



## **An Implementation of Continuous Improvement of The Engineering Management Program at California State University, Northridge**

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## **An Implementation of Continuous Improvement of The Engineering Management Program at University X**

University X has a newly introduced undergraduate program in Engineering Management (EM) which will be going up for ABET accreditation in Fall 2015. In this paper, the authors have discussed the efforts that are being carried out as part of the continuous improvement initiative required for ABET accreditation.

As part of this work, the authors have researched undergraduate EM programs across the country and then have identified patterns which can be used as one of the guiding factors to decide on potential course offerings that the program at university X could have. These will be used for benchmarking purposes and will help carry out future research in order to continue working on program improvements. This paper is thus, a first step in a series of initiatives that will be carried out at university X as part of our continuous improvement efforts for the newly introduced undergraduate EM program.

The results of this first step in continuous improvement will be presented in this paper and the later steps will continue to be published as a series of papers in both local as well as future annual ASEE conferences.

### Introduction

More than two-thirds of all engineering professionals invest a significant portion of their career in managing and administering a wide range of technical engineering and research projects and budgets (CSUN 2012). As the engineering profession evolves, an increasing need has emerged for entry-level engineering professionals who have both a broad engineering background and the knowledge and ability to interface between the business and technical functions of organizations. It was to meet this demand that university X, introduced an EM program at the undergraduate level effective Fall 2009.

Undergraduate engineering management majors learn engineering fundamentals, together with the art and science of planning, organizing, allocating resources, and directing and controlling activities in technological environments. The Bachelor of Science in Engineering Management equips entry-level engineers with knowledge of the business of engineering, making them valuable to their employers and ensuring future professional growth. For students who enjoy people and technology, the technical challenges of engineering, and the opportunity to integrate higher-level organizational considerations into technological decision-making processes, engineering management is an ideal program of study (CSUN 2014), (Becker, 2007).

The undergraduate engineering management degree program includes studies in basic mathematics and sciences, the engineering sciences, engineering management disciplinary

studies, and technical electives, as well as general education. The selection of technical electives can be tailored to particular areas of student interest. The team project experiences in many courses approximate the professional environment that graduates will encounter in their future careers. Program culminating experiences include community service learning course projects and capstone course design projects. Students have access to the well-equipped laboratories, including computing laboratories with discipline-specific software that are essential to achievement of program objectives. (CSUN, 2014)

This was further emphasized by Sorto (2008) when he stated that increasing competition in the marketplace as well as the need for improved productivity had put more of an emphasis on a more effective management of technical functions of a company. Moreover, in search of better flexibility and efficiency, many companies have reduced the numbers and levels of management positions and instead are giving more decision making power to the teams at the operational levels. In high tech companies, this often results in engineers taking more decisions; thus increasing the demand for engineering management courses so as to enable engineers to take better decisions to bring increased value to their organizations.

One of the reasons that the authors of this paper were inspired to do this research as part of their continuous improvement efforts is that despite EM having established itself as a strong discipline with educational degrees, academic journals and professional societies, there is still no firm agreement relatively to the body of knowledge required to establish an engineering management curriculum. A large amount of variation exists among the various EM curriculums (Sorto, 2008). Furthermore, some engineering management curricula are not designed to help students to learn how to make effective decisions and deal with problem solving in highly ambiguous and uncertain contexts (Sorto, 2008). This will also be taken into consideration by the authors when considering changes to the undergraduate EM program at University X.

The undergraduate EM programs that the authors researched were picked from the American Society of Engineering Management (ASEM) website listing of EM programs at the undergraduate level (ASEM, 2013). The schools selected in the first iteration of the online research were:

1. Augustana College
2. Bucknell University
3. Clarkson University
4. The College of New Jersey
5. Columbia University
6. George Washington University
7. Stanford University
8. Miami University
9. Missouri Tech

10. Missouri University of Science & Technology
11. Northwestern University
12. Rensselaer Polytechnic
13. Saint Mary's University
14. Stevens Institute of Technology
15. University of Portland
16. University of Vermont
17. University of South Carolina Upstate
18. University of Alabama
19. University of Arizona
20. University of The Pacific
21. United States Military Academy
22. Western Michigan University
23. Wilkes University
24. York College

On doing a further in-depth study of the EM programs at the 24 schools listed above, the authors realized that despite some of the programs being listed on ASEM's website (as of Dec 2013) as Engineering Management Programs, they were closer to Industrial Engineering.

