

DEVELOPMENT OF A NEW M.S. DEGREE IN ENGINEERING MANAGEMENT

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Abstract

The objective of the graduate program in Engineering Management at California State University East Bay is to train professionals for leadership roles in engineering, manufacturing and service industries. This program will enable individuals with a degree in engineering, science or related fields working in manufacturing and service industries to advance their careers by preparing for management positions. Also, professionals in management positions will benefit from this curriculum by obtaining a formal education in engineering management. The San Francisco Bay Area is a prime location for offering such a degree because of the large concentration of high tech engineering, manufacturing and service industries.

This paper details the development of the M.S. Degree program. We discuss the resource constraints that had to be overcome by developing a curriculum that pulls resources from various departments on campus. The designed curriculum allows us to offer the program without requesting additional faculty positions.

Other considerations include issues such as specific needs of Bay Area professionals and class offerings. We utilize the strengths of the university to develop a balanced curriculum including courses from Engineering, Management, Finance, and Statistics. Special considerations are given to admission requirements, prerequisite structure, and course offerings such that we can create a large pool of qualified applicants for the program.

Motivation

California State University, East Bay (CSUEB) began an engineering program in 1997, starting with a single offering in Industrial Engineering at the undergraduate level. The original vision was to slowly grow the program to a sustainable critical mass by introducing other engineering disciplines and degree options over time.

The need for the proposed graduate degree program was initially discussed in the Industrial Advisory Board (IAB) meeting of the CSU East Bay's Engineering

Department in December 2002. The discussion was initiated in line with the original vision of growth, and based on the need to introduce programs to increase the visibility of the Engineering Department and to increase the enrollment in Engineering to more fully utilize faculty resources. The IAB was unanimous in its belief that Engineering should introduce a graduate program to increase enrollment and visibility.

Current faculty expertise along with a CSU system-wide hiring freeze limited consideration of topic areas to Industrial Engineering and Engineering Management. A graduate degree focused on Engineering Management was seen as a better match than an Industrial Engineering graduate degree at the present time, for three primary reasons:

- First, local demand for graduate level industrial engineering is currently being served by UC Berkeley and by CSU San Jose, both less than 30 miles from CSUEB.
- Second, a graduate IE degree would require a large number of new courses to cover topics at the graduate level, requiring a prohibitive increase in faculty resources, almost exclusively in engineering.
- Third, the pool of potential students was thought to be much larger for an Engineering Management degree than for a Masters degree in Industrial Engineering.

The board members discussed various options and believed that a M.S. degree in Engineering Management would be highly desirable in the Bay Area. Also, the fact that both programs that are needed for offering this degree, Industrial Engineering and a Management and Finance Department, are present at CSUEB means this degree program can be offered without requesting additional resources.

These discussions led to the formation of a taskforce comprised of the Chair of the Engineering Department, the Chair of the Management and Finance Department, and Department of Engineering faculty. The taskforce was charged with analyzing local, statewide and national offerings in Engineering Management, and developing the curriculum and degree requirements for the CSUEB Engineering Management program.

To justify the offering of the new degree program, we had to demonstrate demand in the geographical area and also analyze other engineering management programs in the local area and throughout the CSU system. A targeted survey of potential applicants to the program was identified as the tool to demonstrate demand.

Survey and Results

The individuals who would be interested in this program are working engineers and scientists and recent graduates of engineering and science programs. To substantiate the need for this program we identified a subset of this broad constituent to survey.

We limited the survey to a subset of engineers (Professional Engineers) in the Bay Area and also included the members of the Institute for Industrial Engineers (IIE) local chapter. We acquired the names by contacting the State Board of Registration and IIE local chapter. We received approximately 200 names from IIE and over 10,000 names of licensed engineers in the Bay Area from the State Board of registration. We randomly

selected 2,500 professional engineers out of the 10,000 and included all the engineers from IIE local chapter list.

