Eliminating the Double Standard for the Batchelor of Science Degree in Engineering

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Abstract -- This paper presents a vision that promises a major benefit to the engineering profession. Although the author's experiences are mainly in Electrical and Computer Engineering, the basic idea has importance to Mechanical and Civil Engineering as well.

Introduction

ABET has a definite structure involving EAC (Engineering Accreditation Commission), TAC (Technology Accreditation Commission) and other commissions as explained by their home web site[1]. Professors who are not members of commissions are less involved directly, but could very well have something constructive to say[2]. For example, Professor Eades of Lehigh University sees a conflict of interest between having the power to accredit a particular program and having a mission to improve education[3]. He thinks that the same organization ought not to pursue both objectives, since they might be tempted to impose their own, possibly mistaken views of what engineering education should be.

Obviously it would be difficult to prove any given view is mistaken, and even more difficult to prove that an institution is being pressured to accept a mistaken view. Eades' readers may not agree with him. However, it can be admitted that he contributes a useful thought, since any organization can easily fall into the trap of trying to reach beyond reasonable bounds. Useful thoughts may exert a corrective influence, and possibly help avoid a destructive crisis later.

Proposal – Specify that EAC encourage and accredit engineering technology programs at the baccalaureate level. That is, TAC would accredit only 2-year programs while EAC would accredit only 4-year programs.

Reasons in favor discussed below

1. Joining the two would eliminate considerable duplication of accreditation criteria.
2. Joining the two would help clarify the term 'engineer'
3. Engineering as a profession would appear stronger under one type of accreditation.
4. EAC criteria could work for both types of programs.
5. Accreditation criteria for a 2-year program would not have to be mixed with that for 4-year programs.
6. Fairness to students would increase.

Reasons against discussed below

7. Innovation might be restricted.
8. There might be side effects.

Item 1/Joining the two would eliminate considerable duplication of accreditation criteria -- Baccalaureate programs in engineering technology (TAC accreditation) and a baccalaureate programs in engineering (EAC accreditation) deal with similar subjects, although with differing philosophies. Note the wide variety of institutions in the list of accredited programs[4,5]. For instance, Oklahoma Christian University of Science and Arts, United States Coast Guard Academy and Massachusetts Institute of Technology all claim ABET accreditation in their advertising. Also claiming ABET accreditation are such places as Rochester Institute of Technology, State University of New York Institute of Technology at Utica/Rome and California State Polytechnic University, Pomona. The latter institutions hold TAC accreditation, while the former hold EAC accreditation. A non-specialist has to struggle to explain the differences between the two, because they teach similar topics in electrical and computer engineering.

There are similar not only because graduates cover similar subject material, but also because they will be applying to the same market of engineering jobs. Engineering colleges and technology institutions both advertise that their engineers can be world-class design engineers[6,7]. Graduates of technology and non-technology majors indeed take similar positions with similar titles for similar pay[8,9]. Since the programs are fairly similar, the same commission could accredit them.

Item 2/ Joining the two would help clarify the term 'engineer' -- Industry uses the term 'engineer' differently than academia. In other words, the term 'engineer' is applied broadly within industry, and not in the strict sense of EAC or TAC. Job listings seldom have keywords that mean 'TAC need not apply' or 'EAC need not apply'[10].

Most states define 'engineer' in statute law. However, this does not stop employers from using the term more broadly. Electrical and computer engineers usually work directly for companies, and often do not hold a 'professional' license from their state. So legal definitions are not highly relevant to their employment. Having a uniform set of academic requirements would be a step toward a universal definition of the term 'engineer.'

Item 3/ Engineering as a profession would appear stronger under one type of accreditation -- Engineering would be more credible as a single profession if educators could agree on a common standard, instead of the two now practiced[11]. That is, having two standards suggests two separate professions.

In addition to credibility, there would be more meaning associated with the baccalaureate degree if we could stop having to specify technology or non-technology. Lawyers, for example, claim their position by holding a jurisprudence degree, allowing them to take a state bar exam. Specialization is via elective courses while in law school. Physicians hold a Medical Doctor degree approved by the AMA. Specialization is by a residency program after medical school. Although all is not perfect with medical or law schools, at least they seem to have the right idea. Their idea is to standardize the degree so that the profession seems unified and powerful.

Engineers have a relatively large number of degrees accredited by ABET in addition to EAC/TAC specifications. There are many kinds of baccalaureate engineers (over 60 if you count the EAC/TAC distinction), so we really confuse the meaning of the term engineer. Having EAC and TAC degrees (ABET accredited) also increases confusion among hiring organizations, and raises unnecessary questions about a new hire's educational background.

Item 4/ The new ABET criteria could work for both types of programs -- What EAC and TAC have in common for the baccalaureate degree is an emphasis on goals and outcomes. It should be just as acceptable to have as a goal, professional or practical readiness as it is to have graduate or research readiness. As a way of promoting a broad-minded approach, we want to bring engineering technology baccalaureates together with other baccalaureates for the purposes of accreditation. At the same time, it is desired to avoid judgments about the goals of other institutions.

TAC addresses quite well the 2-year AS degree. Many educators are unaware of differences between current baccalaureate criteria, so Table 1 provides the main differences in the wording of the criteria for computer engineering programs (as an example) as taken from the web. Computer engineering is sufficient for this illustration, although a similar table could be created for electrical engineering (EAC combines computer and electrical engineering). Interested readers are strongly encouraged to read the criteria themselves so that no one is misled by the summary below[11].