Despite there being similarities between IE and EM programs to a certain extent, there are differences between the two, which are highlighted in Table 1. The curriculum summary for the two programs has been adopted from Elrod et al (2007) and is modified as shown in Table 1.

<b>B.S. in Engineering Management</b>	<b>B.S. in Industrial Engineering</b>
Economics	Economics
Probability & Statistics	Probability & Statistics
Senior Design	Senior Design
Total Quality Management	Statistical Process Control
Operations & Production Management	Production Planning & Inventory Control
Marketing	Systems Analysis
Accounting	Operations Research
Project Management	Automation, Simulation & Modelling
General Management & Leadership	Ergonomics, Human Factors, Work Design
	Facilities Design and Plant Layout

Table 1: Curriculum summary (Adopted from Elrod et al (2007))

However, upon seeing the overlap in curriculum and importance of an engineering manager understanding systems engineering, the authors have considered the EM programs, including those with a focus on systems engineering. Due to this, several of the schools studied by the authors, including Stevens Institute of Technology, University of Arizona and Missouri University of Science and Technology, have programs in engineering management and systems engineering.

Considering the above mentioned factors, during the 2<sup>nd</sup> iteration of finalizing the schools to come up with a benchmark for our undergraduate program, the authors narrowed down the schools to the following, listed in Table 2

<b>Names of Schools Considered for 2<sup>nd</sup> Iteration of Research</b>
Clarkson University
George Washington University
Missouri University of science and technology
Missouri Tech
Rensselaer Polytechnic
Saint Mary's University
Stevens Institute of Technology
University of Arizona
University of Pacific
United States Military Academy
Western Michigan University
York College of Pennsylvania

Table 2: List of Undergraduate EM Programs Evaluated for Continuous Improvement of the program at University X

Table 3 names the program and shows the list of the relevant courses for each school chosen

University	Program	Courses
Clarkson University	Engineering and Management	EM 120 Team-based Design & Innovation
		EM 121 Technological Entrepreneurship
		EM 331 Operations & Supply Chain Management
		EM 333 Operations Research
		EM 351 Quality Management & Lean Enterprise
		EM 480 Project Management
		EM 456 Senior Design
		EM 205 Accounting
		EM 211 Enterprise Info. Systems
		EM 286 Org. Behavior I
		EM 432 Org. Policy & Strategy
		EM 310 Prof. Experience

