

AC 2008-723: THE MULTIFUNCTIONAL USE OF A MULTIDISCIPLINARY B.S.E. DEGREE PROGRAM: AN HISTORICAL CASE STUDY

James Farison, Baylor University

Dr. Jim Farison is currently professor and associate chair of the ECE Department at Baylor University, and is also administratively responsible for Baylor's multidisciplinary B.S. in Engineering program. He was a founding member and serves currently as the past chair of ASEE's Multidisciplinary Engineering Division, and is a member of the ASEE Accreditation Activities Committee. He received his B.S.E.E. from The University of Toledo and his M.S. and Ph.D. from Stanford University, before returning to serve on the faculty at UT in the EE and then the Bioengineering departments, including 10 years as dean of engineering in between, before moving to Baylor in 1998. He is currently a member of the ABET Engineering Accreditation Commission, a fellow of ASEE, a senior member of IEEE, and holds PE registration in Ohio and Texas.

The Multifunctional Use of a Multidisciplinary B.S.E. Degree Program: An Historical Case Study

Introduction

The first nationally recognized accreditation of engineering programs was granted by ECPD (the antecedent of ABET) in 1936. Four of those initial programs (3 B.S. in Engineering and 1 B.S. in General Engineering) are still operating and accredited. In 2005, ASEE became the lead society for the ABET evaluation of multidisciplinary engineering programs (B.S. in Engineering and three other related titles). At last count, there were 32 accredited B.S.E. programs in the U.S. (plus 3 General Engineering, 17 B.S. in Engineering Physics and 11 B.S. in Engineering Science programs also under ASEE purview). This paper provides a case study of a current B.S.E. program, the shortest and most generic of the multidisciplinary engineering program titles. The B.S.E. program at Baylor University was first accredited in 1988-89 and has served and continues to serve effectively in multiple roles for our institution since that date, even as other traditional departmental programs have been established around it.

Launching the First Engineering Program

This story begins, at least in a publicly-documented way, in the 1978-79 academic year, when Baylor University approved the formation of the Institute of Engineering Science to develop an engineering degree within the College of Arts and Sciences. The Institute became operational with the hiring of the Institute's first director in 1979, with the mission to start an engineering program. Over the next several years, additional engineering faculty members were hired, and an engineering program with its curriculum and courses was developed. In June 1980, the Department of Engineering and Computer Science (ECS) was formed in the College of Arts & Sciences by combining the new Institute of Engineering Science and the established B. S. in Computer Science program, which was previously offered through the Department of Mathematics. When the initial faculty had completed planning for a full degree program with an appropriate set of all new engineering courses, the 1985-86 catalog announced the full degree requirements and curriculum plan for the new B.S. in Engineering Science program, initially with computer, electrical, and mechanical "options."

In 1988, the Department of Engineering and Computer Science, still a unit within the College of Arts and Sciences, moved into its own new building, called the Rogers ECS Building, after the donors whose contribution enabled the building's construction. The building was constructed specifically to support the programs in engineering and computer science. Somewhere during those early years, the program and degree were renamed to the B.S. in Engineering.

When some of the early students were completing the full professional B.S.E. curriculum plan and were ready to graduate, the institution requested an accreditation visit for the new program by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET). Accreditation was granted in 1989. By 1992, the computer option was subsumed into the electrical option (as a labeled emphasis). Accreditation was renewed in 1994-95. In 1995, the current School of Engineering and Computer Science was

established, with its two units: the Department of Computer Science and the Department of Engineering.

Forming Options within the Initial Program

Gradually, as the number and strength of the engineering program faculty grew and the student enrollment and course selection increased, there developed a greater identification of the program and its students (and faculty) with the two options. Continued development of the two options was influenced by the engineering profession through alumni and employers and considerations such as those reflected by the ABET general and program accreditation criteria. In the year before requesting the 2000-01 accreditation review, the faculty observed that the program's two distinct "options" very nearly fulfilled the respective program criteria for separate professional accreditation. Indeed, each lacked only one subject area for the respective electrical and mechanical program criteria. The faculty (with modest reluctance by some faculty members) agreed to consider presenting these two paths, the electrical option and the mechanical option, as separate curricula for accreditation under the respective electrical engineering and the mechanical engineering program criteria.

