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Mark Federle is currently the McShane Chair in Construction Engineering and Management at Marquette University. He has started Construction Engineering and Management program at MU. Previously he was Chief Information Officer for The Weitz Company in Des Moines for 9 years. During his time at Weitz, the company was recognized with several Vision Awards. Prior to joining The Weitz Company, Federle was the Professor-in-Charge of the Construction Engineering program at Iowa State University, where he taught for nine years. In 1998, Mark was recognized by the ISU engineering student council as the outstanding Construction Engineering Faculty Member. In 1999, he was honored as the Outstanding Engineering Advisor. Mark's career began in the construction industry working as a foreman, superintendent, and project manager for general contractors in Indiana and Michigan. Mark earned his PhD and Masters in Construction Engineering and Management from the University of Michigan. Mark is a licensed Professional Engineer in Iowa and Wisconsin, a Certified Professional Constructor and is a Fellow in the American Society of Civil Engineers. Mark was awarded The Career Achievement Award by Rose-Hulman in 2005. He has served on the national boards and committees for many organizations, including the AGC, the Lean Construction Institute, and ASCE. He has actively served as a judge for the Vision Awards for the past several years. In Milwaukee he is active with the Construction Leadership Council of AGC of Greater Milwaukee and serves on the Advisory Board for the AGC Building, Architecture, & Technology Leadership Academy at Bay View High School.

Starting a Construction Engineering and Management Program

Submitted by: Mark Federle, Marquette University

Abstract:

Marquette University decided to start a Construction Engineering and Management program during the 2007 academic year. An endowed chair, titled the McShane Chair in Construction Engineering and Management, was funded by Jim and Kelly McShane to run the program. After a national search, Mark Federle, an executive with a large construction firm and previous academic experience at Iowa State University, was hired to start the program. The first class of students were enrolled in the fall of 2008. This paper will present the opportunities/challenges in starting a Construction Engineering and Management program. Lessons learned, comparisons to other programs, and other pertinent information will be shared. The program will be undergoing an ABET evaluation during the fall of 2012, if successful it will result in Marquette University having one of less than 15 such programs across the country. To this time, there have been twelve graduates from the program.

Introduction

The impetus for the establishment of the Construction Engineering and Management Program (CEMA) at Marquette came from the alumni. The college has a significant number of prominent alumni now working in Construction and Engineering Management. Over the years, from various conversations with these alumni we learned that the industry and our alumni wanted Marquette University to start a CEMA program at Marquette. The college conducted a marketing and feasibility study and determined that a CEMA program would be a sound investment for Marquette.

In the fall of 2006, the college received a \$5 million gift from two of its alumni, Jim and Kelly McShane, to endow a named Chair in CEMA entitled McShane Chair in Construction Engineering and Management. With this gift in hand, in the fall of 2006, the Civil Engineering department chair prepared a proposal for the Provost to start a new program which was accepted. Subsequently a national search began to hire the McShane chair in Construction Engineering and Management, and an industrial advisory board was assembled to advise the new program on all aspects of its activities.

The Chair search was successful and at the end of 2007, the college hired Dr. Mark Federle to run the new program. He arrived in April 2008.

The program was started in the fall of 2008, accepting both entering freshmen and returning sophomores into the program. During the fall of 2008, with the advice of the Construction Engineering and Management Advisory Council, a technical elective was replaced with a required course Construction Materials and Methods (CEMA 3860). Additionally, changes in the 2011 Math sequence for the Civil Engineering program resulted in the faculty voting to match those changes within the Construction Engineering program.

This paper will present the opportunities/challenges in starting a Construction Engineering and Management program. Lessons learned, comparisons to other programs, and other pertinent

information will be shared. The program underwent an ABET evaluation during the fall of 2012 – if successful that would result in Marquette University having one of less than 15 such programs across the country. To this point there have been 14 graduates from the program.

