

ASCE's Raise the Bar Initiative: Accreditation-Related Barriers and Critical Issues

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Introduction

The conditions and broad requirements of engineering practice are rapidly changing – and they will change even more in the future. Moreover, engineering education is also changing, perhaps more rapidly than ever before. To its credit, ABET in the last decade has made substantive changes in accreditation procedures for engineering programs. The change from focusing evaluations on input measures to an outcomes based approach with much more flexibility is in line with total quality improvement concepts. The fact that each program to be accredited must have detailed published educational objectives that are consistent with the mission of the institution provides potential for variations in the programs and no longer are engineering education programs necessarily in lock-step (1). Differences and uniqueness in individual programs are valued.

Today's engineering graduates must develop better professional skills to go along with their historic strength in technical skills based on mathematics and science. Those professional skills (sometimes referred to as soft skills) are integrated with the technical skills in ABET/EAC Criterion 3 – Program Outcomes and Assessment. At least half of the items listed in Criterion 3 refer to these professional skills – skills that any practicing professional must have whether or not he/she be an engineer. It is anticipated that the foundation for these professional skills are placed as part of the educational process. Words that were seldom mentioned in engineering education a decade or two ago – multidisciplinary team skills, professional and ethical responsibility, effective communication, global and social context, lifelong learning, and knowledge of contemporary issues are all in the ABET/EAC Criterion 3 on expected outcomes. To be sure, these changes did not come because educators suddenly saw the burning need. Industry was a vocal force in stimulating these changes.

Engineering work has changed and will change even more. Engineers are working in a much broader range of professional activities and while this work has always utilized the technical skills of the engineer in concept development, problem formulation, modeling, and solution, many of the jobs of engineers today are not strictly technical in nature. Those jobs that are strictly technical (design and manufacture/build) require a higher level of technical competence than ever before.

Current Conditions

For a number of years, the National Science Foundation has analyzed the dynamics of the U.S. engineering workforce. This covers all engineers, not just civil engineers. This Engineering

Workforce Project involves four NSF Directorates: (a) Engineering; (b) Social, Behavioral, and Economic Sciences; (c) Education and Human Resources; and (d) Computer and Information Sciences and Engineering (2). Some interesting facts emerge which suggests that engineering is an activity that may be quite different from other professions. The NSF data indicate that 2.6 million persons received an engineering degree at some level. Of these, there are 1.0 million graduate engineers in the work force that do not consider their principal occupation to be in engineering. In addition, over a third of a million are not in the labor force (retired, etc.) and 80 thousand are unemployed for a total of 1.4 million with engineering degrees whose principle occupation is not engineering. There are 1.2 million with an engineering degree who consider themselves to be working as engineers. In addition, there are a third as many (0.4 million) who are working as engineers, but do not have an engineering degree. So one-fourth of those whose principal occupation is engineering do not have an engineering degree at any level. It is unlikely that one would find any other profession with so many claiming to work in a field that do not have a degree in the field. This may be an issue of related to professionalism and the relatively unrestricted use of the title engineer.

This picture is unlikely to change since there are few restrictions on who in industry is given the job title, “engineer.” The NSF study shows the three largest non-engineering job classifications of those holding engineering degrees are (1) executives (375,000), (2) sales and marketing (112,000), and (3) computer and mathematical (81,000).

It is noteworthy that civils, chemicals and mechanicals are moving to material science, information systems, management consulting, nano/bio-technology, environmental, and medical applications. It is very hard to predict the future in the current environment where new technologies surface each day because it is difficult to imagine things we have never experienced. Most of us can’t predict well and that is why the “futurist profession” emerged. Businesses have to make decisions on not only what they think will happen, but also the way it will happen. In a matter of days, a new technology can make an old technology obsolete and the investment in it virtually worthless. In most cases, left-brain dominant engineers of the past have tended to think conservatively and not be visionary. Others who were not engineers have the same problem as shown by some past predictions by people who were leaders and knowledgeable in technology (3).

- “I think there is a world market for maybe five computers.” Thomas Watson, Chairman of IBM. 1943
- “I have traveled the length and breadth of this country and talked with the best people, and I can assure you that data processing is a fad that won’t last out the year.” Editor in charge of business books for Prentice Hall, 1957.
- “There is no reason why anyone would want a computer in their home.” Ken Olson, President, Chairman and Founder, Digital Equipment Corporation, 1977.