Nonetheless, the continuing value of the original (general) program was also recognized. Some of the faculty members believed that the general program was better professional preparation for some students than the separate (more specialized) curricula. This issue needed to be settled before submitting the request for evaluation as the 2002-01 accreditation review approached. Were we going to seek accreditation for: 1) one general program with options under the single (engineering) umbrella, or 2) two separate more specialized program options (electrical and computer engineering and mechanical engineering), under the general and respective program criteria? Rather than make the binary decision between these two choices, a third alternative was proposed: 3) retain the single "general" engineering major, to be evaluated under only the general criteria (as before) **and** make the modest changes necessary to present the "electrical and computer engineering" option and the "mechanical engineering" option for separate accreditation under the general and respective program criteria. The "three-program" proposal was ultimately selected by the faculty, still organized within the single Department of Engineering. This plan also provided the increased security in that, if any one of the three programs was not accredited, there would still be both "electrical" and "mechanical" accredited tracks available to our students.

During the interval between making this decision and submitting our three Self-Study reports in June 2000, we had temporarily some question if we would actually have at least one graduate with a transcript that met all of the degree requirements for each of the two new "majors." However, that requirement was met; all three options (electrical and computer engineering, mechanical engineering, and engineering) were submitted and were accredited. At this point, all three majors still led to the same, single, B.S.E. program degree title.

Recognizing the New Majors

With separate accreditation achieved, the proposal was raised to convert our program terminology from "one program (B.S.E.) with three options" to the more professionally

recognized “three separate programs with their respective degree titles” (B.S.E.C.E., B.S.M.E. and B.S.E.). This change proceeded successfully through the full institutional approval process during the 2001-02 academic year. At this time, the entire engineering faculty and all three engineering programs were still in the single Department of Engineering.

Maintaining the Engineering Program during Organizational Change

Over the next couple of years, current students already partially through their curricula sorted out their options, made their choices, and completed their respective program. The general program (B.S.E.), now freed of the electrical and mechanical option structure, became again a more general and flexible program than the preceding two-option structure had permitted. Now, our B.S.E. students could develop a much more individualized curriculum. On the other side, however, the engineering faculty wanted to insure that the major did not become a “weak” path to an engineering degree.

At this time, there was still a single Department of Engineering but this curricular change rather naturally led to further individual recognition of the ECE faculty and the ME faculty as distinct units in their curricular responsibilities. Further, an engineering major committee, with membership representing both the ECE and the ME faculty constituents, was named to formulate and oversee the “new” B.S.E. program, which was now freed of its prior option structure. There was concern that, compared to the ECE and ME programs, the Engineering major would become a weakest-link path to an engineering degree and jeopardize the reputation of the whole engineering program.

By the conclusion of 2002-03, the transition had been largely completed and the general structure for the “new” Engineering major had been formulated. Under these conditions, B.S.E. students are required before the beginning of the junior year: (1) to develop for approval their individualized program plan, and (2) to select one of several course “stems,” which provides a sequence of related courses to an employable-skill level (a senior-level engineering course with a design and/or laboratory experience). While this information about the structure and requirements of the program is complete in the University’s catalog, there is also a multi-page set of worksheets to aid the student and program coordinator in developing and approving the curricular plan for each individual student.

With a growing engineering student enrollment and engineering faculty contingent, the Department of Engineering established its graduate program in 2003-04 with four masters’ degree programs (M.S. in Electrical and Computer Engineering, M.S. in Mechanical Engineering, M.S. in Biomedical Engineering, and Master of Engineering). This growing strength (and complexity) of the Department of Engineering prompted the proposal to divide the single Department of Engineering into the Department of Electrical and Computer Engineering and the Department of Mechanical Engineering. This proposal was approved by the institution, with a separate faculty and chair for each department, and was implemented in fall 2005. This organizational change added the word “interdepartmental” to the characterization of the Engineering major.