Within this paper, these topics will be reviewed:

- Developing a program in a Jesuit University
- Creating buy-in/enthusiasm amongst the industry during a downturn
- Managing prerequisite requirements
- Establishing meaningful Senior Design Experiences
- Maintaining degree requirements

Developing a program in a Jesuit University

One of the first challenges that had to be addressed in creating a new program was balancing the degree requirements that a Construction Engineering and Management program has relative to the ABET curricular requirements and those that are required by our University. Marquette University has a Common Core of Studies that each student is required to complete (as described in our bulletin):¹

The Core Courses

Each knowledge area in the common core provides an essential part of an integrated set of ideas, intellectual approaches, and values. As these courses are completed, a student will be able to see more and more of the “big picture,” that is, the way the approaches of different intellectual disciplines can be brought together to address human problems. Through the courses in the Core, the foundation for a well-rounded education that declares, “We are Marquette” has been established. Students start with courses in rhetoric (6 credits) and mathematical and logical reasoning (3 credits). Then they take basic theology, ethics and human nature courses (with need 6 credits of theology and 6 in ethics and human nature required). Students then add courses in science and nature, individual and social behavior, literature and performing arts, histories of cultures and societies, and diverse cultures (with three credits required in each area).

Totals

The Core of Common Studies is completed by taking:

- 6 credits of Rhetoric
- 3 credits of Mathematical Reasoning
- 3 credits of Literature and Performing Arts
- 3 credits of Histories of Cultures and Societies
- 3 credits of Science and Nature
- 3 credits of Individual and Social Behavior
- 3 credits of Diverse Cultures
- 6 credits of Theology
- 6 credits of Human Nature and Ethics
- 36 total credits

Thus before beginning to address the ABET requirements there are 36 credit hours required (it should be noted that only 6 of those hours (3 credits of Mathematical Reasoning and 3 credits of Science and Nature) fit within an ABET General Criteria 5: Curriculum requirements.²

These requirements are both a challenge and an opportunity; the Advisory Council for the program felt strongly that the common core of studies leads to a much more rounded education for engineering students. Because we had this starting point in creating our curriculum, the natural tension that is sometimes created in trying to fit as much technical content in as possible was simply eliminated (since there was nothing that could be done to change this University requirement it seemed much more readily accepted by the faculty and advisory council than this author has experienced at other universities).

The Plan of Study for the original curriculum is shown below:

CONSTRUCTION ENGINEERING AND MANAGEMENT DEGREE (2009)			
<u>FRESHMAN YEAR</u>			
<u>FIRST SEMESTER</u>		<u>SECOND SEMESTER</u>	
CHEM 1001 ^b , General Chemistry 1	4	CHEM 1002 ^b , General Chemistry 2	4
MATH 1450 ^b , Calculus 1	4	MATH 1451 ^b , Calculus 2	4
Core Rhetoric 1 ^f	3	Core Rhetoric 2	3
GEEN 1200, Discovery Learning 1	3	GEEN 1210, Discovery Learning 2	3
Core Elective ^{c,1}	<u>3</u>	ECON 1001 ^{b,1}	<u>3</u>
	17		17
<u>SOPHOMORE YEAR</u>			
<u>FIRST SEMESTER</u>		<u>SECOND SEMESTER</u>	
PHYS 1003 ^b , Physics 1	4	PHYS 1004 ^b , Physics 2	4
MATH 2450, Calculus 3	4	MATH 2451, Differential Equations	4
GEEN 2951, Engineering Orientation	0	ACCO 2031, Managerial Accounting	3
CEEN 2310, Surveying	3	Core Elective ^{c,1}	3
CEEN 2110, Statics	3	CEMA 3810, Intro. to Constr. Mgmt.	3
ACCO 2030, Financial Accounting	<u>3</u>		
	17		17
<u>JUNIOR YEAR</u>			
<u>FIRST SEMESTER</u>		<u>SECOND SEMESTER</u>	
CEEN 3160, Geotechnical Engineering	3	CEEN 3410, Structural Analysis 1	3
CEEN 2130, Mechanics of Materials	3	CEMA 4815, Mechanical and Electrical Systems for Buildings	3
CEMA 3860, Construction Materials and Methods	3	CEEN 3320, Engineering Materials	3
MATH 4720, Statistical Methods	3	FINA 3001, Managerial Finance	3
HURC 3001, Management of Human Resources	3	CEEN 4350 Law for Engineers	3
PHIL 1001 ^b , Phil. Of Human Nature	<u>3</u>	CMST 1300, Public Speaking	2
	18		17
<u>SENIOR YEAR</u>			
<u>FIRST SEMESTER</u>		<u>SECOND SEMESTER</u>	
CEMA 4830, Construc. Planning, Scheduling and Control	3	CEMA 4840, Construc. Cost Analysis and Estimating	3
PHIL 2310 ^b , Theory of Ethics	3	CEEN 4997, Civil Engineering Design	4
CEMA 3850, Construc. Equipment and Methods	3	CEEN Technical Elective (design) ²	3
CEEN Technical Elective ²	3	THEO Elective	3
THEO 1001 ^b Introduction to Theology	3	Core Elective ^{c,1}	3
	15		16
		Total Credit Hours	134

