The Challenges Facing Engineering Management Education: The Clash between Training, Education, and Research

Mario G. Beruvides, Ph.D., P.E.,
Terry R. Collins, Ph.D., P.E.,
Elliot J. Montes, PhD.

Industrial Engineering Department
Texas Tech University

Abstract

All educators involved in technical or scientific education are faced with the age old dilemma between simply training students and educating students. This problem is not strictly inherent to the sciences, but it is with little doubt present in the training of science based education especially in the education of engineers. The field of engineering management education is no exception and is faced uniquely with some perplexing problems due to market demands for this specific type of engineering educational product. Like most every other engineering education discipline, it is faced with the demands not only for the undergraduate and graduate educational needs of the current workplace, but such other demands as is required by continuing education seminars and training as well as PDHs (Professional Development Hours) for maintaining professional licensure. Most engineering management programs are graduate programs (mainly at the masters level) accepting students from all engineering undergraduate disciplines as well as some science disciplines (with leveling course work). Both the market demands as well as the student's expectations are for an educational product that will prepare engineers as technical managers, thus the MS degrees are usually offered as a thesis or non-thesis option – with the non-thesis option being the overwhelming preference. This places pressures on the research component of engineering management educational frontier. Texas Tech University Industrial Engineering Department developed a Systems and Engineering Management MS degree (thesis and non-thesis) option over five years ago, which has been very successful in recruiting and graduating students. The IE department is currently in the final stages of developing and seeking approval for a Ph.D. in Systems and Engineering Management. This paper presents some of the curriculum and educational issues involved with developing such programs. It also explores the issues and balancing act that must be dealt with in juggling the demands of training/continuing education, education and research (applied vs. theoretical).

Introduction

Formal engineering management education is a little over four decades old. Though some may argue that engineering management started with Fredrick Taylor and his classic text on management titled " The Principles of Scientific Management," the specific educational field known as engineering management commenced in the later 1960's. Bernie Sarchet and Merl Baker started the first engineering management program in the University of Missouri-Rolla. Like any young field of endeavor, engineering management (EM) has undergone some forming, shaping, and its share of growing pains. The field came to be due to the need and demand that industry had (and still has) for competent engineering managers. That is, managers with specific managerial skills that were customized for highly technical or engineering intensive corporations or departments. The MBA provided at most university business schools did not suffice. [1]

From the beginning EM programs were designed to prepare any and all graduate engineers for technical management positions. Thus the incoming graduate students to these programs came from any and all engineering disciplines (mechanical, electrical, civil. chemical, petroleum, etc.). So from the onset, EM programs had and continue to have an interdisciplinary flavor. There are few EM undergraduate programs in the United States (or the world for that matter).[2] Even Universities that do have undergraduate programs, accept non-engineering management bachelor degreed applicants. The faculty teaching in most EM programs, also come from a variety of academic backgrounds. This as we will see later has a major influence on the research conducted in the field. Compounding this interdisciplinary make-up is the applied nature of the field which is also heavily influenced by its beginnings and history. These many influences mentioned above along with other factors have shaped a field of history that is unique and challenging from a curriculum and educational standpoint with a balance between training and education and with a search for identity in the area of research.

Educational Market Demands

Engineering Management is certainly not the only field that struggles with the training vs. education dilemma. Some may say that all engineering disciplines and maybe science and business disciplines are not exempt from this dilemma. This is certainly true. But unlike other fields of study, EM has a far less defined area of research. Some may ask why research is being mentioned in an educational forum such as is the audience of this paper. But in fact, research in any field of endeavor sets the educational platform of that science or art. The other confounding pressure points facing EM are the market demands placed by the purchasers (industrial organizations) of EM products (graduates and research output). The need is practical in nature. There are no jobs for design engineers in EM (per se). There are little if any R&D jobs for EM graduates. The graduates may manage R&D operations, but there is no EM R&D.

In addition to the above stated and because EM programs are an outgrowth of a direct demand by industry, most EM programs have close ties to industry. This is both a blessing and burden. Many organizations working with EM programs (and at times funding their research and maybe financially assisting the programs) at times demand a voice in the design of the curriculum. This

is by no means an imposition of what is and what is not to be taught. The influence is much more subtle than that. The influence is that EM programs research and some graduate courses focus on areas of specialty which reflect the needs of their constituent liaison organizations. This is self reinforcing since over a span of many years, many of the graduates of an EM program are now top level managers in these same liaison organizations. Again, this is not necessarily unique to EM programs, nor it is necessarily a bad thing. But it does create for a challenging educational environment that struggles with educating and not simply training,[3,4] and whose research avenues as we will see later, may at times be quite limited.