The above suggests that predictions are risky. But still we must look at employment shifts in industry and see if these shifts are likely to continue. Luker and Lyons report that for the period 1988 to 1996, the computer and office equipment category (SIC code 357) had a net employment decline from 455,000 to 357,300, or 97,700 – a loss of 21 percent (4). Note that SIC is Standard Industrial Classification and SIC 357 relates to manufacturing. For the same eight-year period, the computer and data processing services category (SIC 737) had an increase in employment

from 656,700 to 1,139,100, or a gain of 482,400 – over 73 percent. They define research & development intensive industries as those with the number of R&D workers at least 50 percent higher than the average for all industries surveyed. With the shifts from manufacturing to services, the services share of all R&D-intensive high tech employment rose by almost 11 percent from 28.0 to 38.9, between 1988 and 1996; manufacturing's share fell during that period from 70 to 60 percent.

Luker and Lyons also present evidence on two significant employment shifts in the U.S. high-tech industries: 1) very slow growth in overall employment and 2) a shift in the industrial composition of high tech industries toward services and away from manufacturing. The demand for high-tech workers is moving toward occupations that have more to do with the production of services than the production of goods. This does not mean that the production of goods is becoming unimportant in our national economy. Rather, it means that manufacturing, and even engineering design, is becoming more automated through the use of technology. Engineers who are to remain productive throughout their careers must continue to learn and update their skills. This continued learning will be most effective if it builds on the strong education of the fundamentals and experience base necessary for engineering practice at the professional level.

Although more data are needed to be totally definitive, the patterns of very recent years show that more of the engineers are employed in small companies. That trend is expected to continue. According to the Bureau of Labor Statistics of those engineers under age thirty in private (for profit) firms, 27 percent are employed in companies with less than 100 employees, while 40 percent are employed in companies with over 5,000 employees

The Engineer of 2020

If we could predict what engineers will be doing in the future, we could better predict what is needed to enter the engineering field as a professional. Part of predicting what engineers will be doing in the future is defining the Body of Knowledge (BoK) that will be required to practice as professional engineers in the future. Those that have the requisite BoK, in addition to the proper attitude and a propensity for life-long learning will be able to move forward and become the future leaders as technologies progress. President William Wulf of the National Academy of Engineering has been a strong advocate of re-looking at engineering education. In his article entitled “The Urgency of Engineering Education Reform” in NAE’S journal, *The Bridge*, Wulf questioned whether the B.S. should be the first professional degree in engineering (5). He points out that most professions do not consider the baccalaureate degree as a professional degree although engineering still does. This creates a number of problems that he discusses. Important among them is the necessity of bypassing needed courses such as the social and management sciences in large part because of the lack of time in the undergraduate program. In mentioning the additional things that engineering needs to cover he says, “We can’t just add these new elements to a curriculum that is already too full, especially if we still claim that the baccalaureate degree is a professional degree.” More recently Wulf spoke on this issue to engineering educators in a plenary session at the 2002 ASEE Annual meeting in Montreal. He again stressed the need to revisit the notion that the baccalaureate degree is the appropriate first professional degree. A story on Bill Wulf and his views on engineering education is in the September 2002 issue of *PRISM* (6).

Through its Committee on Engineering Education NAE is undertaking a two-part study called “The Engineer of 2020.” The first part is to develop scenarios of what engineers may be expected to do two decades from now. What are possible or likely problems that engineers will be expected to solve? That first part is in its final stages and a report will be prepared by December 2003. The second part is to look at the implications of these future scenarios on engineering education. While no one can predict what the outcome might be, it is probably safe to predict that the increased complexity of engineering will be highlighted along with the need for ever more diligent attention to engineering education and what is expected in the profession.

Why Change?

The old axiom, “Don’t fix it if it isn’t broke” is often on the minds of those considering how much education/learning is the minimum for engineering practice at the professional level. Those of us who are educators constantly look at what is best for our students over their entire careers. Professional societies must look at what is needed to determine how its future members will be best served. That is what ASCE is doing in its Policy Statement 465 Academic Prerequisites for Licensure and Professional Practice initiative. The policy states the following: “The ASCE supports the concept of the master’s degree or equivalent (MOE) as a prerequisite for licensure and the practice of civil engineering at a professional level.” Jones and Oberst believe that engineering services are becoming a commodity to be bought from the least expensive source (7). They present a compelling argument regarding engineering in the U.S. and call on the professional societies to play a more active role regarding lack of job security of engineers. Note, many graduating engineers can expect to work for perhaps six employers during their career and many moves will not be career enhancing.

