

AC 2007-471: REPLACING A BACHELORS DEGREE IN ENGINEERING MANAGEMENT WITH A TWO-TRACK MINOR : A CASE STUDY

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Replacing a Bachelors Degree in Engineering Management with a Two-Track Minor : A Case Study

Abstract

The University of Evansville (UE) offers EAC-ABET accredited programs in Civil, Computer, Electrical, and Mechanical Engineering, a CAC-ABET accredited program in Computer Science, and AACSB accredited programs in Business Administration and in Accounting.

Since 1976, UE has offered a BS degree in Engineering Management which is a combination of fundamental engineering courses and fundamental business courses, together with electives. The degree was not designed to be ABET accredited and has never been submitted for evaluation. There were two “ideal” candidates for the degree; students who sought a career at the interface between engineering and business (e.g. technical sales, construction management) and students who wanted a second degree to compliment a degree in engineering or in business.

In recent years, faculty interest in the program has been lukewarm and student demand has been very light. Often the program became a “bail-out” option for engineering students who were struggling with technical material or who decided that engineering was not the career of their dreams. Most of the students entered the program from engineering; almost no students came in through business.

An opportunity to re-examine the program came with the hiring of two new faculty members, one in Mechanical Engineering and one in Business Administration. A small committee was formed to study the current program and offer suggestions for improvement. In addition to examining the program and its students, two external surveys were conducted: one of potential (local) employers and one of other schools which offered degrees in Engineering Management. After completing these surveys and a discussion with UE’s Business and Engineering Advisory Council, the decision was made to discontinue the degree and a new minor in Engineering Management was proposed. The minor is considered to be unique in that it has two completely different tracks, one to accompany an Engineering degree and another to accompany a Business Administration degree. This paper describes the history of the EM degree, the surveys conducted, and the two-track minor that was developed.

Background

The University of Evansville (UE) is a medium size, independent, comprehensive university. Among its four colleges and schools are the College of Engineering and Computer Science and the School of Business Administration. The University offers EAC-ABET accredited programs in Civil, Computer, Electrical, and Mechanical Engineering, a CAC-ABET accredited program in Computer Science, and AACSB accredited programs in Business Administration and in Accounting.

Since 1976, UE has offered a BS degree in Engineering Management (EM). The degree is essentially a combination of fundamental engineering courses and fundamental business courses,

together with about 30 (semester) hours of electives. Originally developed in the mid-seventies, the curriculum was revised in the mid-nineties but it retained its original character as essentially a concatenation of the two disciplines. The curriculum for the “earlier” and “later” programs is presented in Appendix A. The UE EM degree was not designed to be ABET accredited and has never been submitted for evaluation.

Essentially, there were two reasons for offering the degree: first, it provided a framework for faculty from the two units to work together and second, it provided an option for students who did not want to choose between engineering and business. There were two “ideal” candidates for the degree; students who sought a career at the interface between engineering and business (*e.g.* technical sales, construction management, and production supervision) and students who wanted a second degree to compliment a first degree in engineering or in business.

From the beginning, the number of students in the program has been small. In recent years, faculty interest in the program has varied from disinterest (mostly among business faculty) to lukewarm (among engineering faculty). Student demand has been very light; with no more than a handful of entering Freshmen indicating an EM major. More often than not, the program became a “bail-out” option for engineering students, typically sophomores or juniors, who were struggling with technical material or who decided that engineering was not the career of their dreams. Most of the students entered the program from engineering; almost no students came in through business.

An opportunity to re-examine the program came with the recent hiring of two new faculty members, one in Mechanical Engineering, with an MBA and a PhD in Industrial Engineering and a manufacturing background and one in Business Administration with expertise in operations management and production. A three-person committee, including the Dean of Engineering and Computer Science, was formed to study the current program and offer suggestions for its improvement. The initial issues of concern were the small number of students and the non-accredited/not-accreditable nature of the program. After examining the program and its students, a list of six possible actions was developed; the options were:

1. Drop the program as an undergraduate degree offering.
2. Leave the program as it is: a very flexible program with a loosely specified core of engineering and business courses on top of general education and fundamental science and math courses (See Appendix A)
3. Provide a program with a very specific core of existing engineering and business courses that provides approximately 16 credit hours for specialization in either engineering or business using existing courses. It seemed that this option could eventually lead to accreditation.
4. Provide a program with a very specific core of existing engineering and business courses and an additional set of four to five new courses typically found in industrial engineering and manufacturing programs such as Facilities Planning and Design; Production/Operations Planning and Scheduling; Work Methods, Standards and Design;

Product and Process Design; Quality Systems; Modeling and Analysis of Operation. It seemed that this option could also eventually lead to accreditation.

