

First Graduates – The First Cycle In a New Manufacturing Engineering Program

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Abstract

This paper chronicles the three and a half years of offering courses in a manufacturing engineering bachelor's degree program and the first graduating class from this program. The program was designed to meet the specific needs of manufacturers in the western Michigan area where it is offered. The program - a joint effort of Western Michigan University, Muskegon Community College, and local industry - is offered exclusively at one of the university's regional centers located on a community college campus. The efforts of the different partners during this time are reported, as are some of the lessons learned.

Background

In September of 1996 Western Michigan University (WMU), in partnership with Muskegon Community College (MCC) and industry in the Muskegon, Michigan region, began offering a bachelor's degree in manufacturing engineering in its entirety, through on-site classes in Muskegon, Michigan. Muskegon is approximately 100 miles northwest of Kalamazoo, the location of the campus of WMU and where WMU traditionally offers its undergraduate engineering programs. MCC programs include arts and science associate degrees that are articulated with the state's four-year colleges and universities and a variety of vocational and technical degrees utilizing state-of-the-art laboratory facilities (including drafting and CAD, machining, metallurgy, metrology, robotics and automation, and electronics).

Muskegon Community College (MCC) has a new 95,000 square foot building, the Higher Education Center (HEC), where three cooperating universities (including WMU) were to offer upper division and graduate courses. MCC was (and is) extremely interested in expanding the upper division offerings from cooperating universities to better utilize the new facility and to

offer opportunities for its students to continue their education locally and in as seamless a manner as possible.

WMU's presence in Muskegon is the Muskegon Regional Center (MRC), a branch of WMU's Division of Continuing Education. The MRC offers courses toward a bachelor's degree in engineering technology, a BA/BS in General University Studies, several masters' degree programs (including engineering management and industrial engineering), and a teaching certificate program. These WMU programs are primarily for part-time evening students. The MRC uses regular WMU faculty members, who commute from Kalamazoo one night a week, as well as local part-time instructors. Only one WMU faculty member (a tenured professor from the Department of Industrial and Manufacturing Engineering teaching courses in the MS Engineering Management program, MS Industrial Engineering program, and the BS in Industrial Management program) was originally located in Muskegon. The MRC staff consists of the regional center director and her secretary with occasional part-time (student) office assistants. The Muskegon Regional Center moved from nearby rented space to the Higher Education Center at Muskegon Community College upon completion of construction.

The development of a WMU engineering degree for Muskegon was initiated by a Muskegon area industry group, the World Class Manufacturing Council (WCMC) that had identified the need for additional engineers in the region. After a study indicated that a bachelor's level engineering program in Muskegon was viable, development of a proposal to establish an engineering program was initiated by WMU. Early on it was decided that a location-specific engineering program would be needed for Muskegon and that it should be tailored to local needs. WMU established two basic requirements that had to be accomplished by any off-campus engineering program: (1) that curriculum be accreditable by EAC/ABET (in keeping with College of Engineering and Applied Science policy) and (2) that the off-campus program be self supporting (in keeping with WMU policy).

To ensure meeting local needs and expectations, a committee composed of representatives of local industry (taken from the WCMC), WMU, and MCC oversaw program development of the curriculum for the new engineering program. WMU's dean of engineering and the director of WMU's MRC (a non-academic position) represented WMU. Its dean of community services, a science professor (who teaches engineering physics, statics, and dynamics), and the head of MCC's technology department represented MCC. 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 design the manufacturing process.

Students must be able to communicate effectively and be problem solvers in an industrial environment.

The industrial steering committee further specified that the curriculum must provide

- 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”

Based on this goal and these requirements, the degree earned through the new program was defined to be a “Bachelor of Science in Engineering (Manufacturing)” - WMU’s engineering degree’s are awarded as BSE (Specific Area) and are accredited as discipline specific degrees (not general engineering degrees with concentrations in an discipline). Selection of the BSE (Manufacturing) - (BSMfgE) - degree for the program simplified development of a location specific degree, as WMU did not then offer the BSMfgE. This degree differentiation also simplifies the accreditation process both for the new degree and for existing degrees.

