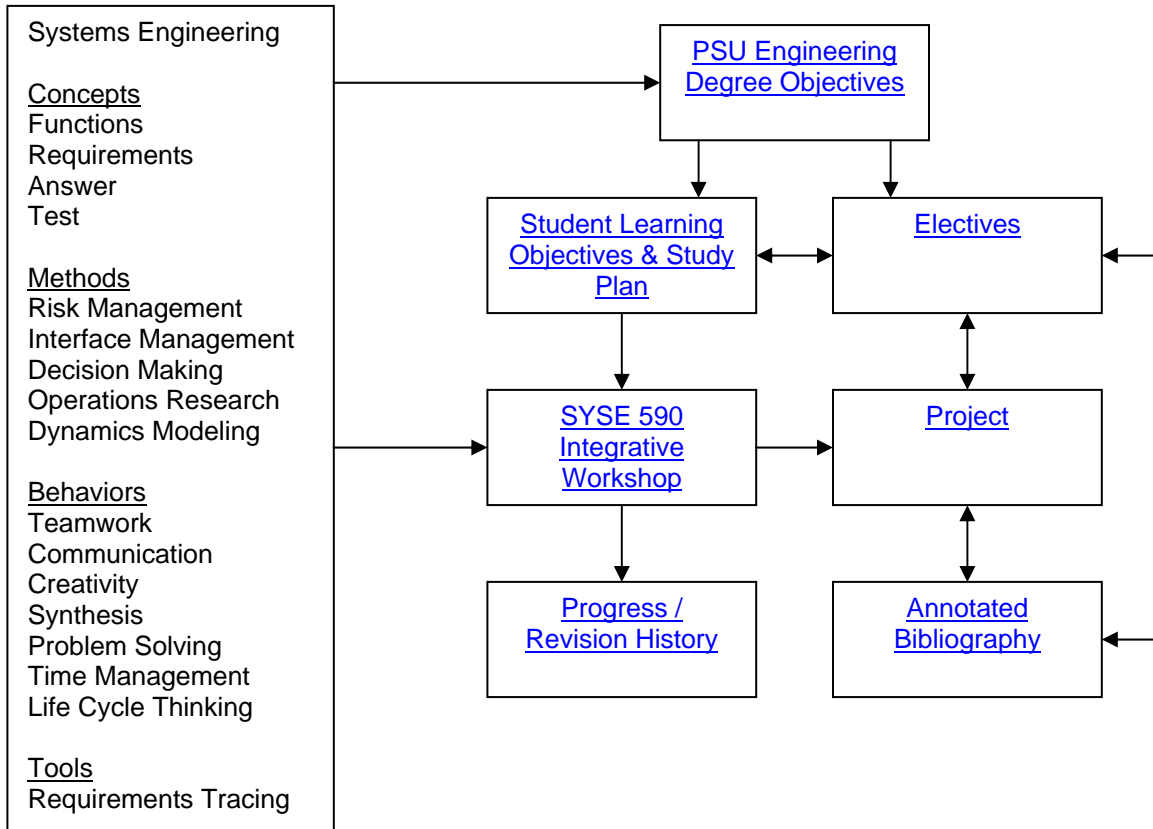


### Systems Engineering Integrative Workshop Concept Map



## **The Masters of Engineering in Systems Engineering at Portland State University**

### Background

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 engineering to function in an interdisciplinary team and apply their area of engineering specialty toward the development of a product, process, or service.

### Learning Objectives

Improve students' ability to engineer complex products, processes, or services.

Develop students' understanding of basic systems concepts and their application to the engineering life cycle.

Develop students' understanding of key systems engineering skills, including team building, communication, synthesis & creativity, problem solving, management of time and resources, database management, and life-cycle viewpoints.

Build on students' existing knowledge and project experiences by providing additional domain specialization or project management tied to systems engineering skills.

### General Requirements

The course of study requires 45 credits all taken at the graduate level. The student will be under the supervision of the Director of Systems Engineering, and a faculty advisor from his department of specialty, and an industry advisor knowledgeable with the student's internship/project experience. Core courses will introduce the student to systems methods and its tools. Elective courses will provide advanced domain knowledge mostly in the student's area of specialty. Courses from other departments will enable the student to apply this domain knowledge in an interdisciplinary, integrated manner. The internship/project will be a capstone experience combining both systems engineering and domain-specific approaches in the engineering of a complex system.

