E-Portfolio
SYSE 590 – Integrative Workshop

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Systems Engineering Masters program
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1. Systems Engineering

Systems Engineering focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then continuing with design synthesis and system validation while considering the complete problem: Operations -- Performance -- Test -- Manufacturing -- Cost & Schedule -- Support -- Disposal. Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Many of us already practice systems engineering, but call it something else: design or development of product, process, and service. This course of study will enable the engineer to function in an interdisciplinary team and apply their area of engineering specialty toward the development of a product, process, or service.¹

2. E-Portfolio Purpose

The purpose of this E-portfolio is to document my coursework plan, objectives and progress. In addition it provides an opportunity for reflection and evaluation of the coursework taken. The further I progress through this program, the more benefit I see in this portfolio. There is something about evaluating each course, its content and its relation to other courses that enhances the learning process. In addition it provides the opportunity to reflect on the application that the program has on your own professional goals.

3. Objectives & Rationale

In pursuing a Masters degree in Systems Engineering, my goal is to further develop my capabilities as an engineer. This should open up the door to new opportunities and provide me with the capabilities, knowledge and tools for further advancement.

I evaluated several systems engineering programs and found the Portland State program attractive for several reasons. It is not too narrowly focused on any one industry. It has good ties to local industry and seems well designed to fit the needs of those industries. At the same time, many students from other parts of the country are enrolled in this program which provides a diverse group of students.

I can see the value of systems thinking in many industries. The tools, knowledge and capabilities developed in this program will be of value in a variety of roles including, but certainly not limited to formal systems engineering roles. I can also see direct application of the knowledge I am gaining in a variety of other roles.

From what I have observed in industry, there is often quite a bit of variance from company to company when comparing job titles vs. actual responsibilities. An advanced development engineer, project engineer or project manager may be doing a significant amount of systems
engineering work. Often times this varies based on the individual's background and experience. In addition, the needs of the company certainly come into play as well.

I do see that most companies do utilize systems thinking in one form or another, which certainly affected my decision to pursue a degree in Systems Engineering. That said, it does seem to be fairly common for systems engineering responsibilities to be carried out by someone other than a dedicated systems engineer. This seems especially true for mid-sized companies with less complex products or systems. In contrast, a large defense contractor is probably much more likely to have a dedicated systems engineering role.

4. Coursework Plan

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<th>Status</th>
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5. Coursework descriptions and reflection

SYSE 591: Systems Engineering Approach

Course Description:

Engineering of complex hardware, software systems encompasses quantitative methods to understand vague problem statements, determine what a proposed product/system must do (functionality), generate measurable requirements, decide how to select the most appropriate solution design, integrate the hardware and software subsystems and test the finished product to verify it satisfies the documented requirements. Additional topics that span the entire product life cycle include interface management and control, risk management, tailoring of processes to meet organizational and project environments, configuration management, test strategies and trade-off studies.²

Term taken: Fall 2010

Professor: William "Ike" Eisenhauer

Text: Systems Engineering: Principles and Practice
By Alexander Kossiakoff and William N. Sweet

NASA Systems Engineering Handbook

Reflection:

I took this course my first term of the program. It provided a very good introduction to the world of systems engineering. I acquired a good base of knowledge regarding the role of the systems engineer as well as a good introduction to the system engineering life cycle. I expect that this will provide a good foundation for future coursework and learning.

Here are a few key concepts that I took away from this course:

- Systems engineering is focused on near-optimal system development and has a broad focus.
- The importance of balancing performance, cost, schedule and risk.
- The importance of interfaces, interactions and modularity.
- The inherent risks and benefits of new technology.
- The crucial role of requirements analysis throughout the process.
- The systems engineering process is highly iterative.
- The systems engineering life cycle is itself quite complex.
SYSE 510: Systems Engineering Management

Course Description:

This course covers the essentials of systems engineering management and its critical interconnection to program/project management. Systems engineering is the integration of several engineering fields into an efficient and effective process for the overall technical management of programs and development of systems and products. Students will gain detailed knowledge in management techniques applicable to activities within Systems Engineering, including trade-off studies, technical performance measurement, cost-effective process tailoring, technical reviews and audits, and others. Several case studies projects will be studied throughout the course to illustrate key concepts and management techniques.  

