Starting An Industry Centered Manufacturing Engineering Program

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In September of 1996 Western Michigan University starting offering courses in its newly approved Bachelor of Science in Engineering (Manufacturing Engineering) Program in Muskegon, Michigan one hundred miles from its main campus in Kalamazoo, Michigan. Development of the curriculum for the new engineering program was overseen by a committee composed of representatives of the Muskegon area World Class Manufacturing Council (WCMC), Western Michigan University (WMU), and MCC (Muskegon Community College). WMU's dean of engineering and the director (a non-academic position) of WMU's Muskegon Regional Center (MRC) represented WMU. MCC was represented by its dean of community services, a science professor (who teaches engineering physics, statics, and dynamics), and the head of MCC's technology department. WCMC was represented by a group of 13 engineers, engineering managers, and manufacturing managers from 13 local manufacturing companies. This committee developed an overall structure for the curriculum as well as defining specific skills and experiences that the courses in the curriculum should provide:

> "*The goal of this curriculum is to develop students who have the ability to take a product design or concept and <u>design</u> the manufacturing process.* Students must be able to communicate effectively and be problem solvers in an industrial environment.
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> The industrial steering committee further specified that the curriculum must provide
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> - Team experiences
> - An understanding of the design process from concept to customer
> - A working knowledge of probabilities and statistics
> - Extensive opportunity for oral and written communications
> - A working knowledge of CAD, process modeling, and simulation
> - An understanding of how to design for manufacturability
> - A firm foundation in mathematics, science, and engineering science"

Western Michigan University required that (1) the curriculum be EAC/ABET accreditable and (2) the program be self-supporting. The curriculum developed was designed to meet both the requirements of the current ABET criteria as well as the ABET 2000 criteria. During the first three to four years, reduced course offerings and smaller class sizes (plus one time startup costs) were projected to create a shortfall in excess of $470,000. To offset this shortfall, local manufacturing companies, the MCC Foundation, local civic groups, and WMU's Division of Continuing Education pledged $470,000 in supplemental support to underwrite the program.

Indicative of the support this program has had from MCC is the lead in raising funds that was taken by MCC's president. Additionally, the MCC Foundation was a major contributor.

The plan for the curriculum and the plan for conducting the program were submitted to the various committees, councils, and boards with final approval for the program being obtained in the summer of 1996. Almost immediately upon final approval of the program, the Department of Manufacturing Engineering was made operational with the hiring of its first faculty member and the offering of the first WMU course in the program. More complete information on the development of this manufacturing engineering program can be found in Peterson (1996).

The First Year and A Half of the Program

The first WMU class in the manufacturing engineering program, an existing WMU freshman level course (IME 150 - Introduction to Manufacturing), was offered in the Fall 1996 Semester with an enrollment of 12 students.

In the Winter 1997 Semester two WMU courses were offered (MFE 120 - Engineering Design and Verification and IME 310 - Engineering Economy) with enrollments of eight and seven students.

In the Summer 1997 Semester one WMU course was offered (MFE 340 - Design for People at Work) with an enrollment of 4 students.

In the Fall 1997 Semester only two WMU courses were offered (IME 150 for the second time and IME 316 - Report Preparation) as MCC was offering two courses (MATH 215 - Probability and Statistics for Engineers and CIS 185 - "C" Programming) which were needed by all the students and one of which (MATH 215) was being offered for the first time. Enrollments were 9 and 5 respectfully for the WMU courses. Enrollment in IME 316 was limited due to its being offered at the same time as one of the required MCC classes (but this class has separate demand as a required class in the BSIM program).

The faculty of the manufacturing engineering department taught all the above WMU courses, with the exception of IME 316 which is commonly taught by an adjunct faculty member.

In the Winter 1998 Semester a full student load, 12+ credit hours, of WMU courses is being offered (MFE 120, ME 257 - Mechanics of Materials, MFE 440 - Production Engineering, and MFE 444 - Simulation of Industrial Operations). Two of these courses are to be taught by the faculty of the Manufacturing Engineering Department, one by an part-time instructor (ME 257), and one (MFE 444) by the resident member of the Industrial and Manufacturing Engineering Department. Projected enrollments are for six students in MFE 444, six students in ME 257, ten students in MFE 120, and ten students in MFE 440.

During the course of the 1996-1997 school year, advising for students entering the program was initially provided by the department chair when in town to advise local students in the graduate programs in industrial engineering and engineering management and the undergraduate program in industrial management. After initial advising, the faculty of the department of manufacturing

engineering provided ongoing academic advising. As the year progressed, the Manufacturing Engineering Department's faculty provided all advising for the manufacturing engineering program. With the start of the 1997-1998 school year the Manufacturing Engineering Department faculty was assigned advising responsibility for both the manufacturing engineering (BSMfgE) program and the industrial management (BSIM) program (for Muskegon Regional Center students).

