Curricula of Engineering-Based MS-MOT Programs

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ABSTRACT

Technology is widely acknowledged as a key determinant for organizational and industrial success. However, few students are academically prepared to provide a systematic approach to the management of this critical factor, technology. This paper is an effort to identify the current programs and courses that are currently offered by engineering master's level programs in this area. Furthermore, it outlines the methodology that was utilized, the observations and results, and their implications.

INTRODUCTION

As we enter the information or knowledge age, it is clear that technology is a major determinant for the success for firms, regions and nations. The development, acquisition, maintenance and sale of technology are critical factors for success[1,2] that should be addressed by academic programs[3,4,5]. These programs seek to develop managers that can appreciate the technical issues at hand and be able to manage[6,7]. These needs have been addressed by two academic disciplines: business schools and engineering departments[8]. This study investigates the master's level curricula and courses offered by engineering departments that focus on technology management with courses such as: management of technology, management of R&D, entrepreneurship, marketing high technology and innovation management.

Other studies[9] have reported the exponential growth of technology management programs. To gauge how well these programs are addressing the needs it is necessary to first understand the current curricula. This preliminary study focuses on this first part, investigating the current curricula, and courses offered by MS engineering programs.

RESEARCH METHODOLOGY

A special effort was made to include larger programs in terms of faculty and students, but programs of all sizes and all engineering disciplines were included, and contacted in the following process:

1. The survey method and the questionnaire were developed. The questionnaire consisted of two pages. The first page contained 12 questions that related primarily to the program offered. The second page contained 10 questions that were course specific.
2. The programs were investigated through their web pages if available.
3. A list of programs was developed from:
   - ASEE's 1994-1995 Directory of Engineering Graduate Studies and Research,
   - A list of engineering management programs provided by Dr. Dundar Kokauglu (Portland State University),
   - A list of engineering management programs developed by Dr. Daniel Babcock (University of Missouri – Rolla), and
   - From references provided during the survey process by the respondents.

4. Cover letters and questionnaires were sent via email to respondents with available email addresses.
5. The organizations that did not respond to the email or were not available through email were contacted via phone to:
   - Identify who would be appropriate to respond for the organization,
   - Obtain a description of the program that addresses technology management,
   - Obtain a description of and characterize the MOT courses,
   - Identify other programs, and
   - Discuss special needs of technology management programs and courses.
6. The results were analyzed and documented.

We are using the term "programs" in a very general sense. Some universities have a technology management or MOT department, some have a specific technology management program, while others had a few courses to cover the area. The first part of the survey attempted to identify the nature of their programs.

We also attempted to characterize the classes that they offered in this area. Since they have very different course titles and the course characteristics that could be used to group the courses are very subjective, this posed a significant challenge. In order to gauge the characteristics of each technology management class, the respondents were asked to evaluate each class using six different criteria. These criteria are structured as a continuum between two opposing poles. For example, the content of the course can range from strongly business (1) to strongly technical (5) or it can be balanced between the two descriptions (3) or somewhat toward either of the poles. A full list of the criteria used is displayed in Table 1. For each of the classes, the textbook used was also sought as well as the number of master's level students who take the course during an average year. Programs that had many courses were asked to describe two or three representative courses.

ASSESSMENT CRITERIA FOR THE COURSES

Characteristic assessed	One pole description	Other pole description
the content value of	1: is strongly business	5: is strongly technical
the emphasis value of	1: is strongly qualitative	5: is strongly quantitative
the scope value of	1: is strongly tactical	5: is strongly strategic
the methodological value of	1: is strongly theoretical	5: is based on cases and projects
the physical value of	1: is strictly local	5: is strictly distance
the instructor value of	1: is a business instructor	5: is an engineering instructor

Table 1.

RESULTS

Seventeen engineering programs responded to the survey during the months of December 1997 and January 1998. These include Arizona State University, Drexel University, George Washington University, Kansas State University, MIT, Portland State University, Purdue University, Stanford University, Texas Technological University, University of Alaska – Anchorage, University of California-Berkeley, University of Dayton, University of Maryland University College, University of Miami, University of Missouri – Rolla, University of Southwestern Louisiana and Widener University. Twenty four percent of the universities

responded to the email, the remaining 76 % were contacted on the phone. Phone calls were used as a follow up, to answer any questions about our survey and to expedite the collection of data.

Programs:
Each school had at least one MS program, while one had two programs. These MS programs are described as Engineering Management (9) or Industrial Engineering (4), MOT (2), Technology Management (2) and Technology (1). The most common career objectives of the students in these programs as perceived by the respondents were technical management (42%), operations (20%), consulting (13%), and R&D management (8%). The other career choices received less than 5% of the responses.

Courses:
The courses sought were those that had significant technology management content. This evaluation is subjective and the respondents were asked to make that evaluation. Most programs had one to four of these courses. Seven of the schools felt they offered a number of courses ranging from nine to eighteen that fit these criteria since most of the courses in the program had significant technical content. These schools generally service regions in which most of the local employers are high-tech firms and their courses are tailored to their needs, including a heavy emphasis on technology and its management. In order to gauge these courses in a standardized way and allow for comparisons, the respondents were asked to evaluate them using the characteristics that are described at the end of this section.

