

**AC 2007-224: ASCE POLICY 465 ? THE MEANS FOR REALIZING THE
ASPIRATIONAL VISIONS OF CIVIL ENGINEERING IN 2025**

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ASCE Policy 465 –a Means for Realizing the Aspirational Visions of Civil Engineering in 2025

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Abstract

For several decades, educators and practitioners in the civil engineering community in the United States have been calling for reform of civil engineering education. In 1995, at the American Society of Civil Engineers (ASCE) Civil Engineering Education Conference (CEEC '95), some of the educational leaders of the profession believed that the time was right to begin the long road to reformation. Their call for action ultimately resulted in the passage of ASCE Policy Statement 465 which states that, in the future, education beyond the baccalaureate degree will be necessary for entry into the professional practice of civil engineering. An ASCE Board-level committee was formed to study and implement the actions that would be necessary to achieve this vision for civil engineering. The purpose of this paper is to discuss ASCE's current plan for implementing these actions including its development of a revised Civil Engineering Body of Knowledge (BOK), modified accreditation criteria, improved civil engineering curricula, and licensure issues.

Historical Perspective

Engineers have been advocating the reform of engineering education for over a century. Seely (NAE 2005) presented a comprehensive review of how engineering education has evolved throughout the 19th and 20th centuries. It is important "...to remember that until the end of the nineteenth century, the primary means by which a young person became an engineer was through a hands-on apprenticeship in a machine shop, at a drawing board, behind a transit, or on a construction site." In the closing years of the 19th century, engineering education, through a formal collegiate education, started to become the predominant method of developing and educating engineers.

As the education of engineers moved into the classroom, a tug-of-war between theory and practice, technical subject matter versus a broad liberal education, and engineering design versus engineering science began. The "...early debates were loud and prolonged, despite calls for changes as early as the 1880s by leading engineers, such as Robert Thurston of Cornell. The most famous study of engineering education (i.e., the Wickenden report of the 1920s) called for less hands-on specialization and more general

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preparation in math and science. (Wickenden 1927)” (Seely 2005). These tug-of-wars have continued through the years and have included topics such as communication skills, basic math and science content, hands-on versus theoretical courses, and fundamental versus applied research.

Some of these issues were temporarily resolved at various times either by the infusion of federal dollars, by curriculum innovation, or by experimentation by forward-thinking colleges of engineering. As the priorities of the nation and the federal government have changed, especially over the last 60 years, the focus of engineering education has also been altered, ostensibly to meet the needs of the nation. The seminal report in this regard was the Grinter report of 1956. This report noted the importance of mathematics in modern engineering sciences and Grinter “...again emphasized such knowledge and the federal government decided to fund fundamental research (as opposed to applied research) and unleashed an avalanche of money for university programs, (*and*) that American engineering schools almost universally adopted engineering science as the core of engineering education” (Seely 2005).

At the beginning of the 1900s, engineering was a leader in formal education with respect to other professions, requiring four years to achieve the baccalaureate degree which was considered the entry into the profession. As the decades of the 20th century marched by, engineering steadfastly maintained that four years was sufficient to prepare the aspiring engineer for entry into the profession. However, other professions, most notably medicine and law responded to changes in society and the growth in their Body of Knowledge (BOK). The effect of this, that engineering is being left behind, can be seen in Figure 1.