Surveys, along with a complete description of the program, were mailed to a total of 2,700 engineers in Alameda and Contra Costa Counties. From these, we received 326 responses, 49 from the IIE members and 277 from professional engineers. This indicates an overall response rate of 12.1%, with an IIE response rate of 24.5%.

The survey form is shown in Figure 1. A short and simple design was used to elicit a good response rate. The responses to questions 4, 5 and 6 are graphed in Figure 2. Indications are that the level of interest in the proposed program is high, as more than 80% of the respondents say that they know of someone in their organization who is interested in Engineering Management, more than 82% indicate that the program is needed in the Bay Area, and 26.4% indicated their interest in earning a degree in Engineering Management. The percentages of positive responses for IIE members and other engineers were consistent.

While the survey targeted engineers only, we believe that this degree program has a much larger constituent. All scientists and others with a B.S. degree can enroll in this program, and we believe a similar level of interest exists for others with a technical background interested in professional growth into management.

Similar Local Offerings (non-CSU)

Currently the only Engineering Management program in the San Francisco Bay Area is at Santa Clara University. Distinctions between CSUEB's proposed program and Santa Clara University's program exist in terms of degree content and accessibility.

Santa Clara University does not cover areas such as simulation or product/process design and other industrial engineering topics covered by CSUEB's proposed curriculum. In contrast, CSUEB's proposed curriculum is a blend of industrial engineering and management. This focus makes the program attractive to individuals with non-engineering B.S. degrees.

Regarding accessibility, Santa Clara University is a private institution with significantly higher student fees of approximately \$27,405 (based on \$609/unit, for 45-units). In contrast, CSUEB is a public university with much lower student fees for California residents at approximately \$2,300 (based on one year's fees) and for non-residents at approximately \$11,300 (based on \$188 per unit for 48 units).

Please respond to the following questions regarding Cal State Hayward's proposed graduate program in Engineering Management.

1. Please provide your name (optional)

2. Please provide your company name

3. What is your educational background

4. Are you interested in a graduate degree in Engineering Management?

Yes or No (circle one)

5. Do you think other people in your organization or profession would be interested in this program?

Yes or No (circle one)

6. Do you believe a new graduate program in engineering management is needed in the Bay Area?

Yes or No (circle one)

7. Do you have any suggestions on the enclosed curriculum?

Figure 1. Survey to identify need for Engineering Management program in the Bay Area.

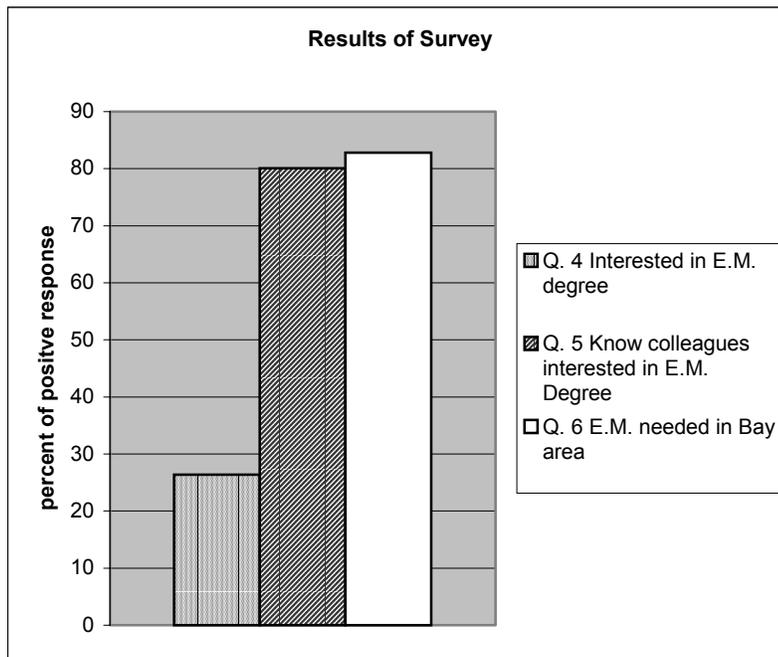


Figure 2 Results of the survey to identify need for Engineering Management program in the Bay Area, in percent based on 326 responses.

