It’s Time to Remove a Barrier to Engineering Education Reform: ABET’s Prohibition on Dual Level Accreditation[a]

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What attributes will the engineer of 2020 have? He or she will aspire to have the ingenuity of Lillian Gilbreth, the problem-solving capabilities of Gordon Moore, the scientific insight of Albert Einstein, the creativity of Pablo Picasso, the determination of the Wright brothers, the leadership abilities of Bill Gates, the conscience of Eleanor Roosevelt, the vision of Martin Luther King, and the curiosity and wonder of our grandchildren.

--The closing paragraph of *The Engineer of 2020 – Visions of Engineering in the New Century.* National Academy of Engineering.[1]

Background

In 2001 the Board of Direction of the American Society of Civil Engineers (ASCE) unanimously adopted a position that supported the concept of the master’s degree or equivalent as a prerequisite for licensure and the practice of civil engineering at the professional level. This became Policy Statement 465 (PS465), which is briefly discussed in the next section. This Board action visualized what civil engineers will need in the future to be competitive professionally in the global market place. It was a visionary step.

About the same time the National Academy of Engineering (NAE) was crystallizing its concern that engineering education needed reform. NAE President William. A. Wulf, among others, started speaking on the subject. Wulf’s concern was that current engineering education, while technically strong, was not providing the leadership skills for engineers to assume a larger leadership role in this increasingly complex technological world. A couple of years after the ASCE adopted PS465, NAE established a Committee on the Engineer of 2020, chaired by G. Wayne Clough, President of Georgia Tech. The report of the committee, *The Engineer of 2020 – Visions of Engineering in the New Century,* was published by NAE in the spring of 2004.

This 100-page report looked to the future. It addresses the question: How can engineers be educated to be societal leaders, able to balance the gains afforded by new technologies with the vulnerabilities created by their byproducts without compromising the well-being of society and humanity? The report provides aspirations for engineering in 2020. At its core, the report calls for us to educate engineers who are broadly educated, who see themselves as global citizens, are ethically grounded, and can be leaders in business and

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public service. Engineers must be armed with the tools needed for the world as it will be, not only as it is today.

In July 2001, about the time PS465 was adopted, Stephen Director, Dean of Engineering at the University of Michigan and chair of the NAE Committee on Engineering Education, spoke at the National Society of Professional Engineers (NSPE) annual meeting on Licensure vs. Professionalism. Director's views, provocative to some, were summarized in the December 2001 issue of NSPE's *Engineering Times.*[2] National Science Foundation (NSF) data show that there are about 1.6 million persons employed as engineers, 0.4 million of those do not have an engineering degree. Moreover, there are about 1.2 million with engineering degrees who are not employed as engineers. Director mentioned what several others, including the civil engineering leader Samuel Florman, have said, namely that the engineering degree is becoming the 'liberal arts' degree of the 21st century. It provides the base for entering a variety of professions, engineering being the principle, but not only one.

In November 2004, the American Society of Mechanical Engineers (ASME) Council on Education issued a paper on, "A Vision of the Future of Mechanical Engineering Education."[3] It spoke of the increasing emphasis on limiting the baccalaureate degree to four years and that the BS program cannot accommodate in-depth technical specialization. In their vision it could, however, adequately cover technical breadth, flexibility, and the skills necessary for lifelong learning. This work by the ASME Body of Knowledge Task Force said that MEs must have intellectual agility and their education provide maximum flexibility. The ASME report referred to the paper by William A. Wulf and George M.C. Fisher (Chair of NAE) published in *Issues in Science and Technology,* spring 2002, entitled "A Makeover for Engineering Education."[4] Wulf and Fisher point to a developing consensus on the need to re-exam engineering education given changes that are occurring in society and the workplace.

These are but a sampling of the numerous, varied, and consistent calls for engineering education reform. ASCE agrees with Dr. Wulf who, in a lecture on September 16, 2003, said "America's engineering education needs to be restructured to meet the growing global competition and to keep pace with the changes in the field."[5]

As PS465 suggests, ASCE believes that the engineer of two decades hence will need a new skill set and a new mind set. The fundamentals of science and mathematics will continue to be the foundation for engineering. But engineering will have additional dimensions. It will be information and molecular based using new and different materials. Moreover, it will be an interactive global enterprise. The future engineer must understand project/activity management, how businesses function, and the social context of engineering practice. The design space has expanded, and now includes social, economic, and policy-related consequences.