Missouri University of science and technology	Engineering Management	ENG MGT 101 Special Topics
		ENG MGT 124 Practical Concepts for Technical Managers
		ENG MGT 134 Managing Engineering And Technology
		ENG MGT 137 Economic Analysis of Engineering Projects
		ENG MGT 147 Engineering Accounting and Finance
		ENG MGT 201 Special Topics
		ENG MGT 202 Cooperative Engineering Training
		ENG MGT 213 Introduction to Complex System Management
		ENG MGT 224 Competition Team Design
		ENG MGT 233 Competition Team Leadership
		ENG MGT 242 Competition Team Communication
		ENG MGT 251 Marketing Management
		ENG MGT 253 Operations And Production Management
		ENG MGT 254 Introduction to Project Management
		ENG MGT 257 Materials Handling And Plant Layout
		ENG MGT 260 General Management-Design And Integration
		ENG MGT 266 Quality
		ENG MGT 299 Engineering Management Senior Design
		ENG MGT 300 Special Problems
		ENG MGT 301 Special Topics
		ENG MGT 308 Economic Decision Analysis
		ENG MGT 309 Six Sigma
		ENG MGT 311 Human Factors
		ENG MGT 313 Managerial Decision Making
		ENG MGT 314 Management for Engineers and Scientists
		ENG MGT 320 Technical Entrepreneurship
		ENG MGT 327 Legal Environment
		ENG MGT 344 Interdisciplinary Problems In Manufacturing Automation
		ENG MGT 345 Energy and Sustainability Management Engineering
		ENG MGT 350 Risk Assessment and Reduction
		ENG MGT 351 Industrial Marketing Systems Analysis
		ENG MGT 354 Integrated Product And Process Design
		ENG MGT 356 Industrial System Simulation
		ENG MGT 357 Advanced Facilities Planning & Design
		ENG MGT 358 Integrated Product Development
		ENG MGT 361 Project Management
		ENG MGT 364 Value Analysis
		ENG MGT 365 Operations Management Science
ENG MGT 366 Supply Chain Management Systems		
ENG MGT 369 Patent Law		
ENG MGT 370 Teaching Engineering		
ENG MGT 372 Production Planning And Scheduling		
ENG MGT 373 Intelligent Investing		
ENG MGT 374 Engineering Design Optimization		
ENG MGT 375 Total Quality Management		
ENG MGT 376 Introduction To Quality Engineering		
ENG MGT 377 Introduction To Intelligent Systems		
ENG MGT 381 Management And Methods In Reliability		
ENG MGT 382 Introduction To Operations Research		
ENG MGT 383 Packaging Management		
ENG MGT 385 Statistical Process Control		
ENG MGT 386 Safety Engineering Management		
ENG MGT 390 Undergraduate Research		

George Washington Univ	ENGINEERING MANAGEMENT AND SYSTEMS ENGINEERING	Fundamentals of Systems Engineering Operations Research Methods Systems Thinking and Policy Modeling I Discrete Systems Simulation Requirements Analysis and Elicitation Quantitative Models in Systems Engineering Critical Infrastructure Systems Systems Engineering Senior Project Survey of Finance and Engineering Economics Applied Optimization Modeling Quality Control and Acceptance Sampling Data Analysis for Engineers and Scientists
Missouri Tech	Engineering Management	Accounting Marketing I Management Styles Marketing II Project Management Human Resource Management
Rensselaer Polytechnic	Industrial and Management Engineering	ENGR 1010 - Professional Development I ENGR 1100 - Introduction to Engineering Analysis ENGR 1200 - Engineering Graphics and CAD ENGR 1300 - Engineering Processes ENGR 1400 - Engineering Communications ENGR 1600 - Materials Science for Engineers ENGR 2020 - Product Design and Innovation Design Studio II ENGR 2050 - Introduction to Engineering Design ENGR 2090 - Engineering Dynamics ENGR 2250 - Thermal and Fluids Engineering I ENGR 2300 - Electronic Instrumentation ENGR 2350 - Embedded Control ENGR 2530 - Strength of Materials ENGR 2600 - Modeling and Analysis of Uncertainty ENGR 2710 - General Manufacturing Processes ENGR 2720 - Computer Aided Machining ENGR 2940 - Engineering Project ENGR 2960 - Topics in Engineering ENGR 4010 - Professional Development III ENGR 4100 - Business Issues for Engineers and Scientists ENGR 4700 - Introduction to Manufacturing Planning ENGR 4710 - Manufacturing Processes and Systems Laboratory I ENGR 4720 - Manufacturing Processes and Systems Laboratory II ENGR 4750 - Engineering Economics and Project Management ENGR 4760 - Engineering Economics
Saint Mary's Univ	Engineering Management	EG 2322-Work Design & Product Measure EG 2325-Industrial Automation & Control EG 2341-Fundamentals of Logic Design EG 3322-Industrial Statistics EG 3333-Lean Production Systems EG 3334-Engineering Economy EG 3336-Applied Optimi. & Analysis EG 3337-Supply Chain Management EG 4330-Quality Control & Reliability