Term taken: Fall 2010

Professors: John Blyler and Jacob Goldstein

Text: Essentials of Project and Systems Engineering Management, Howard Eisner

Reflection:

This course introduced the project structure and how the systems engineer fits in that structure. It also covered many of the tools and processes utilized within that structure. In doing so, it also provided a good overview of the structure of government systems and acquisitions. Coming from the private sector, this was a real eye opener.

I gained a better understanding of the tools and processes utilized. This includes the very crucial tool of systems architecting. Being that the systems engineer often plays a management role in the project, there was also focus on the need to manage people, projects, cost, schedule and risk while trying to achieve and develop good technical solutions.

In addition here are some other key concepts which stand out in my mind having recently completed this course:

- The importance of risk management.
- The importance of requirements management and the importance of not being passive regarding good requirements.
- The importance of simplification and how to simplify without losing key information.
- The importance of integrative management – the realization that the knowledge needed to make good decisions is very widely distributed.
- The importance of good management skills.
SYSE 590: Integrative Workshop

Course Description:

Systems Engineering is an acquired behavior to be developed throughout the Masters degree program. Students and faculty advisors will engage in creative workshop activities integrating technical specialty skills and project experience invoking systems engineering applications of communication, synthesis and creativity, team building, problem solving, management of time and resources, and system life-cycle thinking. A student portfolio will document the program plan and document that the desired behavioral change is taking place. Prerequisite: Consent of Instructor, Total of 4 credits; variable each term. For More Details

When you get your admit-letter, you are asked to start on SYSE 590 immediately. For more information on SYSE 590 see e-portfolios and guidelines.

SYSE 590 tracks student maturity in learning and in using systems engineering as applied to an educational system - the individual’s study plan. SYSE 590 also serves as another vehicle for the student to assess courses and the program. As a consequence of the student's assessment of courses and the program, and as a portion of the four credits, the student may wish to explore additional system engineering topics not explicitly covered in scheduled courses. The final product is an e-portfolio which will be posted on the systems engineering web site. ²


Professor: Herman Migliore

Reflection:
ETM 540: Operations Research in Engineering and Technology Management

Course Description:

Resource optimization is studied through mathematical programming. Emphasis is placed on applying linear programming, and goal programming to engineering management decisions. Problem formulation, mathematical model building, basic principles behind the Simplex algorithm, and multiple objective linear optimization via goal programming are included in the course. Post-optimality analysis is studied from the viewpoint of technology management. The course includes a term project involving a real-life problem.

During winter term, remote SYSE students participate in this course. Typically lectures are recorded fall term for online viewing winter term.

Term taken: Winter 2011

Professor: Tim Anderson

Text: Spreadsheet Modeling and Decision Analysis, Cliff T. Ragsdale

The Numerati, Steven Baker

Reflection:

This course introduced some valuable tools for optimization. That said, some of the best tools are not “multi-purpose” tools, you do certainly need to take a look at any situation and decide “Is this the right tool for the problem at hand?” For the right situation, the information and tools presented have been proven by many in industry to add significant value.

Having worked in the Operations side of the business for about 10 years at a business equipment manufacturer, I can see numerous applications for the tools presented in this course. In addition, I can see direct use of this knowledge by most systems engineers. It provides an additional perspective into operational concerns. If the end goal of systems engineering is to obtain a near-optimal system that achieves the right balance between cost, performance, schedule and risk then it certainly makes sense to consider the operational aspects of the system and ways to optimize operational concerns as well as design concerns.

This was definitely one of the more time intensive courses I’ve taken so far. To others considering this course, I would highly recommend taking it during a time where your commitments outside of the classroom are as few as possible. After hearing feedback from other students who are working full time, the general consensus seems to be that one class at a time is about all that is reasonable. I think most students will find that especially true during the term that they take this course.