In short, ASCE believes the education needs facing the next generation of civil engineers cannot be satisfied with a four-year baccalaureate degree. The necessary professional skills must be integrated in various courses throughout the curriculum, and must extend beyond the traditional bachelor's degree.

Civil Engineering Education Reform – and the Body of Knowledge

Today's world is fundamentally challenging the way civil engineering is practiced. Complexity arises in every aspect of projects, from pre-project planning with varied stakeholders to building with minimum environmental and community disturbance. Addressing this increased complexity will require understanding and solving problems at the boundaries of traditional disciplines. At the same time, reductions in credit hours required for graduation are making the current four-year bachelor's degree inadequate formal academic preparation for the practice of civil engineering at a professional level in the 21st century. Recognizing the preceding situation, and in keeping with the leadership role of civil engineers in the infrastructure and environmental arena and in protecting safety, health and welfare, the ASCE Board of Direction has acted.

ASCE Policy Statement 465, unanimously adopted by the Board of Direction in 2001, states that the Society "…supports the concept of the master's degree or equivalent as a prerequisite for licensure and the practice of civil engineering at the professional level." The ASCE created the Task Committee on Academic Prerequisites for Professional Practice (TCAP^3) to "develop, organize and execute a detailed plan for full realization of PS465."

TCAP^3 developed an implementation master plan for which the Body of Knowledge (BOK) was the foundation. TCAP^3 subsequently formed a Body of Knowledge Committee and charged it with defining the BOK, addressing the role of experience, and describing the roles of faculty, practitioners, and students.

The BOK Committee conducted its deliberations and presented its recommendations in a report entitled, "Body of Knowledge for the 21st Century."[10] The report was arranged by three themes: 1) ***what*** should be taught to and learned by future civil engineering students; 2) ***how*** should it be taught and learned; and 3) ***who*** should teach and learn it. The Committee's primary focus was the ***what*** – and the ***what*** will be the focus of the next several paragraphs.

The ***what*** recommendations are cast in terms of 15 outcomes that, compared to today's bachelor's programs, include significant increases in technical depth and professional practice breadth. Included in the 15 outcomes are the 11 current outcomes of ABET's Basic Level General Criteria (BLGC) for all engineering programs. Each outcome is supplemented with a descriptive commentary. Competency levels (recognition, understanding, or ability) are designated for each of the 15 outcomes.

The four outcomes of the BOK that are in addition to the 11 of ABET include--

- Outcome 12: the ability to apply knowledge in a specialized area related to civil engineering.

- Outcome 13: an understanding of the elements of project management, construction, and asset management.
- Outcome 14: an understanding of business and public policy and administration fundamentals.
- Outcome 15: an understanding of the role of the leader and leadership principles and attitudes.

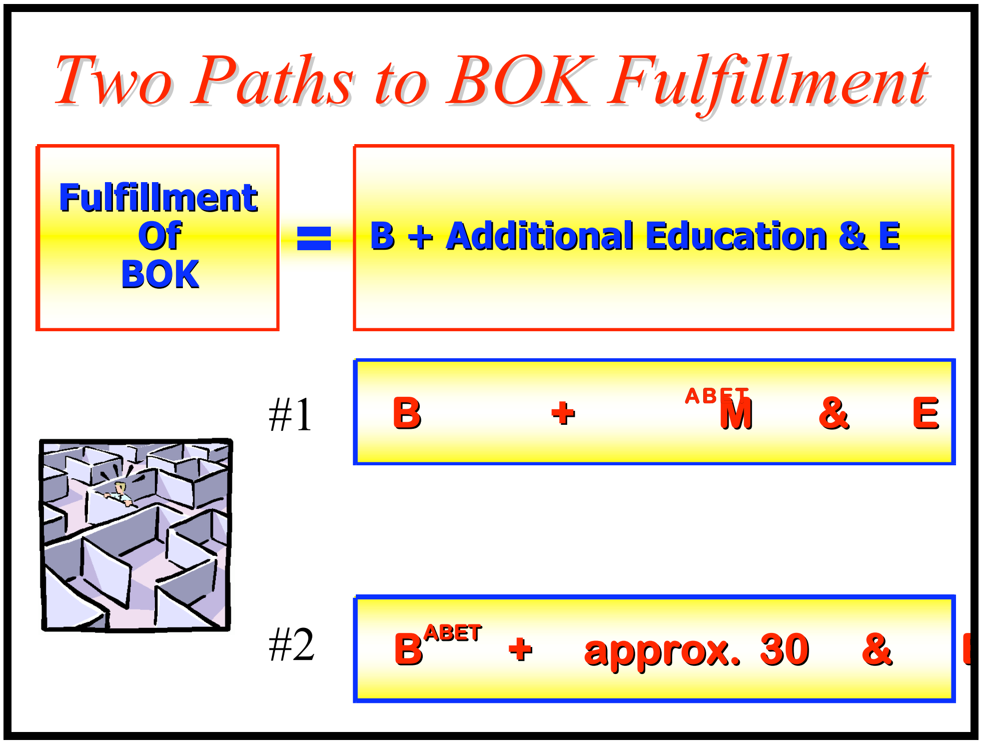
The Curricula Committee of CAP^3, a group consisting civil engineering program managers from 18 different universities, has evaluated how to incorporate the BOK into the undergraduate curriculum. They have found that all of the outcomes of the recently expanded Body of Knowledge can be covered within the undergraduate curriculum, <u>with the exception of Outcome 12</u>, additional technical depth. The additional technical depth component would, by its very nature, be very flexible in its application to allow for a wide range of career paths. Under this situation, the post-BS engineering education would consist of upper level undergraduate or graduate level coursework in professional practice and/or technical topic areas.

