE technical paper and the final Project Report will be graded for writing style and completeness. The total project grade will represent a sizable portion of each student's final grade. In addition, each student will be ranked by each team member for total contribution to the program outcome.

Competition Tracks: (http://sys.virginia.edu/sieds.10)

- Data Mining & Statistics
- Simulation & Stochastic Modeling
- Human Factors & Cognitive Engineering
- Math Modeling & Optimization
- Risk Analysis, Technology Management & Policy
- Life Cycle Analysis
- System Economic Analysis

Grading: Each student's final grade will be determined as follows:

30% Team Individualized Mid Term Exam
30% Final Project report and UVA paper (written)
25% Faculty / Sponsor Evaluation of Team Presentation
10% Team Project productivity self evaluation
5% Timesheets/Notebooks (to be submitted on demand)

Semester Schedule:

January 21. Review Spring Semester Schedule & Eng. Day Poster
January 26. Individual team discussions as required & set appointment schedule
January 28. Individual team discussion by appointment
Feb. 2. Individual team discussion by appointment (USMA registration period open)
Feb. 4. submit UVA abstract (200-500 words) for review prior to Feb 16 submission deadline
Feb. 9. UVA abstract pass-back with suggested changes
Feb. 11. submit final abstract and receive approval to submit abstract to UVA electronically (must be into UVA by Feb. 15 AT THE LATEST!!!)

Feb. 16. Detailed Presentation on Simulation and Analysis Status (1)*
Feb. 18. Detailed Presentation on Simulation and Analysis Status (2**)***
(Eng. Day Posters Displayed and explained)
Feb 23. Detailed Presentation on Simulation and Analysis Status (3**)***
Feb. 25 Detailed Presentation on Simulation and Analysis Status (4**)***
- First Draft of UVA paper due
March 2. individual team work and discussions with faculty advisor
March 4. individual team work and discussions with faculty advisor
(March 9 paper acceptance notification)
March 8-12 Spring Break
March 16. Mid Term Exam Discussion and Preparation
(1st draft UVA pass back & paper approval)
March 18. Mid Term Exam (in-class, no notes, 5 question essay exam)
March 23-25. work on analysis and paper, discussions by appointment
March 30 2nd draft UVA paper draft to Donohue and Faculty for review and comment.
USMA Abstract due and registration deadline ?
April 1. MTE Pass-Back. 2nd draft UVA paper review pass-back for corrections prior to submission – ***submission permission required***
(<April 5 Paper & registration deadline, $75 fee)
April 6. Individual team discussions of project status
Discussion of **UVA Manuscript sent to UVA for peer review**
April 8. Individual team discussions of project status
April 13. DRY RUN for UVA presentation*
April 15. DRY RUN for UVA presentation *
USMA Abstract due for review and submission ?
April 20. DRY RUN for UVA presentation*
April 22. DRY RUN for UVA presentation*
April 23. UVA IEEE Capstone Conference (lv. GMU approx 06:00, ret. 16:00 to 22:00)
April. 27 Final Presentation to SEOR Faculty
April 28 leave for West Point conference (approx 10:00 to 12:00, 6 hour transit time)
April. 29 USMA Capstone Conference
April 30 Return from West Point (ar. Approx noon)
May 4. Reports submitted for Faculty and Sponsor evaluation,

May 4. Course and Team Final Evaluation, Lessons Learned (10:30-11:00)

- * presentation order random selection

Remember: The GMU Honor Code is in effect for this class. If you have any questions as to it's application to your team efforts, please consult with me.

Outcomes:

SYST 495 is the general education synthesis course for the BS in Systems Engineering Degree and as such must address outcomes 1, 2 and 3 (below). Upon completing a synthesis course, students should be able to:

1. Communicate effectively in both oral and written forms, applying appropriate rhetorical standards (e.g., audience adaptation, language, argument, organization, evidence, etc.)
2. Connect issues in a given field to wider intellectual, community or societal concerns using perspectives from two or more disciplines
3. Apply critical thinking skills to:
    a. Evaluate the quality, credibility and limitations of an argument or a solution using appropriate evidence or resources, OR,
    b. Judge the quality or value of an idea, work, or principle based on appropriate analytics and standards

All academic programs at Mason have student learning outcomes that are assessed periodically. Your work from this course has been selected for use in such an assessment in the summer of 2010. Your anonymity is assured and your grade will not be affected. At any time, you may contact the Office of Institutional Assessment (assessment@gmu.edu) with questions, concerns, and comments about the use of your work.

The faculty of the SEOR department evaluate these student outcomes using the factors shown in the following table.