Formulating the New Engineering Program

By this time, the structure of the Engineering major was relatively stabilized. With our institution operating on the semester system, each of the three engineering majors has continued the prior 136-semester-hour required curriculum. Each of the three programs has a major of 67 hours, in addition to the basic science and mathematics component, the general education component, etc. The curricular differences in the three programs are entirely in the 67-hour major component. The ECE major comprises 64 engineering hours and 3 computer science hours. ME's major is 67 engineering hours.

The 67-hour Engineering major is the combination of: 1) a required 25-hour set of engineering core courses (common among all three current programs), and 2) a minimum of 26-27 additional engineering hours, comprising the selection of one of seven prescribed engineering stems, plus 3) other more flexibly chosen but faculty approved engineering electives, to bring the total engineering credits to 51-52 hours. The seven alternative stems currently offered (and ranging from 12-18 engineering hours) are: biomechanics, biomedical signals, computer systems, electronics, fluids and thermal energy, mechanical design, and signal processing. Finally, each engineering major student proposes: 3) a set of courses representing the remaining 16-15 required hours that may be from any subject area that is career oriented but not necessarily from engineering. The entire package is then evaluated against the student's Statement of Purpose (which indicates, by its career focus, why the student is not taking the ECE or ME curriculum and needs the flexibility of the Engineering major).

Since the Engineering major does not have its own faculty or courses, it depends on the ECE and ME courses and faculty for assessment. When a student has prepared the desired plan, a check sheet of outcomes assessment conducted in each course is used to assure that each Engineering graduate has been included in the full set of our required student outcomes measurement. Our primary sources for evaluation of program objectives are our graduates' self-assessment and career path and from our Board of Advocates (industrial advisory board) and other employers of our graduates.

All three of the engineering programs were accredited again in 2006-07.

Incubating Another Engineering Option

Many of our new students come to our institution wanting to "make a difference" for people and/or society in their career. They come here because of some combination of our reputation, values, and strong historical identification with the medical profession and the large and successful pre-med program. Some of these students want a back-up plan if Medical School admission is not achieved, or they know that admission to Medical School is very competitive so that they want to stand out by successfully completing a more challenging program (i.e., engineering) compared to the masses of pre-med candidates. Some recognize that an engineering background can help them in their medical careers (medical devices, research, etc.). And, finally, some want to pursue biomedical engineering as their career focus. Indeed, recently, the most frequently selected choices within the flexibility of the Engineering major have been the biomedically-related stems.

Just as the original Engineering major was an effective vehicle for incubating the Electrical and Computer Engineering and the Mechanical Engineering majors, the Engineering major is now being used as the host for a Biomedical Option developed in 2006-07. The program was formulated by a faculty committee comprising two ECE and two ME faculty members with strong biomedical interests, and was approved by the Engineering major committee.

The structure and paths through the (general) Engineering major described above, with its alternatives of seven distinct engineering stems, are now together collectively called the B.S.E. Flexible Option, with the new B.S.E. Biomedical Option added along side the continuing Flexible Option. And, for completeness, it was verified that the structured Biomedical Option could have been achieved by the appropriate choices from within the existing Flexible Options. While there is currently no specific plan or schedule for proposing a Biomedical Engineering degree program, there has been some discussion about that. Indeed, that is an element in the institution's latest ten-year plan, in which we have just passed the halfway mark.

Summary

This paper has described the potential for using a general engineering major not only as a viable program in its own right but also as a vehicle for a more flexible curriculum or for new program development. Currently, in the profession, such programs are generally called engineering, general engineering, or possibly engineering science. One of the primary considerations of the development described in this paper has been to maintain a conservative strategy with regard to safeguarding program accreditation for our students during new program development, while also continuing controlled and conservative program development within one's resources to provide our students with as many curricular choices and as much flexibility as our resources make possible.