

Creating a Differentiated, Relevant, and Accessible Engineering Management Program

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Abstract

This paper summarizes the step-by-step approach adopted in developing a unique, relevant and accessible master's program in engineering management based on a modular concept with specializations in project and program management, security and safety management, industrial engineering management, and supply chain and e-Logistics. The interactions among practitioners and academicians leading to the development of both 'in classroom' and internet-based 'online' delivery formats are highlighted.

Introduction

Engineering Management leadership has become a highly sought out skill in today's competitive global technological marketplace. It is now a well recognized profession in most industries. Almost half of all engineers enter a management position within 10 years of graduation. In addition, an average engineer changes careers about five times as a result of being trained on different skills and areas of specialty during her/his professional life time [1]. Half of all registered professional engineers primarily utilize management skills rather than purely technical skills [2]. From small companies to giant global institutions, engineering managers are fueling much of the successful development of exciting technical enterprises. Talented and knowledgeable engineering managers command the best assignments, salaries, other compensation and bonuses. They are leaders and entrepreneurs. To cater to such an environment, an effective engineering management program must emphasize important technical-based core management competencies as well as knowledge and capability in specialized functions. These unique requirements call for practitioners' input and review in the increasingly complicated managerial environment of today's competitive global and technical world.

This paper highlights the processes adopted in creating a unique, relevant and accessible master's program in engineering management. Input from experienced engineering management practitioners from public and private companies and organizations were incorporated, without diluting the academic relevance and quality as maintained by academics involved in the curriculum development. The paper also summarizes the step-by-step approach adopted in developing a program based on a modular concept with specializations in project and program management, security and safety management, industrial engineering management, and supply chain and e-Logistics. The interactions among practitioners and academicians leading to the development of both 'in classroom' and internet-based 'online' delivery formats are highlighted, and the methodologies developed for facilitating the

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effectiveness of online delivery, and the benefits and challenges of delivery format, are also described.

Description of National University and Its Student Body

Founded in 1971, National University (NU) is an independent, nonprofit institution of higher education. Since its establishment, the university has dedicated itself to providing educational opportunities to a diverse population of working, adult learners. With more than 17,000 full-time students, National University is the second largest private, non-profit California institution of higher education, with a 32-year history of educating traditionally underserved populations. National University is ranked 7th nationally and 2nd in California for awarding degrees to ethnic minority populations. Thirty-four percent of NU's students are from minority populations and fifty-eight percent are female. NU is ranked sixteenth out of 3,000 institutions nationwide in awarding graduate degrees to minority students. NU also received the California Council on Excellence (CCE) Eureka Award for Performance Excellence in 2002 and in 2003. NU's central purpose is to promote continuous learning by offering diverse instructional approaches, encouraging scholarship, engaging in collaborative community service, and empowering its constituents to become responsible citizens in an interdependent, pluralistic, global community. NU students earn their degrees in a unique one-class-per-month format, and attend classes at night so they can continue to move forward in the workplace. Programs in this format can be completed faster than at a traditional university, albeit in an intense fashion. Each graduate course has 40.5 hours of class room contact. Students are allowed to take only one course at a time.

Initially, the introduction of an Engineering Management program was planned for a class room environment offering. Later, developers were asked to explore ways to expand options, particularly for those students who do not have the option of taking classes offered through traditional class rooms. This need to provide program accessibility for adults located in geographically dispersed areas, and also potentially working during the day, led to the conclusion that a web-based online format would be equally valuable to a traditional 'on site' or 'on ground' offering. Online formats have the capability to conveniently accommodate many such working adults. A lot has changed since the introduction of online graduate programs with the advent of Internet technology. According to a Sloan Consortium report [3], more than 1.6 million people logged on to at least one online class in the fall of 2002. That number is expected to increase by almost 20 percent for the next few years. In addition, when Vault [4], a job-search service and publisher, surveyed almost 300 hiring managers in 2000, 77 percent of respondents said online degrees earned from accredited schools were valuable and effective in the work area. In addition, the survey identified that 80-90 % of employers are reimbursing students for their tuition if the distance learning program is an effective and approved one. Hence, both online and on ground formats for a master's degree program in Engineering Management would be viewed as being equally effective in providing invaluable and effective education. Additionally, such complementary formats would be able to reach significantly higher numbers of students in communities throughout the U.S. than would a program offered traditionally only through brick and mortar schools.