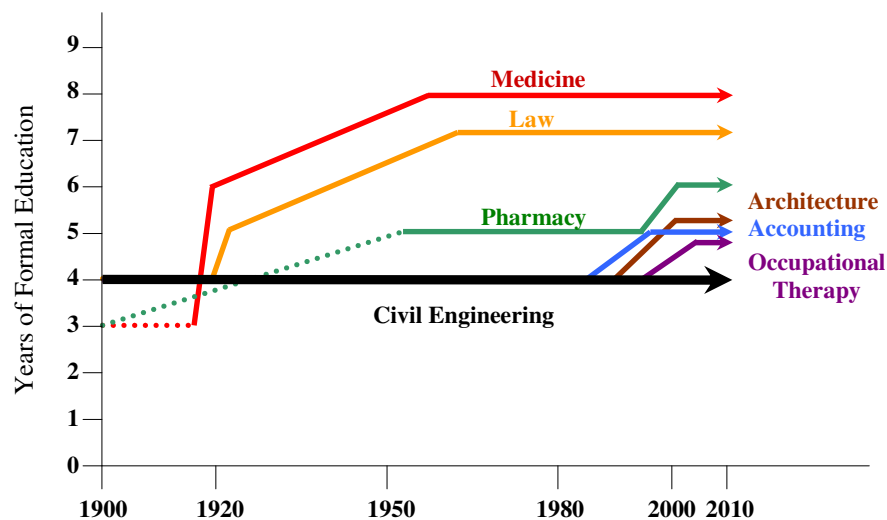


Figure 1. YEARS OF FORMAL EDUCATION REQUIRED TO ENTER THE PROFESSION (Russell et al. 2001)

Arguably, the increase in the engineering BOK has been as large, and maybe larger, than many of the professions identified in Figure 1. Yet, with few exceptions such as Cornell, Minnesota, and Ohio State (Seely 2005), engineering schools maintained four-year programs. Cornell, Minnesota and Ohio State quietly dropped their five-year undergraduate programs and reverted back to the traditional four-year undergraduate program when it became apparent that they were leaders with no followers.

In addition to the rigid adherence to the four-year undergraduate program, engineering programs are being required to squeeze more information into less hours of instruction, as measured by the credit hours required for graduation. This trend is shown in Figure 2 which depicts the decline in semester credit hours required for graduation since the early 1900s.

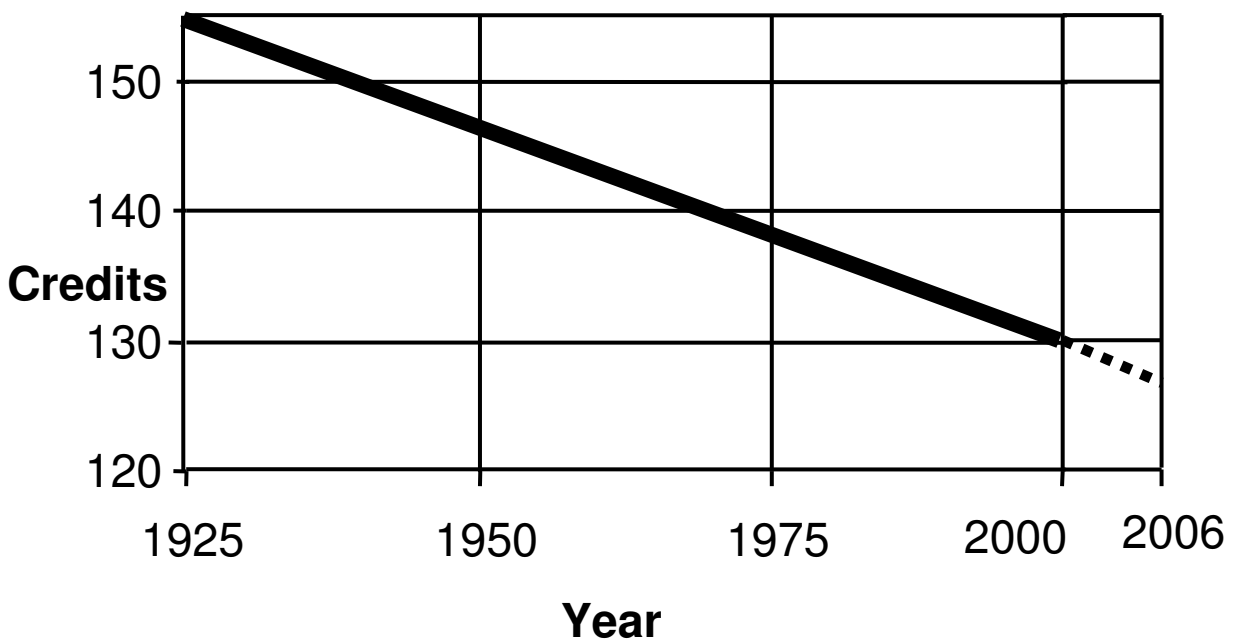


Figure 2. CREDIT HOURS FOR GRADUATION
(Russell and Stouffer 2005)