Student recruitment has been a major activity during the first year and a half of the program. Muskegon Community College has played a major role in this activity. MCC's math and physics instructors have actively presented the program to their pre-engineering students as a viable option for their consideration. MCC's Internship/Apprenticeship Coordinator, MCC's Dean of Community Services, and MCC's Director of Business and Industrial Training are among the programs best recruiters for both traditional and non-traditional students.

The industry members of the Manufacturing Engineering Advisory Committee (the restructured Steering Committee) and their companies have continued to play an active role in program development and oversight. Additionally, the member companies are actively recruiting non-traditional students for the program from their current employees and offering intern opportunities for traditional students in the program. Currently, these companies and others have more demand for interns than the program can supply.

Some Lessons Learned

Several valuable lessons have been "learned" during the first year and a half of the program. Some of the lessons learned were confirmation of beliefs that were held and some surprises were discovered.

Student Growth Is Slow

The number of students in the initial classes has been below expectation. Several reasons were found for this in addition to the anticipated inertia problem of any new program.
The initial class (IME 150) drew a mix of students with the majority well into a pre-engineering program or even having essentially completed a pre-engineering program at an earlier date. The majority of these students were employed full time with local companies. The employed students, who may even hold positions with "engineer" in their titles, intend to take from one course to a full load (approximately four courses). Due to financial aid complications associated with taking classes at two schools at one time and funding support being from just one institution (in this case the community college) some problems occurred. The financial aid issue seems to be resolved but may have little impact as the traditional freshman student population appears to be avoiding the more expensive WMU courses as long as possible. Conversely, the non-traditional students, supported by their employer, want to take WMU courses as soon as possible.

As with any new program it will take time to fully establish its student base and to fill the lower division pipeline. This is especially true with a 2+2 program where the students may be earning an associate degree (with courses that do not apply to the BS degree) and where a sizable portion of the potential student start below the pre-calculus level in math (with the resulting lengthening of the critical path for degree completion).

Also impacting initial enrollment are the course specifications for the program which (as with MATH 215) call out lower division courses which are not in the general pre-engineering program at the community college and were added for this degree program. The first group of manufacturing engineering students took their "last" community college course in the Fall 1997 Semester, with another group projected to finish all community college courses in the Spring 1998 Semester.

During the first year and a half of the program there was a requirement to offer courses for program visibility, but enrollment during this period was understandably low.

Internships Can Impact Enrollment

Local companies, and especially the ones represented on the program steering (now program advisory) committee, are actively recruiting interns and coop students to provided needed technical staff for their companies. This has several advantages including (a) help to the students in funding their education, (b) relevant experience in their chosen field, and (c) allowing the students to more easily see the relevance of what is being taught in the program.

There is, however, a down side to internships in the current economy and in the Muskegon area in particular. One of the reasons for starting the program was to fill a need for engineers coupled with location related recruiting difficulties. The interns drawn from the manufacturing engineering program's students (who are area residents) appear to be doing well in their positions that the employers are increasing their hours per week and in some cases offering the interns full time positions as technicians, junior engineers, and, in one case, an engineer (with the understanding that they are to continue working to complete their degree).

Increased levels of employment result in reduced courses per student per semester and require that the student base be increased to meet course enrollment goals. Currently it is projected to require 48 students in each academic year (junior and senior) to meet the enrollment goal of 24 students per course. Original estimates were for 36 students in each academic year to meet the enrollment goal.

Currently, all the students in the program seeking internships are employed. A backlog of requests for student resumes for internship positions exist. This appears to be attracting students to the program. Additionally, local students interning with local industry, who were planning to go out of the area at the completion of their pre-engineering studies at the community college or are currently at another college, are discussing transferring into the manufacturing engineering program.

An Alternative to an Engineering Program For Many Students Is Needed

The promotion for the manufacturing engineering program has generated a large amount of interest by potential non-traditional students. Unfortunately, many of these potential students have two or more years of college, are fully employed, and have limited free time to pursue a degree. The most significant problem is that the vast majority of these students have no calculus, no engineering physics, and no chemistry. From all their previous college work there *may* be one

semester of course work which can apply to the manufacturing engineering degree. These students generally end up going into WMU's' BS Industrial Management program (a program with a basis in industrial engineering technology and designed for the non-traditional student). For these students the BSIM degree can be completed in less than half the time required for the BSMfgE.