5. Provide an engineering management certificate based on a 12-15 credit management related course sequence. Courses for the certificate could be comprised of existing business and engineering courses (particularly Engineering Economy, Construction (or Project) Management, and Information and Technology), and/or some of the new offerings suggested above.
6. Provide a 30 -33 credit (1 Academic year) Engineering Management Master's Degree program that includes the proposed new courses as 400/500 level (cross-listed) so that they could be used as undergraduate electives (or certificate courses) as well.

Alternatives 4 and 6 would have required adding 4-6 new courses for engineering management which would also be viable as engineering and/or business electives. Alternative 5 might require some new courses, but could also be implemented with existing courses.

Clearly, the alternatives reduced to three general concepts: Eliminate the Program, Modify the Program, Reduce the Scope of the Program. To gain further insight on which way to proceed, it was decided to seek outside input. The chosen method was to perform surveys. Two external surveys were designed and conducted: one of potential (local) employers and one of other schools which offered degrees in Engineering Management.*

Employer Survey

Key customers for our engineering management program are the industrial and commercial employers of our graduates. Their input for our decision was solicited via an e-mail survey. The survey questions were e-mailed to members of UE's Business and Engineering Advisory Council, among whose members are several potential employers of our students such as Whirlpool Corporation (manufacturing), Vectren (energy utilities), TJ Maxx (distribution and sales), and ALCOA (primary production). These companies have regional operations, and most of our engineering graduates are hired by regional companies. While the number of companies surveyed was small (only 7 responses were received), they represented a diverse array of business types and were by far the most likely employers of EM graduates from UE.

The survey asked the individuals to respond to questions that explored: 1) the recognition of the engineering management profession and undergraduate degree, 2) the employability of an engineering management major at the entry level, 3) and suggestions they might have for our engineering management curriculum. With regards to employability we asked about whether they would employ an engineer management major, for what positions, and if resumes from students with engineering management majors would pass an initial Human Resources (HR) screening. The survey also included a brief description of engineering management and the sample curriculum for the program. A copy of the questions together with a summary of the

* A survey of EM alumni was also considered. Previous attempts at an alumni survey for assessment purposes were unsuccessful because of the very small number of alumni and the incomplete nature of available records; therefore the idea of an alumni survey was abandoned

responses is provided in Appendix B.

The results of the survey indicate that the recognition of engineering management as an entry-level bachelor's degree was poor, and though the students were employable, not for entry level engineering positions. Six out of the seven responders were not familiar with engineering management (our program or others). With regards to employability, six of the seven also said that they would employ students with this degree for positions such as operations and production supervision and planning, asset management, systems analysts, lean manufacturing improvement projects, maintenance planning, quality control, business analysis and support. None of the respondents felt comfortable in employing the students in an engineering capacity. One respondent stated that he would not hire someone with this degree. With regards as to whether candidates with engineering management degree would pass HR screening, three respondents said yes, one maybe, and one definitely not for engineering or any "experienced" positions.

As to the curriculum and course suggestions, respondents suggested adding courses typically found in industrial engineering and management curriculums. They suggested more courses related to lean manufacturing, logistics and material handling, project management and financial analysis, leadership and management, and communications. With regards to the balance of engineering and management courses, five felt that it was adequate, one wanted more management courses, and one wanted more engineering courses.

The conclusion that might be drawn from the survey is that our local employers have a clear distinction in their minds between engineering students and management (business) students. This clear distinction might make it difficult for engineering management undergraduate majors to get a chance at an entry-level position with these employers who are not really sure how to place them. From the other comments in the results of the survey it was also clear that these employers would like our engineering students to have more management and business background on top of a standard engineering degree, and would like to have some of their management hires have at least some appreciation of engineering processes and thinking. .