The preceding recommendations of the BOK and the Curricula Committee, combined with the activities of the Accreditation and Licensure Committees, are enabling ASCE to move forward in implementing ASCE Policy Statement 465.

Why Civil Engineering Education Reform Needs Dual Level Accreditation

A catalyst for education reform via the civil engineering Body of Knowledge is the removal of the prohibition on dual level accreditation. The criteria for an accredited engineering program as established by the Engineering Accreditation Commission of ABET "… are intended to assure quality and to foster the systematic pursuit of improvement in the quality of engineering education that satisfies the needs of constituencies in a dynamic and competitive environment."[11] ABET with its Engineering Criteria 2000 tremendously improved accreditation procedures, but it now needs to take the next step toward the future—removal of prohibition on dual level accreditation.

The BOK report identifies two primary paths to attainment of the BOK as shown in the frame below. The BOK could be fulfilled by obtaining a Bachelor's degree plus either a Master's or approximately 30 acceptable credits and experience ("B + M/30 & E"). The "E" in "B + M/30 & E" refers to progressive, structured engineering experience which, when combined with the educational requirements, *results in attainment of the requisite Body of Knowledge.* "B + M/30" represents two different (B + M and B + 30), but related methods to satisfy the formal educational requirements for entry into the professional practice of civil engineering. Both are equally satisfactory in fulfilling the BOK requirements. The two paths are diagramed below and will be described in the following paragraphs.



Path #1: The “B + M” path refers to a formal educational program consisting of a baccalaureate degree and an ABET/EAC accredited master’s degree -- ***if the proposed dual-level accreditation is implemented***. Dual-level accreditation, if implemented, will allow universities to voluntarily seek ABET/EAC accreditation for both undergraduate and graduate programs in the same engineering discipline. While it is not required that the baccalaureate degree (the “B” within the “B + M” path) be an ABET/EAC accredited degree, ***the master’s degree (the “M” within the “B + M” path) must be ABET/EAC accredited.*** In all cases, the overall “B + M” program should lead to the fulfillment of the requisite Body of Knowledge.

Path #2: The “B + 30” path refers to an educational program consisting of an ABET/EAC accredited baccalaureate degree and approximately 30 semester credits of acceptable graduate-level (or upper-level undergraduate) courses in technical and/or professional practice topic areas. It is required that ***the baccalaureate degree (the “B” within the “B + 30” path) be an ABET/EAC accredited degree***. The “30” program does not have to lead to a master’s degree. Some or all of the courses taken as part of a master’s program in a related professional practice topic area may “count” towards the fulfillment of the “30.” In all cases, the overall “B + 30” program should lead to the fulfillment of the requisite Body of Knowledge.

A primary assumption of any path to fulfilling the BOK is that the path include at least one ABET-accredited degree. This is true of both of the paths described above.

In the case of Path #1, the ABET-accredited master’s degree is the primary quality control of an individual’s fulfillment of the formal educational requirements of the BOK.

While it is assumed that most of the individuals following Path #1 will also obtain an ABET-accredited bachelor's degree, this is not required. By doing so, other prospective engineers with undergraduate degrees in the sciences and other engineering-related fields will have an opportunity to fulfill the BOK – and have it validated from an institution granting an ABET-accredited master's degree.