Stevens Institute of Technology	Engineering Management	Management of Engineering and Technology
		Project Management
		Accounting & Business Analysis
		Engineering Design VI
		Modeling and Simulation
		Production and Operations Management
		Analysis of Networks and Strategies
		Engineering Economics
		Elements of Operations Research
		Total Quality Management
		Statistics For Engineers Laboratory
		Statistics for Engineering Managers
		Innovative System Design
		Engineering Design VII
		Engineering Design VIII
		Business Process Reengineering
		Logistics and Supply Chain Management
Analysis of Networks & Strategies		
Total Quality Management		
University of Arizona	Engineering Management	SIE 265 Engineering Management I
		SIE 295S Systems & Industrial Engineering Sophomore Colloquium
		SIE 270 Mathematical Foundations of Systems and Industrial Engineering
		SIE 305 Introductions to Engineering Probability and Statistics
		SIE 340 Deterministic Operations Research
		SIE 367 Engineering Management II
		SIE 457 Project Management
		SIE 431 Simulation Modeling and Analysis
		SIE 415 Technical Sales and Marketing
		SIE 462 Production Systems Analysis
		ENGR 498A or SIE 498A Senior Design Projects I
		ENGR 498B or SIE 498B Senior Design Projects II
		SIE 414 Law for Engineers and Scientists
		SIE 406 Quality Engineering
SIE 464 Cost Estimation		
University of Pacific	Engineering Management	EMGT 155. Computer Simulation
		EMGT 170. Engineering Administration
		EMGT 172. Engineering Economy
		EMGT 174. Engineering Project Management
		EMGT 176. Systems Engineering Management
		EMGT 191. Independent Study
		EMGT 195. Engineering Management Synthesis
		EMGT 197. Undergraduate Research
United States Military Academy	Engineering Management	EM381 ENGINEERING ECONOMY
		EM384 ANYL METH FOR ENGR MANAGEMENT
		EM402 ENGINEERING MANAGEMENT DSN I
		EM403 ENGINEERING MANAGEMENT DSN II
		EM411 PROJECT MANAGEMENT
		EM420 PRODUCTION OPERATIONS MGMT
		EM481 SYSTEMS SIMULATION
		EM482 SUPPLY CHAIN ENG & INFO MGMT
		MG382 HUMAN RESOURCE MANAGEMENT



Western Michigan Univ	Engineering Management Technology	IME 1020 Technical Communication
		IME 1420 Engineering Graphics
		IME 1500 Introduction to Manufacturing
		IME 2610 Engineering Statistics
		IME 2460 Introduction to Computer-Aided Design
		IME 2001 Applied Electricity/Electronics
		IME 2810 Statics and Strength of Materials
		IME 3020 Engineering Teams: Theory and Practice
		IME 3050 Work Analysis
		IME 3150 Work Analysis and Design Lab
		IME 3160 Report Preparation
		IME 3200 Engineering Cost Analysis
		IME 3120 Systems Decision Making
		IME 3260 Operations Planning and Control
		IME 3280 Quality Assurance and Control
		IME 4020 Supervision of Industrial Operations
		IME 4120 Industrial Systems Management
IME 4910 Multidisciplinary Senior Proposal		
IME 4040 Plant Layout and Material Handling		
IME 4920 Multidisciplinary Senior Project		
IME 4930 Multidisciplinary Senior Project Consultation		
York College of Pennsylvania	Engineering & Management	SCM 320 Lean Systems
		SCM 325 Business Process Management and Control
		SCM 495 Continuous Improvement Consulting
		IFS 435 Project Management