University Interviews

Phone interviews were conducted with five ABET- accredited EM programs. Enrollments in the EM programs varied from 45 undergraduate majors to 200. All of the universities that were contacted were not considered to be competitors of UE. Each interview asked a knowledgeable EM program representative approximately fifteen questions about their engineering management program. The guideline for the survey is shown in Appendix C. Results have been summarized into four main areas: (Program) Brand Recognition, Promotion, Minor in Engineering Management, and Future Directions for Engineering Management).

Brand Recognition: All five universities shared that being accredited by ABET has benefited their program and its marketability. Each of these schools has dedicated substantial resources by hiring additional faculty and allocating resources to support the program. Even with accreditation, name recognition of engineering management is still a challenge in the marketplace. Many employers believe the degree means graduates can only manage engineers as they do not understand the full benefits of an engineering management major. Often, universities

have to educate recruiters by asking: “What job skills do you need for this position?” In many cases an engineering management major possesses the skill set for a good fit. This lack of knowledge can also be seen in company job descriptions as employers do not often advertise for an engineering management major.

Promotion: Struggles with brand recognition causes challenges to promotion on two fronts: industry and student recruitment. Although brand recognition is an issue with the engineering management major, there are some strategies recommended for promotion which have achieved success at the programs interviewed. Programs which achieved ABET accreditation have all highlighted that this has helped grow their program. One program only had five students before accreditation in 1993; they now have 80 undergraduate majors. Beyond accreditation, universities need to examine what employers value and then package / target their program to meet these values.

One program in the survey visits target companies to discuss the EM degree. This helps companies identify the importance and value of an EM degree and assists in maneuvering through red tape in the human resource process. Other programs partner with career services to make a first class brochure to emphasize their EM program and its benefits. Additionally EM faculty will attend their university career day and develop a two minute “elevator speech” to use with local recruiters about the benefits of the EM program. Another program surveyed focuses on their alumni and board of directors which have high visibility in industry. Leveraged properly, key external members can be a strong asset to support an EM program. If employers are properly targeted on value, the flexibility of the degree and the hybrid nature of the EM major (Engineering/Business) can have success.

Additionally promotion of the EM program can also have implications for student recruitment. Promotion to students and parents focuses on delivery of the value of an EM degree. A few schools sponsor summer programs such as “Pre-freshman tea” and “Introduction to Engineering” where students and parents can tour the school and begin to learn about the benefits of an EM major. Additional information is given to students and parents about alumni (jobs, salaries, etc) and also links to the university web site.

Other universities target guidance counselors in the immediate area and send a cover letter and brochure for the EM program. Working through their admissions office, they also target their top five feeder schools and visit those counselors personally.

Minor in Engineering Management: According to the survey information collected, one university has had success (80 students per year in minor) in selling a four course minor to industry. These four courses contain classes in Project Management, Organizational Behavior, Engineering Economics, and Statistics which are targeted to corporations as developing “Project-Ready Engineers”. These four course packages are a great recruiting tool for industry and students as they have found the market may pay a premium of up to \$10,000 per year more for these skills as a minor. Additionally the minor in engineering management requires fewer resources (capital investment and faculty) to implement.

Future Directions for Engineering Management: Many programs interviewed were developing plans to streamline their EM program for articulation with an MBA degree. Possible graduate programs discussed were Product and Service Development, Technology, Engineering Management, and Risk Management with more vigor for students to be ready to handle complex decisions.

Developing the Engineering Management Minor

Reflecting on these two surveys, we reached four important conclusions

1. The level of interest in an Engineering Management degree among UE's traditional employers is low.
2. An Engineering Management degree program requires vigorous promotion among prospective employers and prospective students.
3. It is nearly essential that the degree be EAC-ABET accredited, which in turn requires at least a few faculty have the EM program as their primary focus
4. There is considerable interest among employers, as well as some students, in the possibility of blending a "little bit" of business with engineering or a "little bit" of engineering with business.