This alternative program also allows the manufacturing engineering faculty to be assigned to teach in the alternate program when not needed in their own program. Additionally, the graduate programs in industrial engineering and engineering management allow faculty members to "swap" course in appropriate areas of expertise providing richer student experiences in both programs.

Flexibility In Planning Is Critical

The original plan included the addition of a second faculty member in the second year of the program. Based on student interviews and the resulting projections of student enrollment this second tenure-track position was not filled. The current projection is for this position to be filled in the third year of the program.

These student interviews and enrollment projections also showed that the current student population in the program requires night classes. The first year's classes were exclusively evening offerings. The second year's classes are a mix of both afternoon and evening classes. In general, the traditional student wants day classes and the non-traditional student needs evening classes. The program cannot be both full-time and evening only (Monday through Thursday are the non-traditional student preferred nights) due to half the classes having laboratory components which result in many 3 credit courses meeting for five hours per week - a two hour lecture and a three hour lab.

The result is that non-traditional students taking two courses are on campus three or four nights a week for six to eight credits per semester. Since 12 credits are required for full time student status, the two additional classes must be offered during the day - in this case the afternoon, so that the class hours can be contiguous. Additionally, each course must rotate between an afternoon and an evening offering to accommodate the typical, non-traditional, part-time student. The non-traditional student, who desires to progress at a fast pace, appears to have less difficulty being released from work to take a late afternoon class and this complements the community college typical schedule of offering calculus and engineering physics in the morning leaving traditional students free to take program courses concurrently where appropriate.

The coordination of MCC and WMU classes schedules was a major concern during the first two years as the first group of students, who have a variety of academic backgrounds, were completing community college courses which are prerequisites for WMU courses. The students were (and still are) advised to complete the math, science, engineering basics, and computer courses as soon as possible. This has had an initially negative impact on WMU enrollments, but by the middle of the second year allows WMU to accurately forecast future class enrollments and minimize offerings which will have low potential student populations due to missing lower

division prerequisites and reduced student options due to completed courses and the structured nature of the engineering curriculum.

Year Around Course Offerings Are Needed

By the end of the first year of the program it was deemed necessary to modify the course offering plan to allow students to take courses during the spring and summer semesters (which are each half as long as winter and fall semesters with correspondingly more frequent class meetings). To allow the part-time non-traditional student to complete the program in a reasonable period of time at least 5 courses need to be completed in each calendar year. For non-traditional students a 2-2-1-0 (Fall-Winter-Spring-Summer) or 2-2-0-1 schedule appears appropriate. This allows the student one extended period per year without classes. The courses offered during the short semesters are typically 3 credit courses without laboratory requirements. The required upper division philosophy course (PHIL 316 - Ethics in Engineering and Technology) is a prime candidate for this offering since it meets the profile of an appropriate course and full-time WMU faculty are available to teach the course during this time period. A typical engineering course to be taught in these semesters is engineering economy (IME 316).

Implementation of the Program Needs the Same Features as The Introduction of Any New Technology

The framework developed by Peterson (1995) for the evaluation of the likelihood of the successful implementation of new technologies seems to apply to this situation as well as it does to any other change situation (Wyrick and Peterson, 1995). Several key features found in this implementation include an executive sponsor (the dean of the College of Engineering and Applied Science), managerial support of the program (the dean of Continuing Education and the chair of the department, who also chairs the Department of Industrial and Manufacturing Engineering on the main campus), a generally successful history of introducing new degree programs (although this is a unique engineering program for the university), clearly articulate and disseminated goals and strategies for the program (as well as their ties to the goals and strategies of the university as a whole), and ownership of the program by the people who are implementing it (the department's faculty).

Conclusion

The manufacturing engineering program developed by Western Michigan University, Muskegon Community College, and their industrial partners has the potential to be a powerful paradigm for the establishment of manufacturing engineering programs where needed and at relatively low cost to both the students and the offering institutions. The manufacturing engineering program at Western Michigan University was designed by industry to meet local industry needs and shows how an industry centered program can be developed - educating job-ready engineers, who will be contributing to their organizations growth from early in their careers with the ability to continue developing new skills to meet changing needs thoughout their careers. Although the program was designed to meet industry needs it is also structured to meet the education and accreditation requirements as established by EAC/ABET.

As with any project, there are lessons to be learned and applied if the project's goals in time, cost, and performance are to be achieved. Western Michigan University, Muskegon Community

College, and industry in the Muskegon area are applying the lessons they are learning in an ongoing attempt to successfully implement their manufacturing engineering program.

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