### Core Courses (16 Credits)

SYSE 591 Systems Engineering Approach (4 Credits)

EMGT 540 Operations Research (4 Credits)

SYSE 595 Hardware-Software Integration (4 Credits)

One of 3 modeling classes (4 credits):

SYSC 514 System Dynamics

SYSC 527 Discrete System Simulation

SYSC 529 Process Modeling and Simulation

### Elective Courses (16 Credits)

Each student will be under the advisement of the Director of Systems Engineering and a faculty advisor from one of the following departments: Civil Engineering, Computer Science, Electrical & Computer Engineering, Engineering Management, Mechanical Engineering, and System Science. Elective courses will come from any one of these PSU departments based on a plan of study agreed upon by both advisors and the student. Courses from other universities may be acceptable, as evaluated on a case-by-case basis, and up to a limit of 15 credits. Systems Engineering courses are also available as electives.

### Projects & Internships (9 Credits)

Each student will participate in an industrial experience either as part of a formal internship (SYSE 504) or as part of an industrial project (SYSE 506). These industrial experiences will involve the student, faculty advisors and an industrial advisor. The internship may be full time or part time with nine months of full time employment earning 9 credits. The internship/project must encompass systems level considerations as applied to a product, process or service requiring knowledge from multiple engineering disciplines.

### Integrative Workshop (4 Credits)

A total of four credits of interactive workshop between faculty advisor and student are required. The student will be guided to consolidate their project experience and knowledge from elective courses with concepts from their systems engineering core courses. This interaction could be conducted on-line the Internet in SYSE 590 Integrative Workshop (IW). Two important concepts in Systems Engineering are integration and management of interfaces, related to both physical components and product development process. The objective of IW is for the student to exercise these concepts as applied to their course work and project work. The workshop will span the student's entire program under the guidance of an advisor, thus giving the time to achieve several goals. One, the student is given feedback as they apply discipline skills in systems settings. Two, the student will be asked to reflect on past approaches as it relates to newer more advanced systems skills. Third, the IW will review systems topics over several terms, thus reinforcing their use. In this way, behavioral change, from engineering specialty thinking to systems engineering thinking, will be achieved. The program also benefits because students continuously assess how well all courses INTEGRATE to achieve Systems Engineering education goals. Workshops will culminate in a student portfolio summarizing the academic knowledge and practical experience students gained while in the Systems Engineering program.

Summary from systems engineering web page at <http://www.cecs.pdx.edu/Systems/program/masters.html>.

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## **SYSE 590 Integrative Workshop**

The purpose of this course is to guide the learning experience for each student to accomplish a desired objective. I have a collection of courses that should give me the required tools to model a pricing strategy in a simulation model. Systems understanding, simulation, and decision science are the keys to finding the true drivers of profitability.

Summary from systems engineering web page at <http://www.cecs.pdx.edu/Systems/program/masters.html>.

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## Student Learning Objectives & Study Plan

Progress on SYSE 506 project will take place through the course of the program study. Term registration will not necessarily correspond with project activities. Both project and workshop completion will be necessary to complete degree requirements.

In all cases the application spans a wide array of applications describing social, biological and engineering systems.

*Courses in blue have been completed; other courses are in progress or scheduled.*

Class	Term	Core	Elec	I/W	P/I
SYSE 591 Systems Engineering Approach	02 Fall	4			
SYSE 595 Hardware/Software Integration	03 Winter	4			
EMGT 540 Operations Research	01 Fall	4			
SYSC 529 Process Modeling and Simulation	02 Spring	4			
SYSC 513 Systems Approach	00 Fall		4		
SYSC 514 System Dynamics	01 Winter		4		
EMGT 553 Mfg Systems Simulation	01 Spring		4		
FIN 552 Investments	01 Spring		4		
EMGT 525 Strategic Planning in Eng Mgmt	01 Fall		4		
EMGT 555 Technology Marketing	02 Winter		4		
EMGT 530 Decision Mkg – Eng & Tech Mgmt	02 Winter		4		
SYSE 506 <a href="#">Projects</a>	03 Spring				9
SYSE 590 <a href="#">Integrative Workshop</a>	03 Spring				4
	<b><u>Total</u></b>	<b>16</b>	<b>28</b>		<b>13</b>

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## Electives

The purpose of this section is to record program electives and summarize their role in degree completion and learning objectives. The first paragraph of each summary, in quotation marks, is from the PSU catalog.