The combination of the increase in the civil engineering BOK, the need for technical specialization, the convergence of science and engineering, and the reduction in credit hours produced what many described as a crisis in civil engineering education. These issues and many others were discussed and debated at the 1995 American Society of Civil Engineers (ASCE) Civil Engineering Education Conference (CEEC '95). The consensus at CEEC '95 was that reform was essential and that ASCE, as the voice of the civil engineering profession, must take the lead and begin as soon as possible. As a direct result of the conference, an ASCE Board-level Task Committee on Civil Engineering Education Initiatives (TCEEI) was approved and appointed in 1995 "...to champion implementation of educational initiatives deriving from the 1995 Civil Engineering Education Conference" (ASCE 1995).

Recommendations in the TCEEI's April 1998 report to the Board led to the Board's October 1998 adoption of the initial version of Policy Statement 465 (titled "First Professional Degree") which begins: "**The ASCE supports the concept of the master's degree as the First Professional Degree for the practice of civil engineering (CE) at the professional level.**" This policy was explicitly supported in *Building ASCE's Future – Strategic Plan* adopted in 2000 by the Society. The ASCE Board then formed the Task Committee on the First Professional Degree (TCFPD) in October 1999 and charged it with "developing a vision of full realization of ASCE Policy Statement 465 ...and a strategy for achieving this vision" (ASCE 2001).

The final report (available at www.asce.org/raisethebar) of the TCFPD was submitted in August 2001 (ASCE 2001), and it identified the fundamental issue as: *The current four-year bachelor's degree is becoming inadequate formal academic preparation for the practice of civil engineering at the professional level in the 21st century.*

Policy Statement 465, as it was then written, focused on the designation of a master's degree as the first professional degree for the practice of civil engineering. The TCFPD believed that the focus should be on establishing the prerequisite educational requirements for licensure and practice at the professional level and recommended that Policy Statement 465 be re-titled as *Academic Prerequisites for Licensure and Professional Practice* and that the policy be refined to read: "**The American Society of Civil Engineers (ASCE) supports the concept of the Master's Degree or Equivalent (MOE) as a prerequisite for licensure and the practice of civil engineering at the professional level**" (ASCE 2004).

The TCFPD identified strategies and tactics that would be integral to full realization and implementation of Policy Statement 465. Four major action items, each with supporting tasks, were identified as being necessary for completion over the course of the next 20 years. These action items were supported by a total of 31 specific tasks.

In October 2001, the ASCE Board approved the refined Policy Statement 465 entitled "Academic Prerequisites for Licensure and Professional Practice" with the revised Master's Degree or Equivalent (MOE) wording noted above. A new task committee, the Task Committee on Academic Prerequisites for Professional Practice (TCAP³), was authorized and charged to develop, organize, and execute a detailed plan for the full implementation of Policy Statement 465 (ASCE 2004).

In November 2003, the ASCE Board authorized formation of the Committee on Academic Prerequisites for Professional Practice (CAP³) as a successor to TCAP³ with the mission to develop, organize, and implement Policy Statement 465's "Raise the Bar" initiative. By changing from a task committee to a standing committee, the Board explicitly acknowledged the fact that this effort would take many years and require many resources.

Every three years, ASCE policy statements must be reviewed and affirmed, if appropriate, by the Board. In October 2004, Policy Statement 465 was revised and approved unanimously by the ASCE Board. The 2004 review approved the current wording supporting “**the attainment of the Body of Knowledge (BOK) for the entry into the practice of civil engineering at the professional level.**” Undergirding this policy is the belief that, in the future, the BOK necessary to enter the practice of civil engineering at the professional level will be beyond the scope of a traditional 4-year bachelor’s degree and required pre-licensure practical experience. The BOK formulated in support of Policy Statement 465 is defined as the knowledge, skills, and attitudes necessary to be a licensed professional civil engineer.