In the case of Path #2, it is anticipated that 14 of the 15 outcomes will be fulfilled (and validated) by an ABET-accredited bachelor's degree. As previously stated, the Curricula Committee has concluded that all outcomes (except for Outcome 12, technical depth) can be fulfilled and validated by an ABET-accredited bachelor's degree. The "30" of Path #2 can be accomplished by traditional campus-based courses or by distance learning delivery systems. In the future, all or part of the "30" might be delivered through independently-evaluated, high-quality, standards-based educational programs offered by firms, government agencies, and for-profit educational organizations. It is expected that the role of distance learning and independent educational programs will become more prevalent and important in the future for both degree and non-degree granting programs.

In conclusion, ASCE's desire to reform civil engineering education is highly dependent on the existence of a highly reliable quality control for BOTH of its fulfillment and validation paths. In the case of Path #1, ASCE needs an ABET-accredited master's degree to validate fulfillment of the formal educational component of all 15 outcomes. In the case of Path #2, ASCE needs an ABET-accredited bachelor's degree to validate fulfillment of the educational component of 14 of the 15 outcomes. The absolute bottom line is that ASCE needs ABET to carry out its accreditation function – and it needs ABET to do this at both the undergraduate and graduate levels.

ABET's Barrier to Flexibility in Accreditation

The ABET Accreditation Policy and Procedure Manual (APPM) is the document that spells out accreditation policies in detail including any restrictions on accreditation practices.[12] It provides guidance for each of the four accreditation commissions of ABET, the Engineering Accreditation Commission, EAC; the Technology Accreditation Commission, TAC; the Computing Accreditation Commission, CAC; and the Applied Science Accreditation Commission, ASAC. With the exception of CAC, which only accredits programs at the baccalaureate level, the other three commissions have developed accreditation criteria for more than one level, the associate and baccalaureate level for the TAC, and the associate, baccalaureate, and master's level for the ASAC. Oddly, the EAC refers to basic and advanced level accreditation instead of the degree level, i.e., baccalaureate and master's level, which could be a source of confusion. Both the TAC and ASAC specifically permit a named program to be accredited at more than one level if the institution requests it.

However, for engineering programs, Section II.B.8.a of the APPM states, *"Engineering programs may be accredited at either the basic or advanced level. . . . A program may be accredited at only one level in a particular curriculum at a given institution."*

The fall/winter 2003 issue of the ABET Newsletter, *Communications Link*, published an editorial by Ernest Smerdon and Richard Anderson, submitted on behalf of ASCE, entitled "Dual-Level Accreditation."[13] In this article the authors explained the ASCE initiative embodied in Policy Statement 465 and indicated that the alternate paths to fulfill the Body of Knowledge would require a quality assurance program. A portion of that verification process could logically be supplied by ABET, if dual-level accreditation is permitted. ABET is well qualified and the most experienced organization to provide this service, and we encourage it to accept this responsibility in service to the engineering profession. None of us argue that dual-level accreditation should be mandatory. It definitely should not. But those institutions that desire it, and pay the associated costs, should not be prevented from doing so.

To the best of our knowledge, there is no documented historical reason for the current EAC restriction against dual-level accreditation. Moreover, the reasons for past decisions are not important. It is important to cast our eyes to the future and look for ways in which the education of future civil engineers and engineers in general, can better prepare them for the challenges of the decades ahead. That is what the leadership in ASCE has done with PS 465. We plan to work with ABET and sister engineering societies to achieve the important goal of removing the restriction against dual-level accreditation of engineering programs.

Some Possible Concerns by Academia

A number of deans and department heads/chairs have expressed their concerns about removing the prohibition on dual level accreditation. For the purpose of this paper, we have grouped these concerns into three categories. These include concerns about (1) compatibility, (2) cost, and (3) competition.

Some deans and departmental leaders are concerned that ABET's advanced (master's) level accreditation criteria for engineering programs will not be compatible with their existing graduate programs. This is especially true at universities with strong research missions. In working with possible advanced level program criteria, we firmly believe that these concerns can be resolved. For example, ASCE has drafted a three-sentence advanced level general criteria and shared it with the Criteria Committee of the EAC/ABET[14]. This draft criteria states:

> *Advanced Level Programs must develop and publish educational objectives and program outcomes. The criteria for an advanced level program are fulfillment of the basic level general criteria, fulfillment of the basic level program criteria that are appropriate to the advanced level specialization area, and one academic year of study beyond the basic level. The program must demonstrate that graduates have an ability to apply advanced level knowledge in a specialized area of engineering related to the program area.*

The authors understand that the EAC/ABET is currently studying changes to the advanced level general criteria as a high priority project. We also know that the EAC/ABET recently rejected draft advanced level criteria that were considered by many curricula managers as being too prescriptive. It is hoped that the EAC/ABET will adopt new criteria in the near future which are concise and generally comparable to the criteria stated above. This would mean that most, perhaps all, of today's research-based master's degrees would fulfill the proposed advanced level general criteria.