National University's Master's Degree in Engineering Management

National University's Master of Engineering Management Degree (M.S.) Program is designed to bring the benefits of modern technology and high quality graduate-level instruction to engineers/scientists/technologists who may be interested in furthering their skills in engineering management with concentration or specialization in any of the following:

- Project Management
- Security and Safety
- Industrial Engineering
- Supply Chain Management and eLogistics

General descriptive information for each of these areas of specialization is included under individual headings as follows.

Project Management

From small companies to giant global institutions, project managers are fueling much of the successful development of exciting business enterprises. Talented and knowledgeable project managers demand the best assignments, salaries, other compensation and bonuses. They are the future leaders and entrepreneurs. Good project managers are not born but are nurtured from a combination of experience, time, talent, and training [5]. Successful projects don't happen spontaneously; they require preparation, planning, and organization. This program is designed to provide systematic training to those who would like to pursue an engineering project management career and to those who wish to be well positioned to pass the Project Management Professional certification exam administered by the Project Management Institute.

Security and Safety

The 9/11 events and increased business transactions through the Internet have highlighted the national and international need for highly educated and experienced professionals in the area of security and safety engineering. Security and safety engineering is about assessment and building systems to remain dependable in the face of malice, error, or mischance. As a discipline, it focuses on the tools, processes, and methods needed to design, implement and test complete systems, and to adapt existing systems as their environment evolves. This academic program combines the engineering management area with the field of security and safety. This curriculum identifies the common fundamentals and practices that define the theory and effective practice of asset and people protection, and it communicates these principles through a sound academic forum. The highlights of the program include problem identification, assessment, risk reduction and control engineering. Graduates are academically prepared to appear for both the Certified Safety Professional (CSP) certification administered by the American Society of Safety Engineers and the Certified Protection Professional (CPP) certification administered by the American Society of Industrial Security.

Industrial Engineering:

More sophisticated and demanding consumers, along with an emerging global economy, are causing organizations of all types to improve quality and productivity. To meet

these goals, more and more organizations are in need of industrial engineers (IE's) with problem-solving expertise. Industrial engineers design the systems that organizations use to produce goods and services. In addition to working in manufacturing industries, IEs are vital links to quality and productivity in places such as medical centers, communication companies, food service organizations, education systems, government, transportation companies, banks, urban planning departments and an array of consulting firms. IE's educate and direct these groups in the implementation of Total Quality Management (TQM) principles. Especially "hot areas" include manufacturing, health care, occupational safety, and environmental management.

Supply Chain Management and eLogistics:

From small companies to giant global institutions, the concept of integration within business and between businesses has gained increased validity. There has been a growing recognition that supply chain management and eLogistics can help achieve the twin goals of cost reduction and service enhancement. Supply Chain Management and eLogistics have in turn been impacted and driven by e-business strategies and technologies. This program is designed to provide comprehensive academic training on supply chain management and eLogistics.

Curriculum Design

Curricula structured around traditional disciplines – such as mechanical engineering, or others – cannot by itself provide a complete learning base demanded by specialized fields such as the above. This is because traditional disciplines can not provide both the transdisciplinarity, and the enhanced integration of basic fundamentals along with application concepts necessary for such programs. The appropriate mix of transdisciplinary content can be assured by bringing together viewpoints from experienced academics and also from expert practitioners from outside academia. Contributors to development of this program include individuals with the following credentials and experience:

- Vice President of a large engineering contractor dealing with over \$200 million annual projects and 150 people
- Supervisor of a local law enforcement agency dealing with security issues
- Certified Safety Consultant with a consulting firm
- Security personnel from the Navy
- Academics from three different institutions

In this curricula design, fundamental courses are used to ensure a solid understanding of basic principles and concepts, while corresponding application courses are drawn to reinforce the fundamentals and provide for exposure and experience in using the fundamentals needed to address issues and problems. It is important to recognize that the nature of this program attracts students interested in becoming scholar-practitioners working in the field of specialization. This requires an approach to education that is learner-centered, participative, experiential, case/problem-focused, and team-based. As long as these criteria are met, the goal of this program to educate professionals with the capacity to transform theory into practice in collaborative and empowering ways can be achieved.

The curriculum is divided into three modules: core module, specialization module, and electives module. Courses included under each module are listed below.