### **SYSC 513: Systems Approach (4 credits)**

Professor: Wayne Wakeland

“Provides practitioner-oriented definition of systems, including: importance of observer dependence and context, and ideas of meta-systems, subsystems; notion of value system and associated optimization/sub-optimization; aspects of life-cycle project management; the underlying notions of inquiring systems; and key aspects of learning (human) organizations. Qualitative tools for the system's practitioner, including graphical tools, basic ideas of modeling/simulation and structural modeling. Also, the multiple perspectives aspect of the systems approach.”

The understanding of systems and how they are viewed both internally and externally are of primary importance. This course sets the context of how to develop a new system of thinking in an organization including an understanding of various perspectives and exploring alternatives. I was particularly interested in the concept of 'optimization' and whether this can be achieved in a complex system.

### **SYSC 514: System Dynamics (4 credits)**

Professor: Wayne Wakeland

“Introduces concepts and a methodology for analyzing the behavioral dynamics of systems that consist of complex webs of feedback loops. Primary emphasis is on building computer models of these systems and using these models to enhance understanding, make predictions, and find ways to improve the performance of systems and processes. Models are defined in terms of a set of rate equations that are numerically integrated to simulate behavior over time. The process of applying this methodology to real world situations is discussed in detail.”

I wanted to gain understanding of modeling and how systems interact as well developing possible theories regarding drivers in a complex systems environment. This understanding can aid in developing methods of forecasting in a competitive setting. I was also interested in how to build a simulation model. I found that I have some experience in building models but learned the importance of adding the Monte Carlo aspect to the model. I have always verified my models but the validity check has been based on past experience. The Monte Carlo simulation feature adds a validity check that can be used to check a model for accuracy.

### **EMGT/SYSC 553: Manufacturing System Simulation (4 credits)**

Professor: Wayne Wakeland / Tim Anderson

“Introduction of discrete simulation techniques for the modeling of random processes and probabilistic events in the simulation of manufacturing systems; concepts of systems modeling with emphasis on the use of an animated simulation package throughout the course.”

After having some simulation experience from SYSC 514, this class applied some of the concepts to a manufacturing environment. We used Promodel as our software to build our system. I was not as successful in this class as I had hoped considering the subject matter. However, I am better able to scope a problem for simulation and determine the correct *question* to model. Theories regarding queuing and bottleneck analysis were covered and provided the best insight for costing of products through the system.

### **FIN 552: Investments (4 credits)**

Professor: John Settle

“Analytical study of the principles of investment in stocks, bonds, and other security instruments. Includes background study of financial markets and institutions; analysis of the investment characteristics, valuation, and market price behavior of bonds, stocks, and derivative securities, and the choice of appropriate portfolios of these securities. Also included is the study of information and market efficiency, term structure and the determination of market interest rates, and security valuation.”

This course gave me some insight in how to determine a ROI for a corporation, which is a reflection of a system or an engineering effort. For my project, the discussion of the Dupont formula which equates ROI to the following formula:

$$\text{ROI} = \text{Profit/Assets} \times \text{Assets/Sales} \times \text{Assets/Equity}$$

### **EMGT 525: Strategic Planning in Engineering Management (4 credits)**

Professor: Dragon Milosevic

“Critical issues in shaping the competitive strategy for the engineering-driven companies in a turbulent business environment; key steps and end results of the planning process; corporate mission; Key Result Areas (KRAs) and situational analysis including strengths, weaknesses, opportunities, and threats in KRAs. Identifying planning assumptions, critical issues, setting objectives, formulating strategy. Leadership, organizational culture, and structure to support the implementation of a strategic plan as well as the strategic control systems. Case studies, presentations, term projects, teamwork, and interactive exercises.”

This course was well organized and provided a process (an outline) in developing a strategy. The scope could be wide enough where one could apply this concept to any

situation in life. I believe that this class provided some framework to build my project around.

### **EMGT 555: Technology Marketing (4 credits)**

Professor: Robert Harmon

“This course is designed to introduce students to the special issues faced by managers marketing technological products in markets characterized by rapid environmental change. Topics will include an examination of the marketing/engineering /manufacturing interface, product innovation strategies, value-based pricing, buyer behavior and strategic selling, competitive market analysis and positioning, and distribution strategies. Emphasis is placed on strategies for marketing technology products in industrial markets.”

When pricing is developed, the marketing of the product is a key ingredient. In the high tech markets, the product life cycle are often very short. Therefore, proper pricing in the market place is key to maximizing both profit per unit and maximum market acceptance. In high tech markets, this can mean dominance of a market sector or the loss of a market to a competitor.