SEOR Student Outcomes as factors to be Measured by Presentations, Technical Paper, Technical Report, Mid Term Exam, and Team Peer Evaluations

Student's Ability to Demonstrate	**Rating of Performance (4-point scale)** (1=poor, 2=fair, 3 = good, 4 = excellent)		**Score**
1. Knowledge of mathematics through differential and integral calculus and advanced topics in differential equations, linear algebra, statistical analysis, and complex variables	Essential knowledge of mathematics		
2. Knowledge of core systems engineering theory and methods.	Fundamental knowledge in SE Fundamental methodologies in SE		
3. An ability to use modern engineering techniques, skills and tools, including computer based tools for analysis and design.	Experimental tools Essential knowledge of computing		
4. An ability to apply knowledge of mathematics, science and engineering to the analysis of systems engineering problems.	Fundamental knowledge in SE Essential knowledge of mathematics Essential knowledge of science		
5. An ability to design and conduct scientific and engineering experiments, as well as to analyze and interpret data.	Experimental tools		
6. An ability to identify, formulate, and solve engineering problems, including the planning, specification, design, implementation and operation of systems, components and/or processes that meet performance, cost, time, safety and quality requirements.	Problem-solving skills		
7. An ability to function on multi-disciplinary teams.	Teamwork skills		
8. An understanding of professional and ethical responsibility.	Ethics and professionalism		
9. An ability to convey technical material through oral presentation and interaction with an audience.	Oral communication skills		
10. A recognition of the need for and an ability to engage in life-long learning.	Life-long learning and self-education Preparation for graduate studies		
11. The broad education and knowledge of contemporary issues necessary to understand the impact of systems engineering solutions in a global and societal context.	Societal impacts of engineering Global perspective of engineering		

Project Descriptions:

A) West/Rhode River Water Quality Improvement Program
Sponsor: West/Rhode River-keeper, Chris Trubauer;
Faculty Advisor: Dr. George Donohue

The West and Rhode Rivers are major rivers feeding the Chesapeake Bay. They are located approximately 20 miles south of Annapolis Maryland. The River-keeper is responsible for monitoring the water quality of these rivers in cooperation with the Maryland Department of Natural Resources (DNR). The Smithsonian Environmental Research Center is located on the Rhode River and has a continuous water quality monitoring system. The DNR maintains a historical data base and the River-keeper updates spatial-temporal data on a semi-periodic basis. It is desired to conduct projects that will enhance the water quality of these rivers and thus eventually the entire Bay. It is desired that a system-dynamic model be developed that would allow the river-keeper to predict the effects that a collection of proposed water quality improvement projects would produce. A complete design, including cost, Value Hierarchy, water quality transfer functions, systems dynamic model in matlab and projected performance must be developed.

Ref.: Mueller, J.A. and R.V. Thomann, ***Principles of Surface Water Quality Modeling and Control***, Harper Collins, 1987.

West and Rhode River Water Quality Assessment Plans, ,2009.

B) Lighter than Air Unmanned Air Vehicle system Design
Sponsor: Lockheed Martin
Faculty Advisor: Dr. Lance Sherry

The value of UAVs for military and civil applications has been demonstrated in the past several years in a variety of missions as evidenced by the explosive growth in the number of these vehicles worldwide. A UAV provides a platform for sensors and/or weapons without risk to its pilot and a capability to loiter over a point of interest for hours or days. A new generation of lighter-than-air UAVs is being developed to provide persistency of months or years at significantly lower operating costs than the current generation of UAVs. These systems are based on a non-rigid buoyant airship design which is capable of autonomous station-keeping at altitudes of 65,000 feet and carry payloads weighing several thousand pounds. Power for the high altitude airship is all electric and is generated by thin film photovoltaic cells which are mounted on its upper surface. In addition to the PV panels, the power subsystem is comprised of energy storage to allow for continuous day/night operation. As the performance of fuel cells improves, the PV-battery design will be replaced by a PV-fuel cell combination which will reduce the weight of the power subsystem. An operational vehicle needs to generate about 100 Kw to power the propulsion system, payloads, and overhead functions.

The objective of this design study is to examine the benefit of using solar concentrators in combination with photovoltaic cells in reducing the weight of the power subsystem and assess its impact on vehicle flight performance. The current PV panel design weighs approximately 6,000 lbs.

C) Aviation Environmental Management Systems

- **a. Sponsor: Metron Aviation**
- **b. Project Advisor: Dr. Terry Thomson**

This project addresses environmental management systems for airports, particularly with regard to integration of real-time data from noise sensors and from aircraft tracking systems. Students will have access to high-fidelity microphones in the vicinity of Dulles Airport and also to ADS-B aircraft position data. The project will entail constructing a working system that records, analyzes, and correlates the noise and track information. The project will design extensions to the basic system using other forms of data collection such as optical sensors, and may address extensions to other phenomena such as detection of wake vortices.

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D) Hydrogen Powered Transportation Infrastructure

- **a. Sponsor: Reclamationenergy**
- **b. Project Advisor: Sudi West,** <sudi.west@reclamationenergy.com>

Abstract

Hydrogen-based energy technologies have enormous potential to provid
options while reducing demands on non-renewable resources. PATH-E i
system of logistics optimization, infrastructure planning, and social netw
forms the basis of a hydrogen vehicle leasing partnership between Gener
Hydrogen and Enterprise Rent-A-Car. The research proposes a technical
overcome public and commercial risks in developing Hydrogen-based te
introducing consumers to low-commitment common use of hydrogen vel
usage data to justify production by key manufacturers and energy compa
include an 18% reduction in Fossil Fuel use and 20% reduction in CO_2 e
By dynamically mapping a social and financial adoption pathway throug
energy and transportation technology end-states, PATH-E revitalizes dor
promotes technological leadership of U.S. companies, and transforms hy
fuel" into a viable resource towards National energy independence.