

TWO EFFECTIVE USES OF THE B.S. IN ENGINEERING (BSE) DEGREE: GENERALITY AND FLEXIBILITY

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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 comprises two parts: a broad overview of the current “general” engineering programs, as suggested by their titles, and a case study of a current B.S.E. program.

Part I: An Overview of Currently Accredited B.S.E. (and Similarly Titled) Programs

This Part of the paper explores a specific subset of “engineering” programs, giving: 1) a brief general overview of the currently accredited “general” engineering programs in the United States, and 2) a closer look at this set of programs within the ASEE Gulf-Southwest Region.

The first “official” accreditation of U.S. engineering degree programs occurred in 1936, through the Engineers Council for Professional Development (ECPD), the forerunner of ABET. These initial programs offered the “B.S. in Engineering” degree. Interestingly, four of the initial set of accredited engineering programs are still functioning. The next 2 currently accredited multidisciplinary engineering programs were first recognized in 1949 (13 years later). There are 2 more currently accredited programs that were first accredited in the decade of the 1950’s, 6 in the 1960’s, 6 in the 1970’s, 10 in the 1980’s, 16 in the 1990’s, and 23 in the 2000’s.

Now, the vast majority of B.S. programs in “engineering” in the United States are specialized departmental, or discipline-specific, programs (e.g., BSCE, BSEE, BSME, etc.). Nonetheless, there continue to be numerous engineering degree programs in our country that are not discipline specific. Information about the currently accredited “engineering” programs, compiled from the ABET website, is presented here.

The ABET website provides a complete listing of the currently accredited engineering programs in the United States. Among the data included for each accredited program are the official name of the institution, each accredited engineering program offered at that institution, the year of first accreditation of each program, and the year for the next general accreditation review.

The focus here is the ABET information about engineering programs now identified as “Engineering, Engineering Physics, & Engineering Science(s) and similarly named programs” including general engineering and three other “multidisciplinary” titles (Engineering and Public Policy, Engineering-Course 2-A, and Integrated Engineering). The primary reason for focusing on this specific set of programs is that ABET has named ASEE (the host of this conference) is the professional society that provides the PEVs for the accreditation visits to these programs.¹

Currently, the roster of this set of programs numbers 69, distributed by program type as:

35	Engineering programs
2	General Engineering programs
10	Engineering Science(s) programs
19	Engineering Physics programs
<u>3</u>	Other Multidisciplinary Engineering programs
69	Total programs assigned to ASEE

Since one institution has two such programs, the number of campuses represented is 68. More specifically, the ASEE Gulf Southwest Section has 8 institutions with BS programs of these types: 4 BSE programs, 3 BSEP programs, and 1 BSES program.

Another important area of interest is the number of ASEE PEVs required to serve as evaluators for these programs. That number varies considerably from year to year. Over the past four years of ASEE PEV visit assignments, the actual numbers have been:

Fall 2006	17
Fall 2007	16
Fall 2008	8
Fall 2009	13

As indicated, the number varies quite widely and is difficult to predict.

Part 1 concludes with four tables, extracted from the larger national data, that illustrate the issues and variability of the PEV process specifically for the institutions within the ASEE Gulf-Southwest Section that have one of these multidisciplinary programs. Specifically,

Table 1. Data by state (LA, NM, TX) and type (public and private)

Table 2. Data by multidisciplinary programs (BSE, BSES, BSEP)

Table 3. Data by year program first accredited

Table 4. Data by number of other accredited engineering programs

Part II follows these four tables.

College / University	State	Type	Multidisciplinary Engineering Program			Other Information		
			Engineering	Engineering Science(s)	Engineering Physics	Year Program Accredited	Other ABET ENG Programs	Date of Next General Review
	1/1/6	4/4						
McNeese State University	LA	Public	√			1981	0	2009-10
New Mexico State University	NM	Public			√	2005	6	2012-13
Texas Tech University	TX	Public			√	1965	8	2011-12
Tarleton State University	TX	Public			√	2004	1	2011-12
Trinity University	TX	Private		√		1969	0	2011-12
LeTourneau University	TX	Private	√			1988	0	2014-15
Baylor University	TX	Private	√			1989	2	2012-13
Texas Christian University	TX	Private	√			1997	0	2008-09

College / University	Multidisciplinary Engineering Program Area					Other Information		
	State	Type	Engineering	Engineering Science(s)	Engineering Physics	Year Program Accredited	Other ABET ENG Programs	Date of Next General Review
McNeese State University	LA	Public	√			1981	0	2009-10
Baylor University	TX	Private	√			1989	2	2012-13
LeTourneau University	TX	Private	√			1988	0	2014-15
Texas Christian University	TX	Private	√			1997	0	2008-09
Trinity University	TX	Private		√		1969	0	2011-12
New Mexico State University	NM	Public			√	2005	6	2012-13
Tarleton State University	TX	Public			√	2004	1	2011-12
Texas Tech University	TX	Public			√	1965	8	2011-12

