

ABET Accredited Undergraduate Engineering Management Education in the United States

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Abstract

Engineering management education is rapidly growing but programs are very limited across the country. This paper examines the approaches that many universities in the United States are taking to offer engineering management to undergraduate students. This survey of engineering programs, accredited by the Accreditation Board for Engineering & Technology (ABET), examines who, what, why and how engineering management is being taught to undergraduate students in the U.S. It includes a look at the issues in undergraduate engineering management programs and what may be driving the development of these programs. This includes defining engineering management, examining similar programs, and the justification of undergraduate engineering management education.

Introduction

In recent years, engineering management programs have seen rapid growth. However, most of this growth has been at the graduate level. These programs have been created to address the fact that many engineers eventually become managers. These engineers for the most part have very little, if any, management skills at the bachelor level. Traditionally, companies have promoted engineers that have demonstrated very good technical skills to higher paying management positions. Some of these engineers have become terrible managers simply because they lack the different skills needed to deal with the human element of the job. The way engineers are perceived to manage is comically portrayed in a national comic strip. This comic strip depicts an engineer working for a manager that has no idea how to handle many of what seems to be typical office issues. This image portrays the way many view an engineering manager. The recent focus on engineering management is an attempt to address this problem. Engineering Management programs have been developed to provide both a technical and a managerial background to engineering graduates.

William Lannes (2001) IEEE Transaction on Engineering Management article titled “*What is Engineering Management?*” references several authors to answer this question.⁷ Lannes states that several writers use a narrow definition of engineering management like Babcock’s (1996) definition of engineering management as the direct supervisor of engineers or of engineering functions. Thamhain (1992) states that engineering management is fundamentally made up of three different skill categories: leadership skills, technical skills, and administrative skills.¹⁴ Lannes also stated that there is an increasing trend to give engineering management assignments to recent engineering graduates as soon as possible. In addition, the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET) has also put more focus on including engineering management education in undergraduate engineering programs.⁴ This growth may be the result of a better understanding of the discipline and its importance. Industry and ABET recognizes that engineers today need not only have strong technical skills, but also must have management skills to help them with the organizational, staffing, planning, financing, and the human element in production, research and service issues they will soon face. Palmer (2001) states that a different type of engineer wants a degree that

combines their engineering skills with skills in management, and that they are most likely to get promoted and be successful.⁹ This is among the many reasons engineering management education has continued to grow in recent years. This paper summarizes the ABET accredited programs in undergraduate engineering management in the United States.

Development of Undergraduate EM programs

Engineering management education is scattered in many different undergraduate programs across the United States. Some of this education is taking place in business schools, technology programs, and in some dedicated engineering management programs. This may be the result of many engineering organizations becoming aware of the lack of management abilities of many of their engineers. However, there are only three undergraduate engineering management programs accredited under the Accreditation Board of Engineering and Technology 2000-2001 criteria for accrediting engineering programs.⁴ These programs are at the University of Missouri- Rolla, Stevens Institute of Technology, and the United States Military Academy. The ABET program criteria is for engineering management programs using management in their titles. ABET states that these programs must demonstrate that graduates have: an understanding of the engineering relationships between the management task of planning, organization, leadership, control, and the human element in production, research, and service organizations, and understanding of and dealing with the stochastic nature of management systems. ABET also requires program graduates to be capable of demonstrating the integration of management systems into a series of different technological environments.

These programs include the ABET required equivalent of at least three years of study in the areas of mathematics, basic sciences, humanities and social sciences, and engineering topics. A minimum of one and one-half years of engineering topics must be included the program. This is a total of 48 credit hours for a program of 128 total semester hours. These programs combine general engineering sciences courses with engineering management courses. The core courses include subject such as: mechanics, thermodynamics, electrical and electronic circuits, materials science, transport phenomena, and computer science.

The general listing of the undergraduate courses included in each of the three ABET accredited Engineering Management programs are listed below. These courses are in addition to the required engineering core courses. The course descriptions of these courses were found to have an engineering management focus. The other courses in the programs have more of a traditional industrial engineering curriculum concentration. However, the three engineering programs do emphasis engineering management throughout the entire curriculum. These universities award the Bachelor's degree in Engineering Management.