Similar State-wide CSU Offerings

CSU campuses that offer (or have been approved to offer) a degree program of Master's of Science in Engineering Management are:

- Cal State Long Beach (On-line joint program with Cal State Dominguez Hills)
- Cal State Dominguez Hills (On-line joint program with Cal State Long Beach)
- Cal State Northridge
- Cal State Pomona

The CSUEB program will be distinct from these programs in terms of location (all other CSU offerings are in southern California). Other distinctions include different emphasis in the programs course topic areas (all) and differences in that some of the other CSU offerings are extension only and on-line only (CSU LB & DH).

The Curriculum Development Process & Resulting Program

Development of the degree requirements and curriculum were based primarily on: Analysis of specific offerings of engineering management programs across the nation; consideration of CSUEB faculty expertise; advice of the IAB regarding professional needs and; a desire to allow some flexibility for students to pursue their specific interests. The resulting degree requires 48 quarter units, (excluding program prerequisites) taken from required, elective and capstone courses, as outlined in the following sections

Admission Requirements

Possession of a bachelor's degree in engineering, basic sciences or related fields with a calculus background, from an accredited four-year institution with a grade point average of 2.5 or better is required. Degrees from foreign institutions will be individually evaluated. A personal statement, resume, and two letters of recommendations are also required.

Degree Requirements

Prerequisites (each must be completed with a grade of B or better)

- ACCT 3200 Accounting for Management Decision-Making
 - ENGR/ECON 3140 Engineering Economy
 - STAT/ENGR 3601 Statistics and Probability for Science and Engineering I or
STAT/ENGR 5601 Introductory Statistics and Probability for Science and
Engineering
- Equivalent courses can be substituted for these prerequisites.

Required Courses (32 Units)

- ENGR 5180 Product-Process Design
- ENGR 5200 Systems Simulation
- ENGR 5280 Design and Management of Human Work Systems
- ENGR 6200 Project Management
- ENGR 6300 Applied Quality Assurance
- ENGR 6400 Research Methods in Engineering Management
- FIN 6033 Graduate Introduction to Financial Decisions
- MGMT 6130 Enterprise Planning and Control

Elective Courses (12 units)

12 quarter units of graduate courses in Engineering, Business and Economics, Computer Science, Statistics, or related areas. The following is a sample list of electives:

- CIS 6070 Graduate Introduction to Computer Information Systems
- ENGR 6900 Independent Study
- MGMT 6150 Global Supply Chain Management
- MGMT 6470 Management of Technology and Innovation
- MGMT 6560 High performance Management

Capstone Experience (4 units)

ENGR 6899 Project, or pass the comprehensive examination and complete an additional 4-unit elective course.

Approval Requirements

Establishing the Master's Degree program requires approval at a number of levels. CSUEB is organized into four colleges, and the Engineering Department falls under the purview of the College of Science. First the College of Science curriculum committee was asked to approve the program and course offerings. Substantive discussions with this governing entity resulted in revision of the capstone experience from being thesis based to project based.

Next the academic senate of the CSU East Bay approved the proposal and sent it on to the CSU system-wide administration. In order to satisfy the requirements of CSU system-wide administration, the proposal has to provide details in a number of areas including:

- curricula
- survey results documenting student interest
- professional uses of the degree
- expected number of graduates over next five years
- faculty resource requirements
- space and facilities requirements
- library resources
- equipment or specialized materials

We have submitted our request with the supporting documentation addressing each of the areas listed above, and are currently waiting for approval from the CSU system-wide administration. This review at the system-wide level is the final step in the approval process.

Conclusions

In documenting our experiences in developing a Master's Degree program in Engineering Management, we provide insight into the process, tasks required, and strategic decisions made in designing a program to meet our specific needs and constraints.