From this goal and these requirements, a sequence of courses was developed using existing MCC courses, existing WMU courses, and new WMU courses tailored to the needs of the new program. A sequence of courses was selected to allow the program to meet both the “old” and “new” EAC/ABET criteria for manufacturing engineering programs. Additionally, the degree was designed to be offered on a two plus two (2 + 2) basis. MCC was to teach the lower division courses (60 semester hours) and WMU was to teach the upper division courses (as well a three lower division engineering courses - one course per semester during the freshman year and one course in the sophomore year - or 70 credit hours). The resulting program contained 15 new courses - 13 MFE (manufacturing engineering) courses and 2 electrical engineering courses (new courses with their content tailored to the requirements of this program). The faculty of WMU’s College of Engineering and Applied Science did development of specific courses. The input from industry was also used in course development. An example of this was surveying the industry members of the committee to select and rank topics in the quality field for the course in quality assurance.

To teach the new MFE courses, a new department in the College of Engineering and Applied Sciences, the Department of Manufacturing Engineering was established in Muskegon. Although a Department of Industrial and Manufacturing Engineering exists at the Kalamazoo campus, it does not offer a degree program in manufacturing engineering - its most closely related bachelor degrees are in manufacturing engineering technology and industrial engineering. The establishment of a new department located in Muskegon (with offices in the HEC at MCC) placed WMU faculty on-site for teaching, student advising, and student recruiting and retention. It also allows the manufacturing engineering department to set policy and procedures to reflect the expectations of the college for this faculty unit. The chair of the Department of Industrial and Manufacturing Engineering serves as chair the Department of Manufacturing Engineering.

The startup phase of the program was projected to take 4 years. During the first three years, reduced course offerings and smaller class sizes (plus one time startup costs) were projected to create a shortfall in excess of \$400,000. 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 startup funds that was taken by MCC's president.

Program Initiation

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.

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 courses were offered (MFE 120 - Engineering Design and Verification and IME 310 - Engineering Economy) with enrollments of 8 and 7 students. In the Summer 1997 Semester one course was offered (MFE 340 - Design for People at Work) with an enrollment of 4 students.

During the next two and a half years, in the Fall and Winter Semesters, a minimum of 12 credit hours of engineering course work have been offered. With the conclusion of the Fall 1999 semester each course in the curriculum has been taught at least once.

With the completion of the first full cycle of courses, students are beginning to graduate from the program. At the end of the Fall 1999 Semester four students will be awarded the BS Engineering (Manufacturing) degree. Three additional BS Engineering (Manufacturing) degrees should be awarded at the conclusion of the Winter and Spring 2000 Semesters. Of the seven students in this class, three took the first class offered in the program. Three of the remaining students in the 1999-2000 graduating class started in the second year of the program, while the remaining student transferred into WMU from another institution later in the second year. Currently, at least three students are projected to graduate in the 2000-2001 Academic Year.

Six of the seven students in the first graduating class are basically traditional students. The major difference from the traditional student profile is that all of these students worked at least 30 hours per week during their two and a half to three and a half years in the program. Several of the students were full time employees for most of this time. During their time in the program most semesters, including several spring/summer semesters, these students carried a full-time load of classes. The seventh student in this group had completed a tour in the military prior to starting his college career.

Advising for students entering the program was initially provided by the department chair when this individual was in town to advise off-site engineering students in a variety of programs. After initial advising, the faculty member of the department of manufacturing engineering provided ongoing academic advising. By the start of the second year of the program all advising for the

manufacturing engineering program was provided by the Manufacturing Engineering Department faculty.

Some Lessons Learned From the First Class

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

Lesson 1: 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.

As with any new program it takes time to fully establish the student base and to fill the lower division pipeline. This is especially true with a 2+2 program where many of the students are part-time. Some students earn an associate degree (with courses that do not apply to the BS degree) prior to starting in the program. A significant number of the potential students start below the pre-calculus level in math (with the resulting lengthening of the critical path for degree completion).