Finally, most EM programs have yet another influencing factor, that of the media or platform in which the product is delivered. Most all EM programs have a distance education (Internet) component. [5] This is also very market driven. Many of the sponsor organizations in general are very supportive of engineers who wish to further their education, but do not wish to have their employee leave work for an extended period to obtain their degrees. The students echo this desire. A large number of EM students are working engineers who have no intention of leaving their current employment to return to the University main campus. This places much pressure on EM programs, for this new breed of customers is at a distance, and demands the same services and opportunities as the on-campus student. [6] This of course is to be expected (not unreasonable if you are the paying customer). But no doubt, this makes the job of EM educators mode demanding –to provide a seamless education no matter which platform the educational product is being received from.

Curriculum and Research Issues

Like many MBA programs, EM programs can have extensive executive EM component (seminary or more extensive training programs) along with PDH (Professional Development Hour –for licensure) demands.[7] In addition, many EM programs may have outreach initiatives if not simply professional development demands placed upon them. Again, here the demand is of practical nature.

Due to the myriad of forces shaping EM programs, curriculum design and development is no easy task in this field. Another reality facing EM programs is that there are few programs that grant PhDs in the area. [1] Thus much of the research is done at the masters level or is in PhD programs that are in related fields (such as industrial engineering, operations research, management science, or POM-Production Operations Management, to mention a few). This final point again shows the multidisciplinary nature of the field and at times creates some crises of identity. With respect to the masters level work, due to the applied nature of the subject matter and market demands by industry on the degree, most EM programs offer masters degrees with a thesis or non-thesis option. The non-thesis option being the most popular choice of the two graduate degree options. Thus, research in the area is strongly influenced by this.

The research funding sources for engineering management are disperse. The National Science Foundation is not a very good venue for EM researchers. In fact, what would be typical for most engineering disciplines is not the norm for EM. Much of the research is done with industry or a whole host of other funding agencies (not necessarily geared for EM). The publishing sources

are varied like the research funding. EM research funding can be obtained (though difficult) from a large number of agencies; gevermental and non-governmental so it is with publishing. There are established EM publishing venues (The Engineering Management Journal –EMJ put out by the American Society for Engineering Management (ASEM) or IEEE Transactions on Engineering Management). But publishing is also done in a number of engineering and business journals specific to operations research, simulation, production management, etc. It can thus be seen that research in EM is multidisciplinary, interdisciplinary, diverse and quite disperse. This has an effect on EM education and curriculum design and development.

Concluding Remarks

What is presented here is a paradigmatic view of the field of engineering management. There is a bit of an identity crisis in the area of research. But there is also strength in some of the influences placed upon the field. The strong tie to industry allows both the education and research to be close to "where the action is.". The applied nature of the research has led to some fantastic research which is both sound in nature and useful in practice. By noting that much research in EM is applied in nature does not say that good theoretical work is not being done. The future then lies in continuing to develop and mature the field. There is a great need for more EM Ph.D. programs. Texas Tech University's Industrial Engineering Department is specifically addressing this issue. The IE department established a Systems and Engineering Management (SEM) masters (MS) approximately five years ago. The program has been very successful with phenomenal growth. The IE Department is at this time developing a Ph.D. in Systems and Engineering Management. Like other programs, Texas Tech's program has an emphasis on the systems theory approach. Thus the curriculum development has a strong systems emphasis. To address the varied nature of the demands on the EM program, the graduate coursework has both hard and soft (quantitative and qualitative) coursework. There are some twenty courses that are EM related. The courses vary as follows: course on optimization, stochastic processes, two courses on simulation, spread sheet modeling, risk analysis, general systems theory, decision theory, the engineering management environment, industrial cost analysis, advanced economics of systems, productivity and performance improvement in organizations, activity scheduling, inventory control, project management and total quality systems.

The issues facing EM are many and varied. The educational demands are to say the least daunting. But it is in maintaining a balance between these forces (hard vs. soft, applied vs. theoretical, industrial influence, market demands, etc.), that make good EM programs. To fail to embrace the multidisciplinary nature of this field, we believe would be a mistake and ultimately relegate the field to something it was never meant to be.

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Biographic Information

MARIO G. BERUVIDES
Dr. Beruvides is an associate professor of Industrial Engineering at Texas Tech University. He received a Ph.D. in Industrial and Systems Engineering from Virginia Tech and an M.S.I.E and B.S. in mechanical engineering from the University of Miami. His research interests include human and organizational systems performance improvement, engineering management as well as advanced economic performance issues and engineering education.

TERRY R. COLLINS
Dr. Collins is an assistant professor of Industrial Engineering at Texas Tech University. He received a Ph.D. in Industrial Engineering from Oklahoma State University, an MSIE degree from Texas Tech University and an BS in Agricultural Engineering and a BS in Mechanical Agriculture both from Texas Tech University. Dr. Collins’ research interest are in the area of safety engineering and management, industrial ergonomics, engineering management, and engineering education.

ELLIOT J. MONTES
Dr. Montes obtained a Ph.D. in Industrial Engineering from Texas Tech University and an MSIE and BSIE from St. Mary’s University in San Antonio Texas. He is an assistant professor of Industrial Engineering at Texas Tech University. Dr. Montes research interest are in the areas of engineering management, operations research, scheduling, simulation, production systems analysis and engineering education.