Already many engineers are recognizing the need for more education to be successful in their careers. Using the latest data from NSF’s Science and Engineering Indicators 2000 shows that in 1996 there were 63,114 baccalaureate degrees in engineering awarded and 27,761 master’s degrees (44% as many). For civil engineering, the numbers were 12,053 and 5,002, respectively, with 42% being the ratio. While acknowledging that such comparisons may not have much validity, it does indicate that nearly half of the engineers recognize that if they are to be successful they must have education/learning beyond what can be provided in the B.S. degree. For civil engineers the ratio of BS to MS degrees has inched upward from about 37% during the 20-year period from 1966 to 1986 to about 44% in the 5-year period from 1991 to 1996. The same general trend seems to hold for all engineers except for the period around 1986 when baccalaureate degree production spiked to an all time high of nearly 77,000. More recent data from the Engineering Workforce Commission show little change in the trends. (Engineers. The Engineering Workforce Commission. See EWC Homepage at www.aaes.org/ewc or email at ewc@aaes.org).

Accreditation Related Challenges

In order to successfully implement ASCE Policy Statement 465, it would be advantageous to change some of the current paradigms relating to the accreditation of engineering programs. Three of the major paradigms are: (1) dual level accreditation of engineering programs; (2) how to modify accreditation criteria to reflect the “moving target” of the BoK needed to practice at

the professional level; and (3) how will non-traditional programs of post-baccalaureate study that do not culminate in a degree be certified as meeting a minimum standard. The BoK work under ASCE Policy 465 is well underway and should be in essentially final form in the not too distant future.

Perhaps the easiest of these to solve is the issue of dual level accreditation because the infrastructure for achieving this change is presently in place in the form of ABET. The other two challenges are under study and will require mechanisms for implementation that will need to be developed and implemented and widely accepted.

In this paper we are focusing on dual level accreditation. We recognize that there are costs, direct and indirect, to the institutions and ASCE associated with such a move. Nonetheless, we believe that the societies and the institutions will not serve the future needs of their members/students unless these issues related to the profession are addressed.

Current ABET Policies on Dual Level Accreditation

The ABET Constitution and Rules of Procedure do not address the issue of dual level accreditation of engineering programs (8). However, the issue is addressed in the ABET Accreditation Policy and Procedure Manual (9). Section II.B.9. – Program Level addresses the issue of dual level accreditation. While most of the policy and procedure manual has been established by the various commissions, the Board of ABET approved the statements related to dual level accreditation as provided below – quoted directly from the manual.

II.B.9.a. EAC – Engineering programs may be accredited at either the basic or advanced level. Accreditation at the advanced level requires compliance with the general basic level criteria, the general advanced level criteria, and appropriate program criteria. The choices of level of accreditation (either basic or advanced), the degree awarded, and the length of the program are left to the institution. **A program may be accredited at only one level in a particular curriculum at a particular institution.**

II.B.9.b. TAC – Engineering technology programs may be accredited at the associate degree level or at the baccalaureate degree level. Differential criteria are specified as the minimum course requirement for each level. **Programs may be accredited at both levels in a particular program at a particular institution.**

II.B.9.c. RAC – Engineering-related programs may be accredited at the baccalaureate degree or at the master's degree level. **Programs may be accredited at both levels in a particular curriculum at a particular institution.**

Bold print and underscoring has been added by the authors for the purpose of direct comparisons of the dual level accreditation policies for various programs under the different commissions of ABET.

For engineering (EAC), ABET has had the policy of no dual accreditation for several years. But this is not the policy for its accreditation of engineering technology programs (TAC) or the

accreditation of related programs under the aegis of the Related Accreditation Commission (RAC), which is now called the Applied Science Accreditation Commission (ASAC). The latter may be more relevant because the accreditation of programs at a particular institution is possible at both the baccalaureate and master's level.

The problem caused by the prohibition against the accreditation of both undergraduate and graduate level programs in a specific discipline is that if only one or the other degree program is going to be accredited, then the vast majority of civil engineering departments will default to accreditation of the undergraduate degree. For instance, for the accreditation cycle ending September 30, 1999, there are 209 basic level accredited programs in civil and similarly named programs, and two programs accredited at the advanced level (University of Louisville and University of Arkansas). In order for the various professional engineering licensure boards to accept the master's degree in partial fulfillment of the requirements for licensure, then those master's degrees must be accredited or certified by a reputable agency. The licensure boards are not set up, nor do they have the desire to become the accrediting or certifying agency for master's degrees. ABET has an existing infrastructure that could be readily adapted to the accreditation of master's degrees, in addition to the undergraduate degrees.