The core module consists of six courses that ensure a thorough grounding in the fundamental basics of engineering management. These courses are mandatory courses that are required in every field of specialization for today's engineers. (A two course sequence for Masters Project is included in this core module.) The students then move to in-depth study of their chosen area of specialization. This concentration module consists of four courses in the area of specialization. Then the students move to the electives module in which they are required to select two courses of their choice from a list of six. This modular structure produces a flexible curriculum design where adding or dropping a particular specialty can be done at any time in response to changing needs in the marketplace. Also, the list of elective courses can be constantly modified based on the need of current practitioners.

Many of our students are already working in their desired industry. These experienced students have a high degree of self, and other, awareness. This modular curriculum design, allows them to select an area of specialization in addition to two elective courses, challenges them to reflect on their own qualities and competencies in relation to the educational experience, and enables them to move toward greater personal and professional development in their chosen area in the competitive global marketplace. This curriculum can also increase the students' capacities as reflective practitioners. Students, who are highly aware of their roles in their professions, would be able to assess and improve their effectiveness through this approach.

The pedagogical approach followed in this program engages students as active participants in their own learning, in interaction with others, in response to real world problems, and in ways that parallel the process of fieldwork. Students learn how to gain knowledge in an environment consisting of individuals who are supportive and yet different. Faculty members seek input from students with varying viewpoints or backgrounds so as to challenge them to articulate and re-consider their perspectives on issues. The curriculum follows a team-based, problem-focused approach, so that the students experience working in a diverse, small group environment that brings a variety of views and expertise to bear on real world situations, similar to those that they will face in practice. Methods of instruction follow the participative, interactive, and experiential approach. Case study analyses, both individual and team-based, are utilized extensively to apply concepts and strategies to real world situations. Structured exercises in skill training, role-plays, and simulations are also applied in translating theory into practice in a non- threatening manner. A variety of media is used in the teaching aspects of the program to bring reality and freshness to presentations. Examples include case study analysis, video presentations from institutes such as Project Management Institute, American Association of Safety Engineers, ASIS International, and Institute for Supply Chain Management, and special guest lectures by experts on select topics, and field visits. The use of the Internet, in addition to traditional sources, is integrated into students' activities for the gathering and assessing of information. Also, NU's model incorporates adjunct faculty along with full time faculty into every program, so the students have direct contact in several courses to talented professionals employed full time in the field of study. This exposes students to more "real world" types of issues, plus enables them to broaden their

networks of professional contacts. Throughout the academic process, students are asked to maintain individual learning journals to capture and reflect on their experiences and identify all learning relevant to their field of interests.

Degree Requirements

To receive a Master of Science in Engineering Management, students must complete 54 quarter units involving twelve courses. A total of 13.5 quarter units of graduate credit may be granted for equivalent graduate work completed at another institution, as it applies to this degree, and provided the units were not used in earning another advanced degree. Since this program is defined for various areas of specialization, there are specific requirements for the type of courses to be taken.

Program Prerequisites

Candidates for the program must possess a Bachelor's degree in engineering, engineering technology, or physical sciences or a closely related area from an accredited university. Interested students from other disciplines can be admitted to the program; however, they are required to complete additional preparatory courses. Non-degreed students are not allowed to enter this program. For those who have a general non-science and non-engineering degree, admission is based on relevant experience and a set of program prerequisites.

Program Modules and Courses

Core Module: Engineering Management:

EME 600 - Introduction to Engineering Management

EME 601 - Engineering Project Management

EME 602- Management of Risk, Contracts, and Legal Issues

(Prerequisites: EME 600 and EME 601)

EME 603 – Managing Projects in Operation Management

EME 607A Engineering Management Capstone Course

(Prerequisites: EME 602, EME 603 and all pertinent Concentration courses)

EME 607B Engineering Management Capstone Course

(Prerequisite: EME 607A)

Concentration Module: Project Management:

PME 601 - Planning, Performing and controlling Projects

(Prerequisites: EME 602 and EME 603)

PME 602 - Managing Engineering Competencies and Skills

(Prerequisites: EME 602 and EME 603)

PME 603 - Product Management

(Prerequisites: EME 602 and EME 603)

PME 604 - Project Financing and associated Financial Management

(Prerequisites: EME 602 and EME 603)

Concentration Module: Safety and Security Engineering

SSE 601- Introduction to Safety Engineering

(Prerequisites: EME 602 and EME 603)

SSE 602 - Design and Evaluation of Physical Security Systems

(Prerequisite: SSE 601)