### Similarities Identified in EM Program offerings

Based on Table 3, the authors have identified the following similarities in the EM programs at the undergraduate level. Starting off with the fundamental engineering mathematics, it is safe to say that the majority of the programs include Engineering Statistics as one of their primary courses and later on more advanced courses such as Discrete System Simulation and Modeling are introduced. Ensuing courses such as Engineering Economy, Finance and Cost Estimation are offered by the majority of the EM programs considered by the authors. Moving on to more advanced courses, such as Operations Research, Production Management and Operation Planning, Control and Scheduling are provided by almost all the programs. However, despite having similar titles for the courses, the course content did vary from school to school. Supply Chain Management was rarely covered and mostly included as a module under operation research courses. Unlike Supply Chain Management, Total Quality Management and related topics such as: Lean Engineering and Six-Sigma however have attracted a great deal of attention and are well established among EM programs. Systems Engineering, Manufacturing Design (CAD) and Sustainability courses are the gaps identified by the authors in the EM programs. The Systems Engineering and CAD courses are offered by only four programs under different titles. On reviewing the program websites, there has been no offering of sustainability related courses. Lastly, project management is offered by a considerable number of the programs. Table 4 shows the EM programs along with the list of offered courses. In order to better identify the similarities

between the programs, all the similar courses have been highlighted in different colors. The authors have divided the courses into nine major categories, based on the material covered in each course. Furthermore, some courses are merged together in one category depending on the similarity between their contents.

Table 4: Schematic of classification of Topics and listing of courses in EM Programs

	Design courses
	Supply Chain related courses
	Operation Research courses and its subcategories
	Quality Management courses and its subcategory
	Project Management courses
	Economics, Finance and Accounting courses
	Systems Engineering related courses
	Statistics, simulation and modeling courses
	Marketing courses

University	Program	Courses
Clarkson University	Engineering and Management	EM 120 Team-based Design & Innovation
		EM 121 Technological Entrepreneurship
		EM 331 Operations & Supply Chain Management
		EM 333 Operations Research
		EM 351 Quality Management & Lean Enterprise
		EM 480 Project Management
		EM 456 Senior Design
		EM 205 Accounting
		EM 211 Enterprise Info. Systems
		EM 286 Org. Behavior I
		EM 432 Org. Policy & Strategy
		EM 310 Prof. Experience
		ISYS 3010 - Principles and Methods of Industrial and Systems Engineering
		ISYS 3060 - Systems Optimization

George Washington Univ	ENGINEERING MANAGEMENT AND SYSTEMS ENGINEERING	Fundamentals of Systems Engineering Operations Research Methods Systems Thinking and Policy Modeling I Discrete Systems Simulation Requirements Analysis and Elicitation Quantitative Models in Systems Engineering Critical Infrastructure Systems Systems Engineering Senior Project Survey of Finance and Engineering Economics Applied Optimization Modeling Quality Control and Acceptance Sampling Data Analysis for Engineers and Scientists
Missouri Tech	Engineering Management	Accounting Marketing I Management Styles Marketing II Project Management Human Resource Management
Rensselaer Polytechnic	Industrial and Management Engineering	ENGR 1010 - Professional Development I ENGR 1100 - Introduction to Engineering Analysis ENGR 1200 - Engineering Graphics and CAD ENGR 1300 - Engineering Processes ENGR 1400 - Engineering Communications ENGR 1600 - Materials Science for Engineers ENGR 2020 - Product Design and Innovation Design Studio II ENGR 2050 - Introduction to Engineering Design ENGR 2090 - Engineering Dynamics ENGR 2250 - Thermal and Fluids Engineering I ENGR 2300 - Electronic Instrumentation ENGR 2350 - Embedded Control ENGR 2530 - Strength of Materials ENGR 2600 - Modeling and Analysis of Uncertainty ENGR 2710 - General Manufacturing Processes ENGR 2720 - Computer Aided Machining ENGR 2940 - Engineering Project ENGR 2960 - Topics in Engineering ENGR 4010 - Professional Development III ENGR 4100 - Business Issues for Engineers and Scientists ENGR 4700 - Introduction to Manufacturing Planning ENGR 4710 - Manufacturing Processes and Systems Laboratory I ENGR 4720 - Manufacturing Processes and Systems Laboratory II ENGR 4750 - Engineering Economics and Project Management ENGR 4760 - Engineering Economics
Saint Mary's Univ	Engineering Management	EG 2322-Work Design & Product Measure EG 2325-Industrial Automation & Control EG 2341-Fundamentals of Logic Design EG 3322-Industrial Statistics EG 3333-Lean Production Systems EG 3334-Engineering Economy EG 3336-Applied Optimi. & Analysis EG 3337-Supply Chain Management EG 4330-Quality Control & Reliability