Half of the schools (53%) offer a course that is titled similar to "technology management", or "management of technology". These courses varied widely in their content, emphasis and scope as measured with the measuring system described in Table 1 with a scale that ranged from 1 to 5. The results are shown in Table 2. The content is balanced between business and technical. The emphasis is slightly more qualitative than quantitative. The scope is largely strategic. The methodology is based primarily on cases and projects. Most of them are taught locally by the instructors who were generally engineers. The standard deviation suggests the variety of responses. The most consistency was found in the scope, method and physical location of the classes. The number of students that took these classes per year ranged from 14 to 100 with a mean of 42 students. No single textbook was used by more than one school, however a majority used cases.

"TECHNOLOGY MANAGEMENT" TITLED COURSES

	Mean(X)	Standard Deviation (σ)
Content	3.0	1.1
Emphasis	2.4	1.3
Scope	3.7	0.8
Method	4.0	0.8
Physical	1.6	0.8
Instructor	3.9	1.4

Table 2.

The other classes were grouped together since no other obvious common course was found. Their characteristics as shown in Table 3, have less focus as should be expected since they include a wide variety of courses including entrepreneurship, R&D management, project

management, teaming and communications, strategic and technical planning, enterprise modeling, managing technical organizations, management of productivity and quality in technological operations, technology forecasting, applied knowledge systems, legal aspects of technology management and high technology marketing.

OTHER COURSES

	Mean(X)	Standard Deviation (σ)
Content	3.5	1.1
Emphasis	3.5	1.1
Scope	2.9	1.1
Method	3.3	1.1
Physical	1.9	1.1
Instructor	4.3	1.2

Table 3.

The average course in this group is slightly more technical than business, which should be expected from the engineering schools. The emphasis is slightly more quantitative than qualitative in comparison to the more qualitative MOT courses. The scope is balanced between tactical and strategic. The method is slightly more theoretical than based on cases and projects. They were mostly taught locally by engineering instructors. The number of students that took these classes per year ranged from 3 to 800 with a mean of 56 students. Similar to the MOT courses, no textbooks were found to be used by more than one course, and many did not use a textbook.

In addition to the survey results, the process allowed for discussion with the instructors regarding the state of technology management education and common needs for instructors in this area. Most of the larger programs explained how their emphasis provided educational services that were demanded by local industry. Their programs and were designed to provide for those local needs and there was significant innovation on their part to find better ways to serve their customer base. These programs would not be anxious to limit their flexibility in order to comply with confining educational standards that might be created in the area of technology management.

IMPLICATIONS

The observation that stands out is the diversity in the content, emphasis or scope of the programs and courses that address technology management. There is a value in this diversity since it facilitates the customization of the programs and courses to meet customers needs based on regional needs and challenges. Programs in a highly technological region can take full advantage of their resources to offer programs and courses that fulfill local customer needs. This diversity and independence also facilitates innovation, since each program is motivated to find their own way to satisfy customer demands.

Another result of the diversity and independence is a lack of a standard knowledge base in this field, as evidenced by the lack of common programs, courses, textbooks and other educational resources. This lack of standard courses, textbooks and educational resources, such as case studies, makes it harder to develop effective courses in the area. This lack of standardization can confuse potential students and employers since they are not aware of these programs and don't

understand what they offer. This lack of standardization also reduces the credibility and sense of professionalism in the field. For instance, because of the standard knowledge base in mechanical engineering it is much clearer what a mechanical engineering education can do for a student, and many have dealt with mechanical engineers, the profession has gained credibility. However, many respondents commented that this was not the case in technology management.

The results from this study as well as some of the comments made by the respondents point to a few areas of opportunities. These include:

- The development of more **technology management case studies** should be encouraged. A large number of courses use case studies and a number of respondents commented that it was difficult to find appropriate case studies that had sufficient technical content.
- There is no common usage of **textbooks**. This might reflect a shortage of appropriate textbooks. It was noted however, that it might be difficult to develop textbooks that satisfy the diverse demand that exists.
- There is a value to a **standard base of knowledge** in the field to make it easier for students and employers to understand what is offered. Standardized course titles and terminology would also be helpful. However there seems to be a strong desire to maintain independence and flexibility to better meet their perceived customer demands.
- The **integration of the relevant professional organizations** could foster the development of case studies, common textbooks, and a more standard base of knowledge.
- Increased **research and publishing** opportunity in the area of technology management is another way to foster the necessary changes. They could generate the standard base of knowledge and necessary visibility.

CONCLUSIONS

The area of technology management in graduate engineering programs is vibrant, diversified and responsive to local industrial needs. However, this independence leads to a lack of standard knowledge base that makes it hard to disseminate the "brand awareness" of technology management to potential students and employers. At the same time it decreases the explicit demand for educational resources to teach in the area. This was reinforced by the comments made by numerous educators highlighting the shortage of appropriate technology management case studies and textbooks.

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