

An Accredited Engineering Degree Program with Flexibility Designed for Student-Centered Learning

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Abstract

The Bachelor of Science in Engineering (BSE) program at Michigan Tech has been around since the early 70s. We have recently restructured our BSE program to allow students flexibility in pursuing their interests outside of engineering. We also think that this new structure will enable us to use the BSE program as an “incubator” for future engineering programs we may wish to develop. The BSE program is fully accredited by ABET and consists of courses in four areas: 1) a General Education core, 2) a Math and science core, 3) an Engineering core, and 4) an Engineering Emphasis area. The engineering emphasis area provides students with upper-division coursework in a single discipline and enables them to pursue graduate studies within that discipline if they desire. As part of the new BSE program requirements, students are also required to complete directed electives, in an area generally outside of engineering itself. The directed electives are typically in a university minor or certification area. This paper describes our BSE program and provides data on students currently enrolled in it.

Introduction

Engineering programs typically have very little room in the curriculum for students to make choices for interests they might have outside of their disciplines. This lack of flexibility likely acts as a deterrent for some students who might otherwise choose engineering. This inflexibility also often acts as a deterrent in the development of new, cutting-edge engineering programs.

Prior to EC2000, accreditation standards were focused on extensive quantitative requirements. Engineering programs were required to have a certain number of hours in several topics in order to obtain accreditation. Now, however, ABET has embraced outcomes-based education and has significantly reduced the amount of bean counting required in the design of engineering curricula. According to current ABET standards [1], in order for an engineering program to be accredited, students must complete the following coursework:

- One year of a combination of college level math and basic sciences (some with experimental experiences) appropriate to the discipline
- One and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study, and

- A general education component that complements the technical content of the curriculum and is consistent with the program and the institution objectives.

In addition, there are student outcomes that must be achieved and the program should be continuously monitored and improved through adequate assessment practices. Thus, it seems that ABET accreditation standards allow universities a great deal of flexibility in designing programs that meet the needs of their constituents. Unfortunately, it seems that most universities have not yet taken advantage of the flexibility afforded by EC2000 in developing engineering programs.

The Michigan Tech BSE Program Structure

In designing the new structure of our BSE program, we had to ensure that minimum ABET standards were achieved in order to satisfy the accreditation criteria. The basic structure of the BSE degree program is outlined in the following:

- **Mathematics and Science Core** consisting of Calculus I & II, Linear Algebra, Differential Equations, Statistics, Chemistry and Physics (23 credits). Students take an additional 9 credits in math/science electives. The elective courses they take for this core depend on prerequisites for their emphasis area coursework or for the courses in their minor/certification area.
- **General Education Core** consisting of four required courses and five elective courses (28 credits total). Coursework in the General Education core is mandated by university policy. Some elective courses may be “double-counted” towards minor or certification requirements.
- **Engineering Core** consisting of two first-year engineering courses, a semester of Senior Design, a course in Statics and Mechanics of Materials, a course in Thermodynamics and Fluid Mechanics, a course in Materials Science, and a course in Electrical Circuits and Instrumentation. In addition, students take a course in “design implementation”--either a construction or a manufacturing course depending on the specific emphasis area.
- **Engineering Emphasis area** that consists of upper-level courses in a specific engineering discipline. Courses in the emphasis area have been selected to enable students to pursue graduate studies in a given discipline or to prepare them for work in industry upon graduation. The coursework in the Engineering Core and the Engineering Emphasis area must total a minimum of 48 credits.
- **Directed Electives** in the form of either an approved university minor or a certification area. Approved minors on campus are typically 16-18 credits and approved certification areas (including teacher certification) are around 24 credits.

Students in the BSE program are strongly encouraged to pursue a Master of Engineering degree, a professional degree program we have established, that can be completed in just one year of coursework with a 3-credit practicum. As part of the MEng degree requirements, a student can complete up to 12 credits of senior-level coursework meaning that students in the BSE could go back and take some of the courses they didn't take from the discipline in their emphasis area to “round out” their preparation. In this way, students can receive an accredited undergraduate engineering degree, a minor or certificate, and a Masters' degree all within five years' time. In contrast, if they were to follow a traditional degree path in one of the disciplines, it would take 4.5-5 years just to obtain their BS degree and their minor/certification.

In an ABET visit conducted in the fall of 2001, evaluators strongly endorsed the new structure of the Michigan Tech BSE program and recommended it for continued accreditation (the BSE was accredited since the 1970s in a different format). The Industrial Advisory Board for the College of Engineering at Michigan Tech, which is composed of several industry leaders in the state, has also strongly endorsed the newly structured BSE program. Support among faculty colleagues at Michigan Tech is not as strong, however, we have been able to work through most differences of opinion. Many faculty view the program as “watered-down” when compared to traditional programs.