SSE 603, Introduction to Security Engineering

(Prerequisites: EME 602 and EME 603)

SSE 604, Security Engineering - Planning and Design

(Prerequisite: SSE 603)

Concentration Module: Industrial Engineering

IEM 601: Engineering Economy

(Prerequisites: EME 602 and EME 603)

IEM 602: Managing Production Planning and Control

(Prerequisites: EME 602 and EME 603)

IEM 603: Managing Facilities Planning Layout

(Prerequisites: EME 602 and EME 603)

IEM 604: Ergonomics and Occupational Safety

(Prerequisites: EME 602 and EME 603)

Concentration Module: Supply Chain Management and eLogistics

SCL 601- Supply Chain Management Fundamentals

(Prerequisites: EME 600 and EME 602)

SCL 602- Supply Chain Management - Strategies, Design and Implementation *(Prerequisite: SCL 601)*

SCL 603- Logistics Management Fundamentals

(Prerequisite: EME 600 and EME 602)

SCL 604- : Advanced Supply Chain Logistics Management

(Prerequisites: SCL 603)

Electives Module

For electives, students should select two of the following 600 level courses. Some of these courses are more relevant to a given discipline than others and hence students are asked to consult the lead faculty regarding the courses.

EME 604: Quality Management

EME 605: Infrastructure Management

EME 606/TM 655: Management of R & D and Innovation Processes

SSE 608: Science of Explosives and Biological Threat Materials

SSE 609: Planning and Response for Terrorism

QMT 601: Statistics and Business Research Methodology

IEM 605: Engineering Applications of Operations Research

SCL 605: Technology and Infrastructure Requirements for Supply Chain Management and eLogistics / IS 607 System Integration and Client Server Computing
 SSE 606: Managing Information Security

Summary

Table 1 provides a summary of program attributes as a function of specialization. Although this program concept may be similar to that of Duke and George Washington Universities [7,8], one month format curriculum along with program geared for preparing candidates for external certification are unique attributes. Combining the inputs of practicing engineering managers along with those from experienced academics during program development has resulted in a program that integrates fundamentals with relevant applications; offers significant opportunity for choice of specialization; exposes students extensively to current issues and practitioners; can be readily updated due to modular structure; and which addresses needs of the marketplace. Finally, use of both ‘on site’ and online delivery methods makes this degree accessible to geographically diverse learners, including working adults.

Table 1: Master of Science Engineering Management Programs with Four Specializations At a Glance

EMPHASIS	Project Management	Security and Safety Engineering	Industrial Engineering	Supply Chain and eLogistics
FOCUS	This program is designed to provide systematic training to those who would like to pursue an engineering project management career. In addition, people taking this program would be academically trained to take project management professional (PMP) certification administered by Project Management Institute.	This program combines the engineering management area with the field of security and safety. The highlight of the program includes problem identification, assessment, risk reduction, and control engineering.	This program is for people who are working with organizations that are looking for quality and productivity improvement. Specific focus is on the design of systems that organizations use to produce goods and services.	This program is designed to provide comprehensive training on supply chain management and eLogistics to help achieve the twin goals of cost reduction and service enhancement.
MAJOR STRENGTH	<ul style="list-style-type: none"> • Focus on Engineering Projects • Academic training to PMP Certification 	<ul style="list-style-type: none"> • Combined program on Safety and Security Engineering • Academic training to CSP and CPP Certifications 	<ul style="list-style-type: none"> • Combined program on Planning, Quality and Productivity Engineering • Academic training to CSP and CPP Certifications 	<ul style="list-style-type: none"> • Combined program on supply chain and Logistics Engineering • Academic training to CPM Certification

STUDENT PROFILE	<ul style="list-style-type: none"> • Engineering, and applied sciences 	<ul style="list-style-type: none"> • Engineering, and applied sciences • Industrial Hygiene and public Health 	<ul style="list-style-type: none"> • Engineering, and applied sciences 	<ul style="list-style-type: none"> • Engineering, and applied sciences
POTENTIAL JOBS	<ul style="list-style-type: none"> • Project Manager • Program Manager /Director 	<ul style="list-style-type: none"> • Security Manager • Safety Manager • Loss Prevention Manager 	<ul style="list-style-type: none"> • Industrial Engineering Manager • Quality Control Manager 	<ul style="list-style-type: none"> • Manager of Supply Chain Process • Manager of Logistics

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