Missouri University of science and technology	Engineering Management	ENG MGT 101 Special Topics
		ENG MGT 124 Practical Concepts for Technical Managers
		ENG MGT 134 Managing Engineering And Technology
		ENG MGT 137 Economic Analysis of Engineering Projects
		ENG MGT 147 Engineering Accounting and Finance
		ENG MGT 201 Special Topics
		ENG MGT 202 Cooperative Engineering Training
		ENG MGT 213 Introduction to Complex System Management
		ENG MGT 224 Competition Team Design
		ENG MGT 233 Competition Team Leadership
		ENG MGT 242 Competition Team Communication
		ENG MGT 251 Marketing Management
		ENG MGT 253 Operations And Production Management
		ENG MGT 254 Introduction to Project Management
		ENG MGT 257 Materials Handling And Plant Layout
		ENG MGT 260 General Management-Design And Integration
		ENG MGT 266 Quality
		ENG MGT 299 Engineering Management Senior Design
		ENG MGT 300 Special Problems
		ENG MGT 301 Special Topics
		ENG MGT 308 Economic Decision Analysis
		ENG MGT 309 Six Sigma
		ENG MGT 311 Human Factors
		ENG MGT 313 Managerial Decision Making
		ENG MGT 314 Management for Engineers and Scientists
		ENG MGT 320 Technical Entrepreneurship
		ENG MGT 327 Legal Environment
		ENG MGT 344 Interdisciplinary Problems In Manufacturing Automation
		ENG MGT 345 Energy and Sustainability Management Engineering
		ENG MGT 350 Risk Assessment and Reduction
		ENG MGT 351 Industrial Marketing Systems Analysis
		ENG MGT 354 Integrated Product And Process Design
		ENG MGT 356 Industrial System Simulation
		ENG MGT 357 Advanced Facilities Planning & Design
		ENG MGT 358 Integrated Product Development
		ENG MGT 361 Project Management
		ENG MGT 364 Value Analysis
		ENG MGT 365 Operations Management Science
		ENG MGT 366 Supply Chain Management Systems
		ENG MGT 369 Patent Law
ENG MGT 370 Teaching Engineering		
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ENG MGT 381 Management And Methods In Reliability		
ENG MGT 382 Introduction To Operations Research		
ENG MGT 383 Packaging Management		
ENG MGT 385 Statistical Process Control		
ENG MGT 386 Safety Engineering Management		
ENG MGT 390 Undergraduate Research		

Stevens Institute of Technology	Engineering Management	Management of Engineering and Technology Project Management Accounting & Business Analysis Engineering Design VI Modeling and Simulation Production and Operations Management Analysis of Networks and Strategies Engineering Economics Elements of Operations Research Total Quality Management Statistics For Engineers Laboratory Statistics for Engineering Managers Innovative System Design Engineering Design VII Engineering Design VIII Business Process Reengineering Logistics and Supply Chain Management Analysis of Networks & Strategies Total Quality Management
University of Arizona	Engineering Management	SIE 265 Engineering Management I SIE 295S Systems & Industrial Engineering Sophomore Colloquium SIE 270 Mathematical Foundations of Systems and Industrial Engineering SIE 305 Introductions to Engineering Probability and Statistics SIE 340 Deterministic Operations Research SIE 367 Engineering Management II SIE 457 Project Management SIE 431 Simulation Modeling and Analysis SIE 415 Technical Sales and Marketing SIE 462 Production Systems Analysis ENGR 498A or SIE 498A Senior Design Projects I ENGR 498B or SIE 498B Senior Design Projects II SIE 414 Law for Engineers and Scientists SIE 406 Quality Engineering SIE 464 Cost Estimation
University of Pacific	Engineering Management	EMGT 155. Computer Simulation EMGT 170. Engineering Administration EMGT 172. Engineering Economy EMGT 174. Engineering Project Management EMGT 176. Systems Engineering Management EMGT 191. Independent Study EMGT 195. Engineering Management Synthesis EMGT 197. Undergraduate Research
United States Military Academy	Engineering Management	EM381 ENGINEERING ECONOMY EM384 ANYL METH FOR ENGR MANAGEMENT EM402 ENGINEERING MANAGEMENT DSN I EM403 ENGINEERING MANAGEMENT DSN II EM411 PROJECT MANAGEMENT EM420 PRODUCTION OPERATIONS MGMT EM481 SYSTEMS SIMULATION EM482 SUPPLY CHAIN ENG & INFO MGMT MG382 HUMAN RESOURCE MANAGEMENT