For those licensure candidates that choose to pursue the "30 credit" route to their advanced education, then the accreditation/certification options are much less clear. ABET accredits programs that lead to degrees; they do not accredit groups of classes that are taken to fulfill a body of knowledge requirement that do not lead to degrees. Therefore, some other mechanism, other than ABET, is needed in order to certify this other pathway to attainment of the requisite body of knowledge. The ASCE committee is currently studying various options that could be implemented to provide this required certification.

Whatever is done in engineering must be based on the merits of such a move as relates to engineering. The reason for presenting the information on the TAC and RAC policies as contrasted to EAC policies is only to show that ABET is flexible. The challenge for us is to make a persuasive argument on this matter in relation to the objectives of the American Society of Civil Engineers as stated in the Board-approved ASCE Policy Statement 465. While not every ASCE member is in agreement with this position, nor would we expect such, we believe the evidence for such a move is building and the transition to the notion that a baccalaureate degree alone is no longer sufficient education to enter professional practice in civil engineering is gaining momentum. We accept as proper and appropriate that the additional learning, education and experience beyond the baccalaureate degree can take many forms. But the demands of professional practice, in its many variations, for the engineer practicing in the first half of this century simply cannot be met with a baccalaureate degree education alone in virtually all cases. If engineering services and engineering practice are to be more than a commodity to be bought at the lowest price, then more professional/technical learning is needed. Flexibility in how this is approached is being considered by a number of civil engineers.

What we suggest is improvements for the future and for the benefit of the profession and future engineers. It in no way will affect the status of current engineering professionals. A possible time table is 2020 for implementation with provision to hold-harmless current practicing licensed engineers.

For more background on the issue of what will be needed for future professional practice in engineering, particularly civil engineering, the reader is referred to two other papers presented at this ASEE Annual Conference, June 23-25, 2003, Nashville, TN. These papers are in the proceedings and are:

1. Task Committee on Academic Prerequisites for Professional, "ASCE's Raise the Bar Initiative: Master Plan for Implementation"
2. Welsh, S.W., "ASCE's Raise the Bar Initiative: The Practice Oriented Body of Knowledge"

Summary and Conclusion

ASCE is working on developing a consensus on what is needed for the practice of civil engineering at the professional level. The individual state boards of licensure will determine who is qualified for a license to practice civil engineering in each state. We hope that ABET and the EAC will be open to the notion that institutions that voluntarily request to do so, should have the opportunity to obtain EAC accreditation of programs at both the master's and baccalaureate level. This would be based on the BoK that is agreed to be essential for professional practice. This would be the first step. The other two accreditation related issues that were noted in this paper will also be discussed within ASCE, and, we hope, the other professional engineering societies. For now we would like to see discussion of all of these issues in the state and local sections of ASCE and to receive comments from all engineering professional societies, engineering education administrators, ABET Board members and EAC Commissioners, and interested persons.

¹ EAC. 2000. Criteria for Accrediting Engineering Programs. ABET.

² Burton, Lawrence and Linda Parker. 1998. Intersections of Engineering and Management: What Do the Data Show? Prepared for ASEE National Convention, June, 1998.

³ Taken from the Business Section, *Kansas City Star*, January 17, 1995.

⁴ Luker, William, Jr. and Donald Lyons. 1997. Employment Shifts in High Tech Industries, 1988-96. *Monthly Labor Review*. June 1997.

⁵ Wulf, Wm. A. 1998. The Urgency of Engineering Education Reform. *The Bridge*. 20(1):4-8.

⁶ Sanoff, Alvin P. 2002. A Quiet Sort of Revolutionary. *PRISM*. 12(10):26-30.

⁷ Jones, Russel C. and Bethany S. Oberst. 2002. Are Current Engineering Graduates in the US Being Treated as Commodities by Employers? Paper presented at the 2002 Conference of the European Society for Engineering Education, Florence, Italy, September 9-11, 2002.

⁸ ABET. 2000. The ABET Constitution and Rules of Procedure as of October 28, 2000. ABET

⁹ ABET. 2000. Accreditation Policy and Procedure Manual. Note, this covers the procedures for the four accreditation commissions of ABET.

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