Also lengthening the time for the first classes were the specific courses specified for the program which (as with MATH 215) call out lower division courses that are not in the general pre-engineering program at the community college. Additionally, the program sees a significant influx of students from other programs (both engineering and non-engineering) and other colleges which significantly lengthens the time to complete a degree especially if pursuing the degree on a part-time basis.

A significant obstacle to filling the pipeline is the number of part-time students in the program. Several students are taking courses at the rate of two courses per year. Many are taking about 5 courses per year, which equates to one full time semester per year. This, along with the 2+2 nature of the program, means that it is not going to be uncommon for it to take in excess of four years for an entering freshman to reach the upper division section of the program.

The major lesson learned is that recruiting is the key to success. There has been part-time recruiter budgeted for next year to supplement initial recruiting efforts by the faculty and regional center director.

Lesson 2: Evening Classes are Paramount and Flexibility In Planning Is Critical

Student interviews and enrollment projections show that the current and future student population for the program requires night classes. The first year's classes were offered exclusively evening offerings. The second year's classes were 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 student preferred nights) due to half the classes having laboratory components which result in many 3 credit courses meeting for 5 hours per week - a 2 hour lecture and a 3 hour lab.

The result is that non-traditional students taking two courses are on campus 3 or 4 nights a week for 6 to 8 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 (allowing the student to intern with local companies). Thus, each course must rotate between an afternoon and an evening class offerings to accommodate the typical non-traditional 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 had an initially negative impact on WMU enrollments. By the middle of the second year WMU could accurately forecast future class needs of known students.

In the first four years of the program, course scheduling was reactive to enrollments, student progress, and student desires (i.e. when did they want to graduate and how many courses were they willing to take in a given semester). In year six the MFE program will be offering a fixed rotation of courses. Year five of the program will have a schedule of courses, which bridge the gap.

Lesson 3: Year-around Course Offerings

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 meeting). 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 to work best (or be most acceptable to students). 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 310). Other courses are offered over both Spring/Summer semesters.

The need for year around course offerings also accommodates the full-time student who is working full-time as an employee of a local company or part-time as an intern with local companies. Twelve credits are the most these students can fit into their schedules. Since the curriculum requires 16 to 18 credits per semester, a third semester of eight to twelve credits is needed. The students and local companies enthusiastically support the full year intern (versus rotating coop plans) so the MFE program has evolved into three semesters per year, which allows students to still graduate in four years with extensive practical experience.

Conclusions

The manufacturing engineering program at Western Michigan University was design by industry to meet local industry needs. The program is designed to develop job-ready engineers, who will be contributing to their organizations' growth from early in their careers. All four of the students graduating at the end of the Fall 1999 Semester are employed. Two of the four have been full time employees during their entire time in the program. One was hired into a full-time engineering position during his last semester. The fourth student started a full-time position concurrent with graduation. All are staying with the company with which they were associated (as either a student intern or full-time employee) during their senior year.

Of the three students graduating in the next two semesters, two are currently full-time employees (in engineering positions) and the third has accepted an engineering position at which he will work while completing miscellaneous remaining courses.

Industry is getting job-ready engineers with the skills that they need. Industry has a local source of engineering education for current employees. Muskegon Community College has an on-site program in engineering into which their students can move into upon completion of their associate degree. Western Michigan University has a paradigm for offering BS Engineering degrees at remote locations. Another city and its community college have requested that the Manufacturing Engineering program be made available on-site. The plan to accomplish this is currently in process.

The next hurdles for the program are increasing the faculty size, obtaining ABET/EAC accreditation, and growing the student enrollment to a breakeven point.

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William R. Peterson is an Assistant Professor of Manufacturing Engineering at Western Michigan University. He was the first faculty member in the Manufacturing Engineering program in the case reported above. Dr. Peterson received a BIE degree from Auburn University in 1970, an MBA from Kearney State College in 1984, and a Ph.D. in Industrial and Systems Engineering in 1995. Prior to returning for his doctorate in 1990 Dr. Peterson was an engineer/engineering manager in a wide range of industries.