The first insight is that program development is a collaborative effort. We enlisted the entire engineering faculty and consulted with faculty from business and statistics. We sought input from stakeholder constituencies including Industrial Advisory Board members and potential students. We sought council from recognized scholars in engineering management. We modified the program based on the guidance and input from these potential stakeholders.

The second insight is that it is possible, for our set of circumstances, to construct a program with little increase in resource requirements. This is accomplished through utilization of existing courses and employing tiered¹ courses. This strategy is especially powerful at CSU East Bay, where our engineering program currently consists only of undergraduate industrial engineering. At more established programs, many engineering courses are populated by engineers from multiple engineering disciplines, whereas at CSU East Bay our engineering courses are populated only by I.E. students, leading to under utilization of faculty resources. Populating some of those courses with engineering management students accommodates influx of new students while promoting more efficient use of existing faculty resources. Use of an applied project for the capstone experience similarly allows for greater utilization of faculty resources than would an academic based thesis.

A further insight is recognition of the natural synergy that exists between undergraduate industrial engineering and graduate engineering management programs. This became evident as engineering management offerings at other universities were analyzed, and as we discussed areas of expertise of current faculty with respect to engineering management topic areas. Since a major portion of industrial engineering focuses on efficient integration of people and systems, it is natural that many courses, as well as faculty areas of interest, are common to I.E. and E.M.

A final insight pertains to the criticality of multiple sources in determining need for the program. Survey of potential students provides a good indication of demand. Analysis of specific offerings of by others gives a fairly good indication of the supply, and allows program designers to determine commonalities and distinctions that will exist between the established and the proposed programs. Our utilization and analyses of these two data sources provided the basis for a our program design as one that will be seen as providing a comparable level of quality, but with distinct differences and advantages over competing programs. Our proposed program is distinct in that it is the only CSU

¹ Utilization of existing courses where graduates and undergraduates attend the same lecture, but with some difference in course assignments and expectations.

program offered in the Northern California SF Bay Area Region, and it has a different emphasis and cost advantage over local non-CSU offerings.

Our analysis of local graduate programs revealed that while there are a large number of MBA programs in the greater San Francisco Bay Area, there are almost no MEM programs. This requires most engineering managers to either rely on ‘on-the-job’ experience, or to seek education via an MBA rather than a more focused MEM. This despite the findings of the American Society of Engineering Management, which states that:

“The ability to manage and administer large technical engineering and research projects and budgets will continue to challenge engineering management skills; That approximately two-thirds of all engineers were spending a substantial portion of their professional careers as managers; That the management of technology required improved management processes; and that a career path that places engineers in management must be supported by engineering management education and organizations that strive to develop and enhance management skills.” American Society of Engineering Management
(<http://www.asem.org/about/index.html>)

For more information about the engineering department at Cal State East Bay, please refer to:

<http://www.sci.csuhayward.edu/engineering/index.html>

Biographies

Dr. David Bowen is an Assistant Professor at California State University, East Bay. He is an experienced educator, researcher, manager and consultant in the areas of: Human work systems, Engineering education, Creating, training and facilitating improvement teams, Capacity modeling, Cycle-time reduction, and Human Factors Engineering. He has served as a panelist for the NSF and a US Peace Corps volunteer.

Farnaz Ganjeizadeh is an Assistant Professor at California State University, East Bay. Her research interests include manufacturing processes improvement, strategic planning, new product introduction, simulation output analysis and applied operations research, quality assurance and product cost management.

Dr. Saeid Motavalli has extensive industrial and academic experience. He is currently a professor and department chair of industrial engineering at CSUEB. Dr. Motavalli's area of research is manufacturing systems. In particular he is interested in problems related to process flow analysis, facilities planning, project management, and workplace design. He has published extensively in these areas.

Dr. Helen Zong, PE, is an associate professor of industrial engineering at California State University, East Bay since 2000. Before joining CSUEB, she was an associate professor at St. Cloud State University in Minnesota for 7 years. Dr. Zong has conducted many manufacturing and service improvement projects and training for industry.