Table 1— Baccalaureate Criteria Reflecting Differences in Goals

	EAC (IEEE)	TAC (Conventional)
1	Must Go Beyond Calculus	Must Apply Calculus
2	Analyze&Design Complex Software/Hardware	Fundamentals of Software/Hardware
3	Basic Science Required	Physics Required Based on Trigonometry
4	Communications Abilities Required	Reading and Documentation Abilities Required
5	Faculty Must Have Education, Experience, Evidence of Scholarship, Communications Ability	Three Years Experience and a Masters Degree or Equivalent

Point 1 – EAC suggests statistics and advanced math, implying knowledge of differential equations, complex variables, linear algebra, and discrete math. TAC, in contrast, suggests that upper division courses include calculus where appropriate. Differential equations, transform methods, numerical methods and statistics are encouraged, but not required. Differences naturally exist because of the differing goals of the programs. With proper interpretation of the criteria, computer engineering technology programs could meet EAC criteria.

Point 2 – EAC asks for analysis and design, so evidence of this would have to be found for EAC accreditation. TAC, on the other hand, does not require analysis and design unless it is a

program goal. Many technical institutes already have analysis and design as a goal, so they are set for EAC accreditation.

Point 3 – EAC requires basic sciences while TAC requires physics. Physics is a basic science, so technology programs could meet the spirit of the EAC requirement.

Point 4 – Communications abilities are demonstrated by student and faculty activity in professional societies (for example, IEEE). This allows engineers to communicate, and to build on each other's work, instead of each having to re-invent the wheel whenever they design something. Although the TAC requirements are modestly stated, some technology programs require several courses in technical writing. Therefore they could meet the criteria.

Point 5 –EAC requires education (not necessarily a Ph.D.) while TAC requires a Master's degree. TAC asks for 3 years of industrial experience while EAC only asks for 'experience.' Clearly technology institutes could meet EAC, since having a Master's is evidence of education, and 3 years at a company is evidence of experience.

Item 5/ Accreditation criteria for a 2-year program would not have to be mixed with that for 4-year programs -- It would be better if the baccalaureate criteria were separate from the applied science criteria. Time and time again the baccalaureate criteria is presented as an afterthought to the AS criteria, as is obvious by reading the criteria [11]. Mixing the two creates problems. For example, in TAC Section IIG2b2 in which it is required that AS students be prepared for immediate employment, or to move directly into a baccalaureate program without penalty. This is a problematic requirement, since immediate employment with the AS degree is not necessarily compatible with preparation for a baccalaureate.

Four-year engineering technology degrees have sprung from institutions that originally offered only the 2-year AS degree, as the published list testifies[5]. Consequently, ABET accreditation of these programs is focused on 2-year standards, not 4-year standards. What seems to be happening is that technical institutions are expanding away from 2-year degrees, although some students still take the AS degree as a step toward the BS degree. A partial reason for the move away from 2-year technical institutions is the explosive growth of locally funded community colleges.

Another reason is that electrical and computer engineering has become so complicated that additional years are required to learn it. For example, complex CMOS (complementary metal oxide silicon) technology involving thousands of logic gates can now be applied as readily as the small-scale bipolar technology of the distant past. Clearly the electrical and computer engineering fields are growing more rapidly than ever, as is the accreditation process.

Item 6/ Fairness to students would increase -- Students and parents are easily confused by the subtle differences between the different types of engineering degrees. More than one young student has been disappointed to find that credit from a TAC program does not generally transfer into an EAC program. Also, bright young engineers are recruited into a technology program only to discover that they cannot pursue graduate work because their degree is unacceptable. Having only one type of accreditation may help alleviate this sort of difficulty.

Item 7/ Innovation might be restricted -- An example of an innovative option is 'embedded systems'[12]. Another is 'ASIC engineering'[13]. It remains to be seen whether or not innovative programs can be accredited.

Item 8/ There might be side effects -- It could be a problem politically if state institutions in geographically similar areas offer similar degrees. For instance, assume that college A offers a degree in electrical and computer engineering technology, but becomes accredited under electrical and computer engineering. If college B across the street is already accredited under electrical and computer engineering, it looks bad; the state board of higher education might become alarmed about an apparent duplication of degrees.

Conclusion

There are compelling reasons for proposing that 4-year technology programs become accredited under EAC. In fact, the new ABET criteria for EAC seem designed for proposals of this sort. EAC has taken a quantum leap forward by focusing on goals and outcomes. The next step logically is to reap a benefit by re-organizing the commissions as proposed above.

[1] http://www.abet.org/
[2] A. Sanoff, Under the magnifying glass, ASEE Prism, October 2001.
[3] A. Eades, ABET Revisited, ASEE Prism, Feb. 2002.
[4] http://www.abet.org/accredited_programs/EACWebsite.html#C
[5] http://www.abet.org/accredited_programs/TACWebsite.html
[6] http://ar.byu.edu/dept_academ_advise/gemajor/98/dc/395220dc.html
[7] http://www.rit.edu/~706www/newpages/eet/about.html
[8] http://www.oit.edu/~career/survey/
[9] http://career.asu.edu/V/offers/CollofTech&AppSci.htm
[10] http://careers.latimes.com
[11] http://www.abet.org/criteria.html
[12] http://www.east.asu.edu/programs/
[13] J. R. Burger, et. al., "Project-oriented MS Degree in Engineering Technology Emphasizes Educational Depth," Proceedings of the ASEE 2000 Conference, St. Louis, MO.

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