Parallel to, and independent of, the Policy Statement 465 activities, the National Academy of Engineering (NAE) was also studying the future education of engineers. The NAE’s Committee on Engineering Education originated and chartered a two-phase project. The first portion of the project culminated in a report entitled “The Engineer of 2020 – Visions of Engineering in the New Century” (NAE 2004). The second report is entitled “Educating the Engineer of 2020 – Adapting Engineering Education to the New Century” (NAE 2005).

The second report validates ASCE Policy 465 by stating that:

“It is evident that the exploding body of science and engineering knowledge cannot be accommodated within the context of the traditional four year baccalaureate degree.”

In addition, the first recommendation of the second report indicates that:

“#1 The baccalaureate degree should be recognized as the “pre-engineering” degree or “bachelor of arts” in engineering degree, depending on the course content and reflecting the career aspirations of the student.” (NAE 2005)

The congruence between ASCE Policy Statement 465 and the NAE report is evident. The report’s other recommendations are equally supportive of the direction that ASCE has taken with regard to Policy Statement 465. This report has also had an influence on the efforts of a new Body of Knowledge Committee as described in the next section. The content of the Second Edition of the Civil Engineering Body of Knowledge (BOK2) will be supportive of the NAE report and its recommendations.

Activities of the Committee on the Academic Prerequisites for Professional Practice (CAP³)

The last five years have produced significant progress in ASCE’S “Raise the Bar” initiative, from the creation of a Civil Engineering Body of Knowledge (BOK), to a significant change in reactions and attitudes toward this initiative, to the modification of

the licensure Model Law compatible with ASCE Policy Statement 465. Figure 3 shows the CAP³ master plan.

The fundamental charge of CAP³ is to develop, organize, and implement ASCE's "Raise the Bar" initiative. To accomplish this multi-phased goal, CAP³ has spread its efforts over several fronts including curricula, licensure, accreditation, and the development of the next edition of the Civil Engineering Body of Knowledge. CAP³ has involved not only ASCE membership but experts from other engineering and education disciplines in these efforts as well. Constituent committees have been carrying out efforts in each of these four areas.