¹ As ECON 1001 which meets the core Individual and Social Behavior Knowledge area, remaining Core electives should be taken so as to address History of Cultures and Societies, Literature and Performing Arts, and Diverse Cultures.

² Note that co-op is required for the CEMA program. One academic credit is awarded for each co-op work term completed, three of which can be used as a technical elective towards degree requirements.

Table 1 – Construction Engrg Curriculum 2009

Creating buy-in/enthusiasm amongst the industry during a downturn

One of the interesting challenges that developed within the first year of the program was the downturn in the Commercial Construction Market, by some accounts, dropping 28% during 2009³ which created a number of challenges for the new program.

The first challenge was in the recruitment of students; the growth of the program depends on parents and prospective students seeing construction as having strong job prospects, this was simply not the case in 2009 or 2010 (at least within this part of the country). Much of the student recruitment effort, therefore, focused on the expectation that the industry would have recovered before students entering the program had graduated. While that analysis somewhat helped in the recruitment of students, it had a negative impact on the ability of the students recruited to find co-op positions (which is a degree requirement unique to the Construction Engineering and Management program at Marquette University). It is important to note that there were several students who chose to switch their major from CEMA to another Engineering degree simply to avoid this co-op requirement that was seemingly impossible to meet for those students.

The second challenge was helping students find placement in construction firms. Because most of the other engineering disciplines tended to have a few companies that hired broadly within the curriculum there was a need to help career services and the co-op placement office understand that most construction firms would likely only ever hire one or two students in any one academic year; they were much more accustomed to fostering a few significant relationships rather than having a broad based effort to provide as many opportunities as possible. A significant amount of effort in outreach to construction companies and associations was required. Because the student body is much more geographically dispersed than in typical construction programs, this required much more effort than was originally anticipated. Additionally, most construction firms had hiring freezes (at best) or reduction in forces that made job searching for the students significantly more challenging.

Managing prerequisite requirements

One of the early challenges that was created in starting a new program with several new courses was how to provide students with the opportunities to take courses as soon as possible without violating the prerequisites that had been established. In some cases these prerequisites were less about the knowledge that would be gained in the earlier courses being used in subsequent courses and more about the need to create a lock-step process for student enrollment. In addition, the required co-op and the limited faculty meant that in all cases, the Construction Engineering and Management courses could only be offered one time per year.

It has been determined that this will be an on-going problem. To satisfy ABET requirements and ensure that students are not taking courses out of sequence, Curriculum substitution forms must be completed by the students and signed off not only by the program chair, but also the department chair and the College Assistant Dean of Academic Affairs. This has resolved the challenge but has led to an increase in the amount of paperwork required during the advising process. Also, due to the differences between this program and the others in the College of Engineering, one of the more interesting challenges is fighting the student rumor mill that certainly is a more efficient and rapid communication channel than sending out advising emails. Students at Marquette University seem very willing to accept the advice of other students or

assume that what another curriculum requires is the same as within their curriculum. This has created challenges in ensuring standard policies and procedures are followed for all students within the curriculum.