Re-examining our originally identified six options in light of the four survey conclusions and our present and near-term future available resources, we eliminated all options except number 5 – an Engineering Management Certificate, based on 12-15 hours of course work in addition to a degree. Upon further discussion and careful examination of both our engineering (including Computer Science) and business degree requirements, we found that with careful planning, a student could incorporate about 15-18 hours into the degree requirements. Because UE is a Liberal Arts-based institution, the idea of "majors" and "minors" is well entrenched; therefore we decided to redesign our EM program as a minor. According to the UE Undergraduate Catalog "A minor will generally require at least 18 semester hours of coursework (some of which may be specified) in the minor subject area." Of course, the typical minor is taken from an area in which majors are available, such as a student whose major is History choosing a minor in Political Science. Since we have no Engineering Management program/department, our minor would be atypical – still, the 18 hour minimum must be met. An important benefit of the "minor" approach is that the primary or "major" degree would still be ABET- or AACSB-accredited; the EM minor would fit into the "unspecified" portion of the degree requirements.

From the beginning, we desired an EM minor that would be available to students in both Engineering and Business. It was apparent that any such minor would need two completely different tracks: engineers would need to learn fundamentals of business and business students would need the fundamentals of science and engineering/technology. Each group provided its own set of challenges. For the engineers, the issue was how to integrate the 18 hours into an already crowded schedule (It was decided at the outset to attempt to design a minor that could be incorporated into the existing eight-semester engineering and business curricula – at least in ideal circumstances- rather than requiring an additional semester.) For the business students, the issue was that they would not normally have the mathematics and science background required for most engineering courses. The minors, as developed, have a further unique feature; they are only

valid when accompanying the particular major, i.e. they can be earned only by engineering or business students, each taking the specific set of courses prescribed. A major in any other discipline, say, History, cannot earn an EM minor.

Engineering Management Minor for Engineering Students The courses required for an engineering major to earn the Minor in Engineering Management are (each is 3 hours credit):

1. INTERDISCIPLINARY 150 - The American Corporation
2. ECONOMICS 101 or 102 - Macroeconomics or Microeconomics
3. ENGINEERING 390 - Applied Engineering Mathematics
4. MANAGEMENT 300 or 377 - Principles of Management or Organizational Behavior
5. MANAGEMENT 310 - Operations Management or CIVIL ENGINEERING 324 Construction Management
6. ENGINEERING 409 - Engineering Economy and Decision Making

This set of courses has essentially a project management focus. Two of the courses, “The American Corporation” and “Macroeconomics”/“Microeconomics” can satisfy UE General Education requirements. Nearly all engineering students are required to take Applied Engineering Mathematics; at least one-half of this course is dedicated to probability and statistics. One of the two Management courses can be used as a Free Elective and the Engineering Economy course can satisfy a Technical Elective requirement, so five of the six courses can be taken as part of the existing requirements. Civil Engineering majors are not permitted to use Construction Management for the EM minor as it is required for the CE degree, so only the sixth course must be taken outside of the requirements for an engineering degree.

Engineering Management Minor for Business Students The courses required for a business major to earn an Engineering Management minor are:

1. ENGINEERING 101 - Introduction to Engineering (Electrical Engineering or Computer Engineering section) or ELECTRICAL ENGINEERING 210 - Circuits (3 hrs)
2. PHYSICS 121 or 210 - College Physics I or University Physics I (5 hrs)
3. CHEMISTRY - 118 Principles of Chemistry (4 hrs)
4. MECHANICAL ENGINEERING - 197 Integrated Design I (2 hrs)
5. MATHEMATICS 134 or 211 or 221 – Survey of Calculus (3 hrs) or Calculus I with Precalculus Review (5 hrs) or Calculus I (4 hrs)
6. CIVIL ENGINEERING 324 OR 374 - Construction Management or Environmental Engineering I (3 hrs)

This set of courses is designed to give the student an eclectic introduction to mathematics, science and the three primary engineering disciplines available at UE; Civil, Electrical/Computer, and Mechanical. While a business student has much more “elective” room in the curriculum than an engineering student, this set of courses is still quite “efficient” as the mathematics, chemistry, and physics courses can all satisfy General Education requirements. The business curriculum requires, at the minimum, Survey of Calculus. The majority of business students currently take “general education/survey” courses in the sciences; the EM minor requires them to step up to the same chemistry that engineering and science majors take plus

either calculus-based physics or the algebra-based physics course taken mainly by health-services majors.