Western Michigan Univ	Engineering Management Technology	IME 1020 Technical Communication IME 1420 Engineering Graphics IME 1500 Introduction to Manufacturing IME 2610 Engineering Statistics IME 2460 Introduction to Computer-Aided Design IME 2001 Applied Electricity/Electronics IME 2810 Statics and Strength of Materials IME 3020 Engineering Teams: Theory and Practice IME 3050 Work Analysis IME 3150 Work Analysis and Design Lab IME 3160 Report Preparation IME 3200 Engineering Cost Analysis IME 3120 Systems Decision Making IME 3260 Operations Planning and Control IME 3280 Quality Assurance and Control IME 4020 Supervision of Industrial Operations IME 4120 Industrial Systems Management IME 4910 Multidisciplinary Senior Proposal IME 4040 Plant Layout and Material Handling IME 4920 Multidisciplinary Senior Project IME 4930 Multidisciplinary Senior Project Consultation
York College of Pennsylvania	Engineering Management	SCM 320 Lean Systems SCM 325 Business Process Management and Control SCM 495 Continuous Improvement Consulting IFS 435 Project Management

Recommendations to improve the broader range of undergraduate EM divisions:

After having discussions with a number of industry professionals and based on the categories of courses identified in Table 4, the authors would recommend the following changes to be made to the undergraduate EM programs:

Concordant to the increasing market's needs for well-rounded engineers with technical backgrounds it is strongly recommended to re-structure EM programs in a way to educate students in technical aspects of engineering first and later introduce supplemental managerial courses to establish an exceptional program for entry-level students seeking job opportunities in the market. Furthermore, it's imperative to include fundamental design courses in order to make EM programs well-balanced and prepare students for manufacturing and engineering management jobs.

In today's business environment, it's nearly impossible to run a business without having the knowledge of at least one computer programming language. Therefore it is strongly recommended to at least offer some basic computer programming courses as a part of the electives offered in EM programs.. Additionally, due to the vital role of Supply Chain Management in the success of any business, it is recommended to engage students with more supply chain related courses during their undergraduate studies and provide them with more

practical opportunities enabling them to apply their academic knowledge in a real world environment. In line with the last point it is encouraged to involve students in more practical projects preferably as a group in which the real time projects are well simulated to establish a unique opportunity for the students to deal with day to day challenges of a real project. Bringing in guest speakers from industry to exemplify concepts taught in class could also enhance the students' understanding of the subjects as well as serve as a networking opportunity for students. Lastly, entrepreneurship and innovation is one of the major drivers in today's economy and thus has received a great deal of attention from engineering programs across the country. Providing students with such courses as Engineering Innovation Management will allow them to explore new possibilities and bring added value to the organizations they work at.

### Future Research

Based on the recommendations made, before implementing them, the authors will be creating surveys to evaluate their recommendations and prioritize course offerings in the undergraduate program. These surveys will be sent out to both students as well as industry professionals and employers, since they are all stakeholders in this process.

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