Possible Degree Combinations

Engineering Emphasis Areas are available in any of the engineering disciplines that Michigan Tech offers. These include: Biomedical, Chemical, Civil, Computer, Electrical, Environmental, Geological, Materials, Mechanical, and Mining. In addition, there are several approved minors and certificate areas at the university. Table 1 includes a sample of the more popular minors and certificate areas available to Michigan Tech BSE students.

Table 1: A Sample of Available Minors and Certificates

Design Engineering	Certificate	Industrial Forestry	Certificate
International Business	Certificate	Media	Certificate
Modern Language	Certificate	Writing	Certificate
American Studies	Minor	Astrophysics	Minor
Biochemistry	Minor	Biological Sciences	Minor
Chemistry	Minor	Communication Studies	Minor
Computer Science	Minor	Earth Sciences	Minor
Ecology	Minor	Economics	Minor
Electronic Materials	Minor	Environmental Studies	Minor
Ethics and Philosophy	Minor	Historical Studies	Minor
Journalism	Minor	Physics	Minor
Music	Minor	Remote Sensing	Minor
Secondary Teaching	Certificate	Structural Materials	Minor

The new structure for the BSE program enables a student to pursue interests outside of engineering and promotes student-centered learning. A student could choose to combine an engineering emphasis area of Electrical Engineering with a minor in Electronic Materials, or Computer Engineering with a Media certificate, or Geological Engineering with Remote Sensing, or any type of engineering with International Business, etc. The degree combination possibilities are nearly limitless.

Comparison of the BSE with a “Traditional” Engineering Program

Required and elective courses for each engineering emphasis area have been identified. For the majority of the emphasis areas, the most significant difference between the BSE and the traditional program is in the number of senior technical electives a student takes. Table 2 illustrates a comparison between the BSE with a Mechanical Emphasis with our BSME degree program.

Table 2: Comparison of BSE with Mechanical Emphasis and BSME Degree Programs

BSE with Mechanical Emphasis		Standard BSME	
Math and Science	32 credits	Math and Science	32 credits
General Education	28 credits	General Education	28 credits
First-year Engineering	6 credits	First-year Engineering	6 credits
Senior Design	3 credits	Senior Design	6 credits
Electrical Circuits	3 credits	Electrical Circuits	3 credits
Material Science	3 credits	Material Science	3 credits
Combined Statics/ Strength of Materials	4 credits	Two separate courses in Statics and Strength of Materials	6 credits
Combined Fluid Mechanics and Thermo	4 credits	Two separate courses in Fluid Mechanics and Thermodynamics	6 credits
Upper level engineering courses	25 credits	Upper level engineering courses	38 credits
Directed Electives	20-24 cred- its	Free Electives	3 credits
Total	128-132 cr	Total	131 credits

As it can be seen from the data presented in this table, the primary difference between the two degree programs is that BSME students complete 38 credits of required upper division mechanical engineering courses compared to only 25 credits for the BSE students. This difference of 13 credits, coupled with some credit “savings” in fundamental courses results in an increase of nearly 20 credits in which a student can enroll in courses outside of engineering, if desired.

Student Recruitment and Enrollment

To date, there are only a handful of students enrolled in the BSE program. One student, who wants to be a roller coaster engineer, is pursuing a mechanical engineering technical emphasis and has

selected several civil-structural courses as his set of directed electives. Yet another student is pursuing a computer engineering emphasis with a minor in music, enabling him to seek employment in the music industry upon graduation. One student is pursuing a computer engineering emphasis with secondary teacher certification. Several students are pursuing a mechanical emphasis with a minor in manufacturing. A marketing survey was conducted among second-year engineering students during the fall semester. Through this survey, it was found that the primary barriers to increasing the number of students who choose this degree seem to be: (1) lack of awareness of the program itself and (2) hesitation to enroll in a program with no proven track record for job placement. Of the students surveyed, sixty included their name and email on the form indicating that they wished to be contacted with further information on the program. We will also be working with staff in the Career Center regarding interfacing with corporate recruiters to ensure the employability of the BSE graduates. Problems that we have discovered in the initial deployment of this program include a lack of structure for things such as advising. There were some students being advised by the Associate Dean of Engineering, others advised from the Engineering Fundamentals Department, and still others from one or more disciplinary departments. Another problem has been in assigning students to computer labs, etc. We are currently working through these problems and developing some common procedures and processes.

Conclusions

An accredited engineering degree program that allows students flexibility in pursuing interests outside of engineering has been successfully developed and launched at Michigan Tech. The program consists of core courses in math, science, and engineering. The program also includes specialization in a traditional engineering discipline, enabling graduates to pursue an advanced degree if they so choose. Although the demand for this program has been minimal thus far, we believe that there is a potential for it to grow significantly. Results from a marketing survey indicate that students are interested in the program, once they learn about it.

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Bibliography

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