Introduction to Engineering is a project-based course primarily for freshman engineers; it is taught in sections focused on one of Civil, Electrical, Computer, or Mechanical engineering. An EE or CoE section provides a good introduction to electrical and computer technology – typically based in robotics. Particularly adept business students may take the introductory circuits course if they have completed either form of Calculus I.

UE's Mechanical Engineering program features an Integrated Design sequence in which students from all class-levels take a design project course each Spring semester. The course features a team-based design project, often competitive. Underclass students often join teams led by upper-class students and projects often include entries for national competitions (Formula-SAE, Moonbuggy, SAE Aerodesign). The business/EM student gets an introduction to Mechanical engineering by participating on one of these teams.

The two Civil engineering options are courses that are very characteristic of the field, but do not involve particularly high-level mathematics. Construction Management develops skills similar to the business student's own courses in management; it is the construction application that is the most valuable. The Environmental Engineering course will draw most heavily on the chemistry background; at UE, students in Environmental Studies (an Interdisciplinary/Arts and Sciences discipline) take CE 374 alongside our Civil engineers.

Current Status and Summary

All of the changes described were formally implemented during the Fall 2006 semester. The Bachelor of Science in Engineering Management was discontinued and no more students are being admitted to that program. One BSEM student graduated in December 2006 and about 3 remain in the program. Although they will be permitted to complete the degree, two are considering switching (back) to the Mechanical engineering program.

At the same time that the BSEM was discontinued, the new two-track EM minor was approved. A new undergraduate catalog is currently in process, so the availability of the minor will be published first there. We seriously doubt that many students will seek out UE specifically because we offer this minor, but it may help some decide in our favor. We expect that most students who elect to pursue the minor will not discover it until after matriculating at UE.

The proposal for the minor was circulated among our Business and Engineering Advisory Council prior to its submission to the on-campus approval process. Several endorsements were received. The completed package was shared with the Council at its fall meeting.

We trust that this option will be well received by both students and employers. We expect that more engineering students than business students will take advantage of it. Now we must wait for a few years to determine what our on-going assessment reveals about the success of our two-track minor.

Appendix A

Curriculum for Previous Engineering Management Degrees

1976-1996

The EM degree had three formal options: Engineering Management/Civil Engineering Option; Engineering Management/Electrical Engineering Option; Engineering Management/Mechanical Engineering Option. The requirements were as follows:

- All of the first four semesters of the “option” (e.g. all courses required during the first four semesters for a mechanical engineering major). This included 3 credits of Macroeconomics
- Specific courses from the School of Business Administration
 - Microeconomics
 - Two courses in Accounting
 - Principles of Management
 - Production and Operations Management
 - Business Policy
 - Business Law
 - Introduction to Marketing
 - Statistics
 - Introduction to Operations Research
- Upper Level Engineering courses
 - Engineering Economics
 - Engineering Management Research Paper
 - 4(ME), 6(CE) or 10(EЕ) credits of discipline-specific courses
 - 9 credits of discipline- based electives
 - 3 credits to be chosen between engineering or business

1996-2006

The EM degree had only one formal track. It was designed to provide the basics of all engineering disciplines, a very small degree of engineering specialization, and a substantial number of electives to allow a student to customize the program to address a specific career goal

The requirements were:

- General Education, to include Macroeconomics
- Three semesters of Calculus
- One semester each of Chemistry, Physics
- Introduction to Engineering or Introduction to Computer Science plus one course in computer programming
- Statics and Circuit Analysis I

- Three core engineering courses, selected from: Dynamics, Mechanics of Materials, Thermodynamics, Environmental Engineering, Circuit Analysis II, Logic Design, Linear Systems, Data Structures Programming Languages, Software Engineering
- Specific courses from the School of Business Administration
 - Microeconomics
 - Two courses in Accounting
 - Principles of Management
 - Production and Operations Management
 - Introduction to Marketing
 - Quantative Modeling or Business Information Systems
- Engineering/Business Options: Engineering Economics or Fundamentals of Finance; Engineering Mathematics(includes statistics) or Statistics
- Twenty-seven credits of Major Electives (Engineering or Business or closely allied relevant courses)
- Six credits of free elective