A great deal of time was devoted to a group project. The project turned out to be a very complex optimization problem, probably more challenging than expected. That said, sometimes it is better to
choose a more challenging project rather than an easy one. You may learn more from a more challenging one, however there is certainly a fine line between “big enough” and “too big.” On a separate note, I do think that Dr. Anderson’s recommendation regarding group size (3 to 4 people being optimal) is a wise recommendation for a class project such as this. My observation is that an educational group project is much different than group projects in the work place. The inherent difference in leadership structure can make a large group challenging for a class project such as this.

I took this course during winter term 2011 and then took Reducing Risk in Decision Making the following term (Spring 2011.) I found this to be a nice progression. I would recommend taking this course first if you have the option to do so.

**SYSC 514: System Dynamics**

**Course Description:**

A lab and web-based course that introduces the student to the study of the dynamic behavior of continuous systems that contain feedback. A simulation software is used as part of the course. "Lecture" materials are provided using PSU's online course management systems. Class time is used to assist students in carrying out various labs to reinforce the primary concepts. For more information: [http://www.sysc.pdx.edu/classes/514.html](http://www.sysc.pdx.edu/classes/514.html)

**Term taken:** Winter 2011

**Professor:** Wayne Wakeland

**Text:** *Business Dynamics*, John Sterman

**Reflection:**

So, how does System Dynamics benefit the Systems Engineer? For me, a large benefit (but certainly not the only benefit) was a different mindset. After taking this course, I began to recognize the presence of feedback in many systems that I encounter. I think that is one of the key benefits to taking this course, it will likely change your way of thinking and give you more of a “systems thinking” approach.

The course utilizes Vensim simulation software and a combination of texts that provide insight into simulation and modeling of complex systems (particularly ones containing feedback.) Utilizing the software to model various types of systems allows you to really understand and visualize the types of feedback that are present in many systems.

The concept of path dependence was introduced in this course (as well as many other useful concepts.) Several good examples were given of path dependence from the engineering and business worlds. Basically how the initial actions taken can set the course for either success or failure. I found this to be a
particularly interesting concept and one that is demonstrated in many areas including the requirements engineering process.

**SYSE 573: Requirements Engineering**

**Course Description:**

This course provides the knowledge and skills necessary to translate needs and priorities into system requirements, and develop derived requirements, which together form the starting point for engineering of complex hardware/software systems. The student will develop an understanding of the larger context in which requirements for a system are developed, and learn about trade-offs between developing mission needs or market opportunities first versus assessing available technology first. Techniques for translating needs and priorities into an operational concept and then into specific functional and performance requirements will be presented. The student will assess and improve the usefulness of requirements, including such aspects as correctness, completeness, consistency, measurability, testability, and clarity of documentation. Case studies, many involving software-intensive systems, will be used. Prerequisite: SYSE 591 Systems Engineering Approach or SYSC 513 Systems Approach or Consent of Instructor. See Syllabus for more details.²

**Term taken:** Spring 2011

**Professors:** Dorothy McKinney, Jacob Goldstein

**Reflection:**

I came away from this course with a much better understanding of how requirements should be developed, maintained and communicated. I appreciated the focus on examples from industry (failures and successes.) I found the information, tools and techniques presented to be invaluable. The course really uncovered a lot of misconceptions regarding requirements and how they should be developed and managed.

One example of a technique that I had not previously considered was to purposefully state what the system will not do. It seems much more common to spell out what the system will do and that is (and should be) the bulk of most requirements documents. However by taking some time to look at the known limitations, it allows you to confirm that the exclusion of certain functionality is the correct decision.

The project provided an excellent opportunity to utilize the tools, techniques and knowledge presented. I find that repetition and application are key steps in the learning process. So, doing a project to develop a requirements document really helped drive home the concepts presented in the course. One thing that really stood out to me was that the requirements document needs to be something that is understandable by a large audience. Stakeholders with different backgrounds will be utilizing this
document, so having a requirements document that is concise, clear and unambiguous is really crucial. Especially considering that the requirements document will serve as the basis for the expenditure of a significant amount of resources.

Overall this was an excellent course and one that most engineers will find to be very relevant.