A second major concern is cost. With the current severe financial constraints that higher education faces, the fear that dual level accreditation will impose a significant additional overhead cost to the institution is logical. We acknowledge these legitimate concerns. Undoubtedly, there will be some additional costs associated with dual level accreditation, but we believe these will be considerably less than some fear, if certain relatively minor changes are made in the engineering accreditation procedures.

The most significant of these changes would be the use of a single program evaluator for both the basic and the advanced level programs – and making the evaluations concurrent. In most basic and advanced level programs of the same name, there is much overlap in the undergraduate and graduate faculties, the facilities, and the administration. Institutional resources such as libraries and computer facilities will be the same. Therefore, it is feasible that one person, properly trained, could evaluate both programs with perhaps no more than an additional half day of on-site time. There will only be one meeting with the university officials, so that burden on the institutional leaders' time will not increase. There is already precedent within the Technology Accreditation Commission (TAC) of ABET for one visitor to evaluate two closely related programs, or two levels of programs in the same area. The additional cost for one person to evaluate two programs (or two levels of the same program) during one visit is small compared to the overall cost of the accreditation process. Specifically, according to the current ABET fee schedule[15], an additional fee of $200 per program is charged when a single evaluator is used to evaluate two or more closely related programs. Even when coupled with the maintenance fee of $235 per year for an additional program, this is far less than the $2,650 minimum fee charged for a separate program evaluator.

The second change would be in the content of the self-studies for the two visits. We believe there would be much overlap between the two self-studies, and they could be combined in one document. Analysis of the current EAC/ABET self-study questionnaire[16] reveals that the faculty, facilities, institutional support, financial, and tabular data required for an advanced level program would be very similar (if not the same!) as that of a basic level program of the same name. The form and content of the other sections of the self-study would be similar because the advanced level program evaluation would also utilize an outcomes based assessment process. In most cases, the extra coordination time for an additional program would be significantly reduced by the reality that the same academic department would be overseeing both the basic and advanced programs. The effort in financial and personnel resources should be much less than twice that required for the basic level self-study. Again, it should be stated that this process is optional, and thus it is presupposed that any program that applies for dual level accreditation would therefore be motivated to produce the required documentation.

The third concern expressed by a few university leaders was the issue of "competition." As one department chair stated: "If most of the other civil engineering departments in my region seek the accreditation of both their bachelor's and master's programs, I will be pressured to do the same." While the authors are legitimately concerned about issues of compatibility and cost, we are less concerned about the competitive pressures that might exist between different engineering programs. Our general observation is that these pressures are healthy and, ultimately, in the best interest of engineering students. This is especially true if the "competition" is to meet a standard that is publicly vetted by the profession's official standard bearer for engineering education, ABET. If an environment of healthy competition motivates engineering programs (at all levels) to continually assess and evaluate their programs in a rigorous manner, the true goals of engineering accreditation will have been met.

Conclusions and Summary

We believe other participating societies in ABET would consider approving the concept of dual level accreditation for the same reason ASCE believes it will benefit the profession. ASCE's study of what body of knowledge will be required for future practice at the professional level determined that the required knowledge exceeds that which can be gained during the traditional baccalaureate program. Other societies are studying the same questions and concerns.

If more education is required for entry into the profession, should that education be monitored by ABET to ensure a minimally acceptable level of quality? Or should it abdicate quality assurance responsibilities in engineering to another entity? We believe ABET, as the respected collective voice of the profession, is in the best position to fulfill this need. No program will be forced to seek dual level accreditation, but such should not be denied those programs that desire it.

In summary, it is our opinion that engineering departments that desire to have their basic and advanced level programs accredited in order to achieve their respective program educational objectives, should be permitted to do so. Similarly, programs that choose not to seek dual level accreditation should not be forced to do so. It must remain an institutional decision, but those institutions that desire it should not be prevented from achieving that goal. We believe that removal of this prohibition would be another step towards educational reform that will be necessary if our engineering graduates are to compete in the increasingly diverse world of the 21st century.

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