Appendix B

Engineering Management Degree Program Survey (Industrial)

Questions are in Roman, Responses in *Italic*

1. Are you familiar with an engineering management degree at the undergraduate level?

- 6 *NO*
- 1 *YES*

2. Do you employ engineering management majors?

- 7 *NO*

Given a graduating student with a background described by the curriculum (sample provided):

3. Would you have entry level positions for graduate with this preparation?

- 3 *YES*
- 3 *Possibly (Not in Engineering)*
- 1 *NO (without significant curriculum changes)*

4. What types of positions would a person with this background be suitable for?

- *Operations and Production supervision and planning,*
- *Asset Management and planning*
- *Systems analysis*
- *Lean Manufacturing/process improvement projects and team leadership*
- *Maintenance planning,*
- *Quality Control*
- *Engineering consulting firm (business analysis and support)*

5. Would this type of graduate be suitable for a track in operations or production supervision?

- 5 *Yes*
- 2 *Yes –but there would be no special consideration due to degree*

6. Would you consider hiring a graduate with an engineering management degree (as described by the enclosed curriculum)? Why or Why not?

- 1 *No*
- 6 *Yes*

7. Would you rather hire a graduate from a “classical” program (Civil, Mechanical, Electrical, Industrial Engineering)
- *Not necessarily*
 - *1 Yes*
 - *1 No*
 - *2 Yes –for technical roles or in engineering departments*
8. Do you offer any internship for which engineering management majors would be eligible? (Full-time, part-time, paid, unpaid)
- *1 Yes*
 - *Sometimes/Future*
 - *4 No*
 - *Perhaps*
9. What are your suggestions regarding the curriculum (consider courses and emphasis)?
- *Lean Manufacturing related courses*
 - *More engineering, few less business courses*
 - *Leadership/management, communication classes*
 - *Logistics and Material Handling*
 - *Project management and financial analysis*
10. Would you expect or desire someone with this degree to have more of engineering or more of a management focus?
- *2 OK as-is*
 - *Engineering, but balanced program mix OK*
 - *Management, but balanced program mix OK*
 - *Balanced OK*
 - *Management*
 - *Engineering*
11. Would someone with this background pass your initial HR screening? In other words, do your current criteria preclude candidates with this type of background from having the opportunity to talk to hiring managers?
- *3 YES*
 - *Maybe – if Lean Mfg. expertise or training*
 - *3 Not for Engineering or experienced positions, but for other positions*

Some Statements From Responses

1. Are you familiar with an engineering management degree at the undergraduate level?
 - *No statements offered*
2. Do you employ engineering management majors?
 - *I don't believe that we have anyone with an engineering management degree; however it is a degree that I would consider for certain applications.*
 - *No, we do not explicitly hire engineers or individuals with engineering training.*
3. Would you have entry level positions for graduate with this preparation?
 - *Yes. We would consider these types of individuals for many of the various supervisory rolls we have as well as some of the more analytical business analysis engineering positions we utilize today.*
 - *We would look at an engineering management graduate for a position in Operations, probably starting as a frontline supervisor (in order to learn our business), with the expectation that they move into a "special projects" position, i.e. improving efficiencies or improving material flow.*
 - *Possibly, but likely as crew leader, not in engineering*
 - *Not in the engineering department, but possibly in another department.*
 - *Not likely without changes to the curriculum.*
4. What types of positions would a person with this background be suitable for?
 - *1st Line Facilitators and Materials Planning/Scheduling*
 - *They would be suited for production supervision, maintenance planning, QC department or technical supervision. They may also be suited to work for an engineering consulting firm.*
 - *If program changes per our suggestions, then we would hire for positions in operations leadership, lean manufacturing leadership, or materials handling/management.*
5. Would this type of graduate be suitable for a track in operations or production supervision?
 - *Absolutely*