College / University	Multidisciplinary Engineering Program Area					Other Information		
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Texas Tech University	TX	Public			√	1965	8	2011-12
Trinity University	TX	Private		√		1969	0	2011-12
McNeese State University	LA	Public	√			1981	0	2009-10
LeTourneau University	TX	Private	√			1988	0	2014-15
Baylor University	TX	Private	√			1989	2	2012-13
Texas Christian University	TX	Private	√			1997	0	2008-09
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Texas Tech University	TX	Public			√	1965	8	2011-12
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LeTourneau University	TX	Private	√			1988	0	2014-15
Texas Christian University	TX	Private	√			1997	0	2008-09
Trinity University	TX	Private		√		1969	0	2011-12

Part II: Historical Account of Launching and Maintaining an Engineering Program – A Case History

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. 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. Over the next several years, additional engineering faculty members were hired, and an engineering program with its curriculum and courses was developed. 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 and named 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 BSE 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. There was some modest reluctance expressed by some faculty members to see the loss of the more general program. However, overall, the BSE faculty 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 2000-01 accreditation review approached. Was the department going to seek accreditation for: 1) one general program with options under the single “engineering” umbrella, under only the ABET general criteria, or 2) two separate more specialized program options (“electrical and computer engineering” and “mechanical engineering”), under the ABET 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. This alternative 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. The “three-program” proposal was ultimately selected by the faculty, still organized within the single Department of Engineering.

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 electrical option and mechanical 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 to insure that the student’s program interests and the ABET accreditation requirements are met.

With a growing engineering student enrollment and engineering faculty contingent, the Department of Engineering extended its scope to the graduate level 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). The growing faculty strength and program 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 continued the prior 136-semester-hour required curriculum. Each of the three programs had 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 were exclusively in the 67-hour major component. The ECE major comprised 64 required and elective engineering hours and 3 computer science hours. ME’s major was 67 required and elective engineering hours.

The 67-hour Engineering major was the combination of: 1) a required 25-hour set of engineering core courses (common among all three of the 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, 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 proposed: 3) a set of courses representing the remaining 16-15 required hours that could be from any subject area that is career oriented but not necessarily from engineering. The entire package was then evaluated against the student's Statement of Purpose (which indicated, by its career focus, why the student was not taking the ECE or ME curriculum and needed 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 2006-07.²

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 considerable historical identification with the medical profession and our 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 they want to stand out by successfully completing a more challenging program (i.e., engineering) compared to the masses of pre-med candidates with a liberal arts or science degree. 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 alongside 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 separate 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 are now well past the halfway mark.

Additional Recent Changes

The most recent change in the Baylor engineering programs occurred during 2008-09, when the faculty considered the length of the three engineering B.S. programs, each of which required a minimum of 136 semester hours, including a 67-hour engineering major, which are well above most engineering programs and more than required for accreditation. After comparing that requirement with many other similar institutions, the engineering faculty decided to reduce those requirements by 7 hours to the current 129 semester hours for the three engineering degree programs, with reductions for the major to 63 in BSECE, and 64 hours in BSME and BSE, by eliminating a previously required 4-hour computer programming course and one engineering course in each program.

Summary

Part I has presented an overview of the history and current status of the set of program that ABET now labels “Engineering, Engineering Physics, & Engineering Science(s) and similarly named programs.” For ABET program accreditation purposes, ASEE is the corresponding sponsoring society for these programs in the same way that ASME is for Mechanical Engineering programs. And, more specifically, information about the programs of these types (i.e., “Engineering, Engineering Physics, & Engineering Science(s) and similarly named programs”) currently offered by institutions in the ASEE Gulf-Southwest Section has been presented.

Part II has described the potential for using one of these general engineering programs 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 (e.g., establishing a traditional “disciplinary” engineering program). One of the primary considerations has been to maintain a systematic and conservative strategy with regard to safeguarding program accreditation for our graduating students during each stage of new program development, while also continuing the 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.

References

- [1] James B. Farison and Zhuocheng Yang, “A Review of Accredited Multidisciplinary Engineering Programs and ASEE’s Role as the Lead Society for Their ABET Accreditation,” Proceedings of the ASEE Gulf-Southwest Annual Conference, The University of New Mexico, Albuquerque, New Mexico, March 26-28, 2008.
- [2] James B. Farison, “The Multifunctional Use of a Multidisciplinary B.S.E. Degree Program: An Historical Case Study,” Proceedings of the ASEE Annual Conference, Pittsburgh, Pennsylvania, June 22-25, 2008.