**SYSE 575: Reducing Risk in Decision Making**

**Course Description:**

This course will examine the concepts, techniques and tools for managing risk and making decision as key components of the systems engineering process. In this course, risk connotes a measure of the probability and severity of an undesired event. This course begins with an overview of the risk management (identifying, assessing, monitoring, and mitigating) and decision process. Differences between mission critical and non-mission critical programmatic risk will be emphasized. Other topics include the limits of expected value-based risk analysis, decision making strategies such a max/min, min/max and regrets. Formal methods in risk analysis, elementary decision analysis and decision trees, multi-objective decision making, Pareto techniques, optimality, and trade-off analysis will be covered. Risk and decision techniques will be contrasted with the interfacing processes of program management and software engineering, from both the government (DOD) and industrial perspectives. For more details see [Syllabus](#).

**Term taken:** Spring 2011

**Professor:** William "Ike" Eisenhauer

**Text:**

- *Risk Assessment and Decision Making in Business and Industry*, Glenn Koller
- *NASA Systems Engineering Handbook*
- *Probabilistic Risk Assessment Procedures Guide for NASA Managers and Practitioners*

I took this course after taking Operations Research the prior term. I found this to be a nice progression. Some of the information in Operations Research served as a good base for this class.

I found this course to be quite useful and can see utilizing the information on future projects. I’ve faced situations in the past where it is certainly not easy to tell what level of risk is present and as such it’s difficult to see which decision is the best option or what course of action is appropriate. This course introduced some good techniques and tools to assess the level of risk, the amount of certainty regarding those risks and determine the risk-weighted value of various alternatives.

The value of information really stands out to me as key. By accurately assessing the level of risk present, you should be able to add value to a project. By quantifying the level of risk present, you can then decide how to act. So, the information discovered may be that an opportunity is best avoided. The
information discovered could also lead you to plans to deal with that risk to reduce it. Either way, you are now acting on better information and that should improve chances of success. Success could be a better chance of successfully completing a project, improving profit level or simply reducing the amount of loss if/when problems do occur.

This course involved a project to utilize the tools presented and apply the learning. I found this to be an effective method of learning. For my project, I chose a situation that I faced in the past. The information discovered was not what I expected, but was certainly of value.

**EAS 561: Reliability Engineering**

**Course Description:**

Failure is a fact of engineering. No product or system can be assumed to work correctly 100% of the time. The engineering effort to even attempt to design such a system would be both time and cost prohibitive. In light of that, the reliability of systems can not be ignored and must be studied to ensure, at least, we grasp the reality we are dealing with. This course provides an in depth study of the engineering and management of the reliability space. Including describing and quantifying reliability, as well as examining the modeling, test design, trade off analysis required of engineers involved with products and systems that do not perform 100% correct at all times.²

**Term taken:** Summer 2011 (in progress)

**Professor:** William "Ike" Eisenhauer

**Text:**

**Reflection:**
SYSC 529: Business Process Modeling & Simulation

Course Description:

The primary emphasis is on using discrete (and possibly continuous) system simulation models to analyze business processes, including administrative processes, decision-making, product development, manufacturing, and service delivery, etc. Discrete system models characterize the system as a flow of entities that enter and move through various processes, queues, and decision logic according to various probability functions specified by the modeler. Monte Carlo sampling is used to calculate statistical measures of system performance, such as throughput, average queue length, resource utilization, etc. For more information: http://www.sysc.pdx.edu/classes/529.html

Term taken: Fall 2011 (planned)

Professor:

Reflection:
SYSE 506: Masters Project

Course Description:

The nine credits of SYSE 506 are a capstone experience that exercises systems engineering concepts in a comprehensive project of interest to student and advisors. The student may work on a project potentially in their area of domain knowledge and potentially for their current employer, but the project must encompass: a) systems thinking, b) a systematic approach, c) identification of customer and stakeholder needs, d) requirements management, d) validation and verification, e) formal interface management f) assessment of results. The scope of the project is well defined and must satisfy objectives related to technical engineering, student learning, and systems engineering areas. The project generally starts with a formal proposal, continues with progress reports, and ends with a stand-alone final report. Contact Director.\(^2\)

Terms taken:

Professor:

Reflection:
6. Works Cited

1. http://www.cecs.pdx.edu/systems/program/about.php