University of Missouri at Rolla Bachelor's Degree in Engineering Management

EM Focused Courses:

- Managing Engineering and Technology
- Management Accounting Systems
- Financial Management
- Marketing Management
- Personnel Management
- Human Relations in Technical Management
- Management for Engineers
- Technical Entrepreneurship
- Management Information Systems
- Project Management

- Business Logistics Systems Analysis
- Total Quality Management
- Managerial Decision Making
- Packaging Management
- Energy Management Engineering
- Engineering Management Practices
- Managing Engineering and Technology
- General Management –Decision and Integration

Stevens Institute of Technology
Bachelor's Degree in Engineering Management

EM Focused Courses:

- Production and Operations Management
- Engineering Management Laboratory
- Engineering Management Design Project
- Total Quality Management
- Engineering Management
- Project Management

United States Military Academy
Bachelor's Degree in Engineering Management

EM Focused Courses:

- Human Resources Management
- Introduction to Engineering Design and Systems Management
- Professional Engineering Seminar
- Systems Design and Engineering Management
- Introduction to Systems Design for Engineering Managers
- Project Management
- Production Operations and Management
- Engineering Management Applications and Practices

In addition to these programs, there are four other undergraduate ABET accredited engineering programs with management in their titles but do not offer a degree titled as Engineering Management. These programs are found at Montana State University at Bozeman, North Dakota State University, Oklahoma State University, and Rensselaer Polytechnic Institute. These programs were found to offer limited and more specific management related courses. The degrees and courses offered in these programs are listed below.

Montana State University- Bozeman
Bachelor's Degree in Industrial and Management Engineering

Management Courses:

- Project and Engineering Management
- Production and Engineering Management
- Six hours of Professional Electives

North Dakota State University
Bachelor's Degree in Industrial and Management Engineering

Management Courses:

- Introduction to Engineering and Management
- Management of People Systems
- Program and Project Management

Oklahoma State University
Bachelor's Degree in Industrial Engineering and Management

Management Courses:

- Industrial Organization Management
- Information Systems for Management Decisions and Control
- Industrial Engineering and Management Seminar.

Rensselaer Polytechnic Institute
Bachelor's Degree in Industrial and Management Engineering

Management Courses:

- Engineering Economics and Project Management
- Production and Operation Management and Cost Accounting
- Production and Operations Management for Industrial Engineers
- Management Science I & II
- Engineering Project Management
- Information Systems I & II

Other ABET engineering related and engineering technology accredited programs that include management in the program's names range from business college based programs to physics programs. These programs offer different types of degree specific management options or include limited electives with a focus on management. Most of these programs were developed with mutual efforts between the engineering and business colleges. Program titles include: Industrial Management, Management of Technology, and Manufacturing Management. These programs topics include traditional business courses such as accounting, economics, finance, law, management, and marketing. Kocaoglu's (1994) study found that most Management of Technology programs were found to be in business colleges, and Industrial Management programs were mostly found in engineering departments.⁶ As of today, these programs are still mostly based in the same departments. This information is based on university catalogs and university course listings for the programs examined.

Opportunities for EM Undergraduates

Most employers do not directly hire recent bachelor's level engineering graduates as managers. Many engineers do not move into any management type of position until they have gained at least five years or more experience with the exception of military officers. The United States Military Academy EM program is designed to give its graduating officers the skills needed to be successful in today's highly technical military. These graduates are the only ones that will definitely be responsible for making decisions and solving problems immediately upon graduation. However, all of the other EM programs examined believe that they are preparing students with an accredited engineering degree for future management oriented opportunities. In addition to obtaining a technical background, engineering management graduates will have management and people skills that will be used in today's team based work environment.

Undergraduate engineering management graduates are being placed in positions that range from pharmaceutical, manufacturing, transportation and distribution, and production industries. They are also being hired as shift managers, technical salespersons, and even in the financial industry. Engineering management graduates from an accredited engineering program are eligible to take

the Fundamental of Engineering (FE) exam, which opens the door for these graduates to acquire their Professional Engineering license.

Conclusion

The need to address engineering management is driving many universities to develop and implement engineering management programs. However, only a few accredited programs are at the undergraduate level. There are many that believe that engineering management should not be at the undergraduate level because recent graduates are most likely not assigned to any engineering management projects for several years after graduation. According to Lannes (2001), an undergraduate engineering degree only prepares a student for the first (engineering) phase of ones career and the graduate degree prepares them for the transition to the management phases of their career.⁷ An informal survey of many attendees at the 2001 ASEM national conference did believe that any amount of preparation of future engineers in management skills would be a great benefit. Several of the attendees indicated that their universities were developing undergraduate or graduate engineering management programs. As stated by Rosandich et. al. (2001), areas of human behavior and social systems are given less focus in engineering management programs and this may be the result of the limited engineering management faculty in those areas.¹¹ This limitation may also have an affect on the development of new engineering management programs in the future. It should also be noted that the Australian Institution of Engineers (IEAust) has also mandated that engineering management be introduced in its undergraduate engineering programs.¹⁰ In addition, McMaster University in Canada has a five year program that leads to a Bachelor's of Engineering and Management degree. This degree is offered in nine different engineering disciplines. This program is in conjunction with the Schools of Business and Engineering. This trend is likely to continue and spread to other technical disciplines.

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