- *No more or less suitable than other hires to track to a supervision role.*
 - *They would be considered, but would need to compete with others with a variety of degrees. There is nothing special about this degree that would set them apart from other qualified candidates. Besides the technical skills, soft skills are used to screen/select candidates for supervisory positions.*
6. Would you consider hiring a graduate with an engineering management degree (as described by the enclosed curriculum)? Why or Why not?
- *Yes. We are seeing an increasing amount of emphasis placed on being able to analyze a businesses' operational performance which often requires someone with some engineering skills as well as a strong business background. These types of individuals are seldom found in engineers who have taken a typical path through an engineering organization. They often come from those who have moved throughout the organization and had greater exposure to people and financial management opportunities.*
 - *Our building would consider hiring graduates from this curriculum because of the perspective and discipline that it appears to provide, promoting a strategic and methodical thought process.*
 - *Yes, but not in the engineering department. Typically, engineers or engineering managers have engineering degrees and have worked as engineers. It would be very difficult, but not impossible, for some one to manage engineers or engineering projects unless they have worked as engineers. If we were to sub-contract most of our engineering work and we needed some one to manage and review the contractor's work, then we may consider hiring some one with an engineering management degree. This graduate is more suited to work in a production, technical, QC or maintenance group.*
 - *Not likely per the current curriculum*
7. Would you rather hire a graduate from a "classical" program (Civil, Mechanical, Electrical, Industrial Engineering)
- *No statements offered*
8. Do you offer any internship for which engineering management majors would be eligible? (Full-time, part-time, paid, unpaid)
- *If the program changes per our suggestions, then we would be willing to provide internships to support the student's education. Further, this curriculum should require internships in order to fully teach the Lean Manufacturing principles.*

9. What are your suggestions regarding the curriculum (consider courses and emphasis)?

- *If the target role is production crew leader, some people leadership classes and emphasis would be good*
- *We strongly believe that the Engineering Management degree, while still being based on both basic engineering principles and business concepts, could be much more valuable to industry if a third component were included – Lean Manufacturing. Lean Manufacturing consists of many tools used in manufacturing such as cell design, quick changeover, kanbans, reliability centered maintenance, 5S programs, etc. All of these tools are focused on eliminating waste in the manufacturing world. Toyota’s Production System (TPS) is another embodiment of these principles. If the Engineering Management degree were to include classes and internships in learning and applying these tools, then these graduates would be very effective and valued contributors in industry. And perhaps the better title for the curriculum would become “Lean Manufacturing”.*

10. Would you expect or desire someone with this degree to have more of engineering or more of a management focus?

- *I would have thought that there would be more classes on how to manage from a leadership or communication basis. That being said, I would rather hire someone with strong engineering skills and teach them management aspects to reflect our culture.*

11. Would someone with this background pass your initial HR screening? In other words, do your current criteria preclude candidates with this type of background from having the opportunity to talk to hiring managers?

- *Their degree would be sufficient depending upon the job. This would be suitable for a 1st Line Facilitator, but would not meet the capabilities for an engineering position.*
- *If a graduate from a credible “Lean Manufacturing” curriculum were to approach us today, I am confident that they would be given serious consideration for employment.*

Appendix C

Telephone Interview Questions For Schools With Undergraduate EM Programs

1. Are you accredited by some organization, and if so, which?
2. What is your enrollment in engineering management?
3. What is the number of specific engineering management courses that you offer? (i.e., excluding math, statics, statistics etc which may be offered primarily for other degree programs)?
4. Is your program focused more toward a) engineering (mechanical), engineering (industrial), or management?
5. What is your placement of students in the job market (percentage placed, what types of positions, and number of companies recruiting)?
6. What types of organization typically hire your graduates?
7. In what starting positions?
8. How do you promote the engineering management degree to students and to companies (or hiring entities)?
9. Do your students tend to directly enroll engineering management, or do they transfer from other programs?
10. How many faculties do you have who primarily teach engineering management courses?
11. Does your program include a co-op and internships aspect?
12. Are these paid or unpaid?
13. How many companies (or hiring entities) are involved?
14. What are your feelings on the need or benefit of the engineer management degree at the undergraduate level?
15. What do you see as the future direction of engineering management programs at your institution or in general?