### **EMGT 530: Decision Making – Engineering and Tech. Mgmt (4 credits)**

Professor: D. Kocaoglu

“Decision and value theory concepts are applied to technical and management decisions under uncertainty. Multi-criteria decisions are analyzed. Subjective, judgmental values are quantified for expert decisions and conflict resolution in strategic decisions involving technological alternatives. Hierarchical decision modeling approach is introduced. Individual and aggregate decisions are measured. Decision discrepancies and group disagreements are evaluated. Case studies are included in the course.”

The decision making process more often has elements of uncertainty and requires subjective factors. Pricing is no exception. Understanding the risks and possible outcomes are key to making the best decision.

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## Project

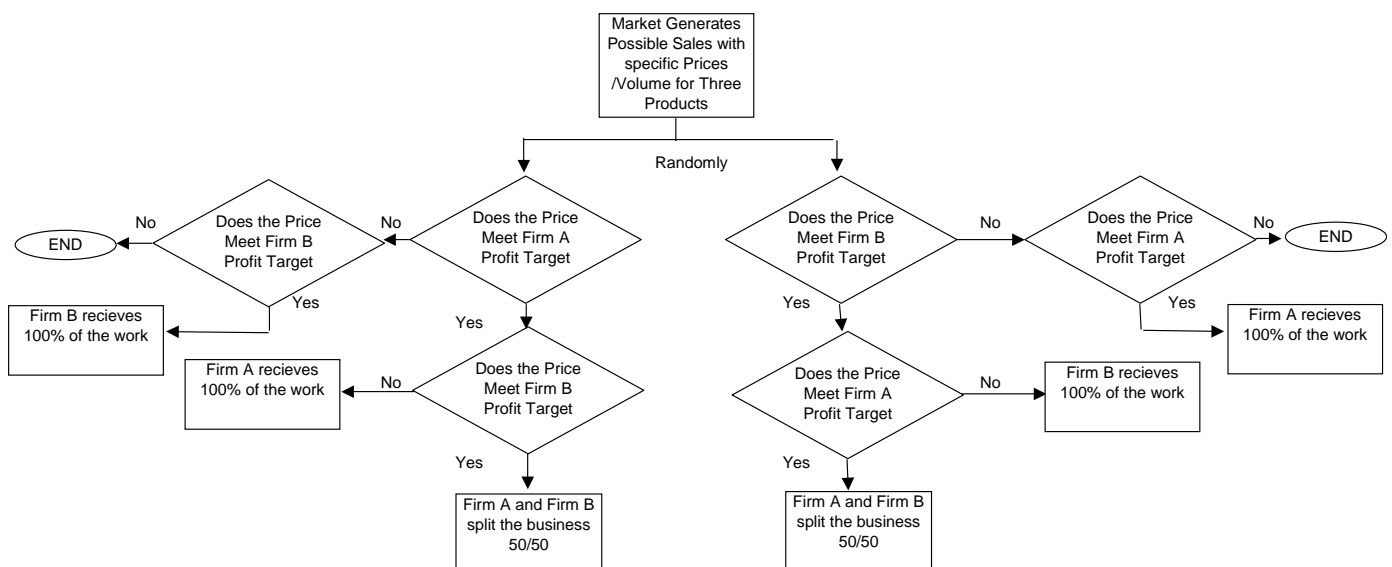
The basis of my project is that standard costing does not provide sales the proper objective to maximize profitability for the firm. While standard costing does provide a good estimate of inventory valuation, it fails to identify the most profitable sales.

My project would be to build a simulation model of two firms operating in the same market. Both firms have a portfolio of three products with varying standard costs and material content. I will assume the market generates needs for these three products on a random basis with specific price and volume numbers. (Assume that the market is a commodity market with no pricing strength from either firm.)

Firm 'A' targets a standard margin target using a cost plus margin methodology. Firm 'B' targets a ROA using a cash flow per minute on the bottleneck tool in the manufacturing process. Since both firms are capital intensive and have similar cost structures, most of the costs are fixed and can be modeled with a simple spreadsheet analysis by adding the sales and volume from the simulation model. The performance will then be modeled with traditional financial analysis.

The connection to Systems Engineering is the development for new products should be measured using cash flow tied to a ROA measure. Many firms currently evaluate new products on a standard costing mechanism, which does not optimize the overall function of the firm to maximize shareholder value.

The underlying assumption is that share price or the market value of a firm is dictated by the ROI provided by the operations of the firm. The one with the higher ROI should be the best investment for shareholders.



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## Project

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## **Annotated Bibliography**

The purpose of this section is to document works

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