Establishing meaningful Senior Design Experiences

Another challenge that exists in creating a Construction Engineering program is to establish meaningful Construction Engineering Senior Design Experiences. There were a multitude of challenges related to this aspect of the program. The first is working to overcome the mindset and terminology used within the Civil faculty and alumni of Construction Management rather than Construction Engineering. The Civil Engineering – Construction exam on the Professional Engineers licensing exam, defines design experiences related specifically to construction engineering using a common language to define these experiences: From the NCEES website, construction depth is specifically tested in these areas⁴:

- I. Earthwork Construction and Layout
- II. Estimating Quantities and Costs
- III. Construction Operations and Methods
- IV. Scheduling
- V. Material Quality Control and Production, and
- VI. Temporary Structures.

This definition provided the framework to define the types of experiences that would be sought from our industry mentors sponsoring senior design experiences. However, this remains an on-going issue with some of the faculty, who seem to primarily define construction engineering design as being closely aligned with structural design. Moreover, some of the experiences proposed by our industry mentors seem more focused on referring to topics of Construction Engineering with the words Construction Management, this has led to a perception (at least within a subset of the faculty and students within Civil Engineering that these projects are somehow less appropriate (or perhaps worthy) than Civil Engineering projects. Thereby requiring a consistent and persistent effort by the faculty to reinforce the ABET requirement the Construction Engineering Design experience.

Furthermore, it was determined that the students tended to prefer to work in teams of only Construction Engineering students on their projects (at least in part because of common coursework and time availability issues). It was imperative to meet the ABET requirements of a cross-disciplinary approach that the faculty leading the senior design course understand the need for mixed teams working on these projects.

Maintaining degree requirements

There has been interesting challenges related to maintaining the degree requirements within the Construction Engineering program. The first has been maintaining the degree requirement of a three-semester co-op experience during the worst economic slowdown in construction since the great depression. While the co-op specifically requires alternating work-terms for students after their sophomore year, the change in the economic situation for most contractors who had typically employed Marquette University students was such that this was no longer a viable option. With the input from the advisory council, the faculty was tasked with developing

internships and other work experiences that would support the goals of the required co-op (work experiences for all students prior to graduating) and the realities of a limited number of those work experiences being available. Through a concerted effort in contacting as many contractors and engineering firms who might hire construction engineers and relying on the support of the alumni and friends of Marquette, along with specific and consistent encouragement of the students, it has been possible to maintain this requirement through the flexible definition of what a co-op means. As the economy has recovered, this has allowed the requirement to be enforced for all but 2 years of graduates; even then, less than half of the students did not meet the formal definition of the co-op with all but two students having at least 2 internship or co-op terms.

Lessons Learned

1. A close connection with industry is critical – especially through the economic downturn, growing a program and maintaining the co-op requirement required a significant amount of industry interaction – this is critical to the success of the program.
2. Involve industry in the classroom – our students benefit from having guest speakers both in class and in the student organizations – this lead to significant synergy for co-op and full-time positions.
3. Have meaningful measures of success – for this program it meant 100% placement of co-ops and graduates (within one month of graduating).
4. Recruit students – both in the high school and from other programs at Marquette, it was very important to provide enthusiasm for the construction industry – especially given the challenges finding jobs (and the negative press that construction received from 2009 through 2012).
5. Develop active mentorship within student chapters – the program leader is an advisor to three different student organizations that has increased enrollment within the program

Conclusion

The challenges in starting what will hopefully become the 13th ABET-accredited Construction Engineering program starting in July of 2013⁵ within a Jesuit institution provide lessons for other universities seeking to start similar programs. Clearly the growth in Construction Engineering programs in the US indicates that the potential exists for an increasing number of Colleges of Engineering (6 of the current 12 programs have received their initial accreditation since 2006) with more currently planning on an accreditation visits in the next several years.

¹ <http://www.marquette.edu/programs/core/overview.shtml>

² <http://abet.org/DisplayTemplates/DocsHandbook.aspx?id=3143>

³ <http://econpost.com/us/construction-industry-spending-fall-2010>

⁴ http://cdn2.ncees.co/wp-content/uploads/2012/11/Exam-specifications_PE-Civil_PE-Civ-Construction-Apr-2008_with-1304-design-Standards.pdf

⁵ <http://main.abet.org/aps/Accreditedprogramsearch.aspx>