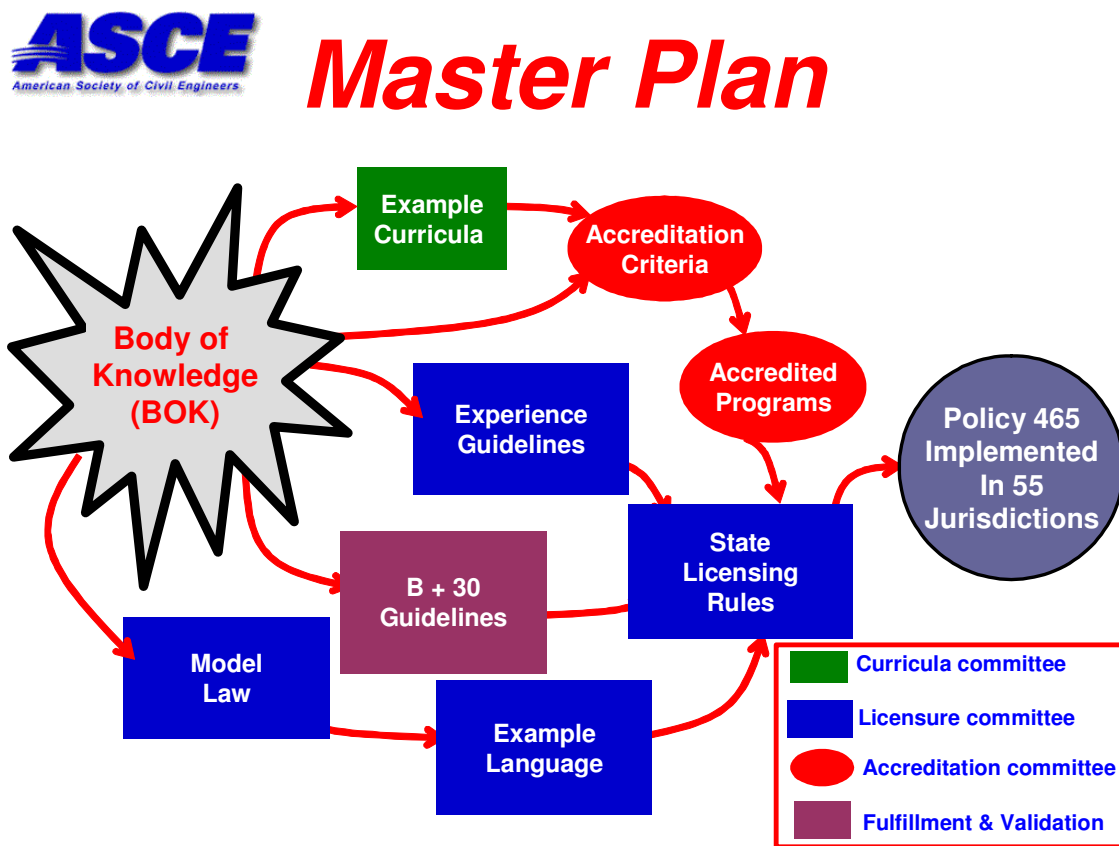


Figure 3. CAP³ MASTER PLAN

The organizational structure for CAP³ is shown in Figure 4.

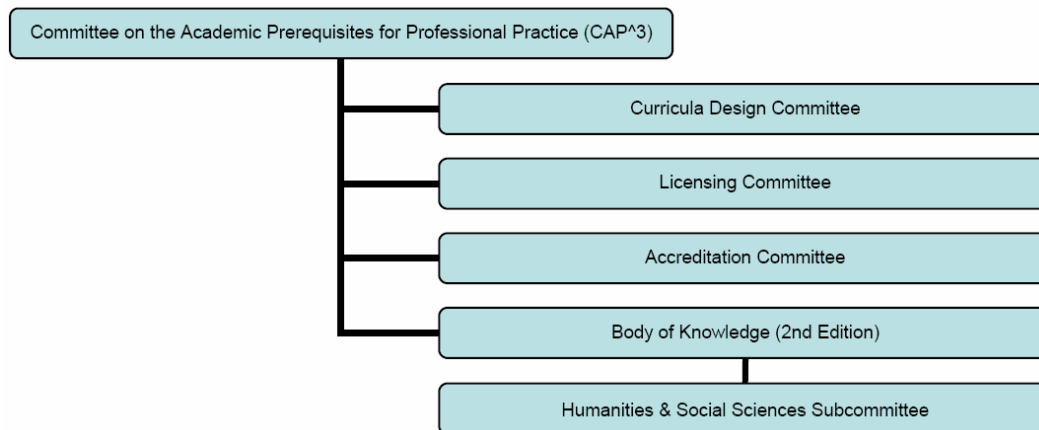


Figure 4. ORGANIZATIONAL STRUCTURE OF CAP³

Overall accomplishments of the four constituent committees in 2006 are described in the four sections below. Descriptions of the three new committees are included as well.

Curricula Design Committee:

Part of the knowledge, skills, and attitudes outlined by ASCE are obtained through formal structured education, and other parts are obtained through focused professional experience after graduation. Consisting of curriculum design experts from 25 civil engineering programs across the United States, the Curriculum Design Committee was charged by CAP³ with two fundamental tasks: (1) determine the current status of civil engineering education in relation to the formal educational component of the BOK and (2) determine the nature of change necessary to support the formal educational (bachelor's and master's) expectations of the BOK.

Specifically excluded from the charge of the Curriculum Committee was to “determine the professional practice experience and alternative programs (the +30 credit hours path) for achieving the educational expectations of the BOK.”

This committee completed its mission by the end of 2006 and their report is available at www.asce.org/raisethebar. In meeting its goals and objectives, the committee mapped the BOK outcomes on existing curriculum. This process provided many suggestions on how to improve the next edition of the BOK. One of the most valuable contributions was to recommend that all outcomes use “action verbs” from Bloom’s Taxonomy of Educational Objectives to provide more universally accepted and understood required levels of achievement.

Several other conclusions were also developed as a result of the committee’s work. The BOK, as it currently exists, is not accomplished within current four-year civil engineering curricula. All programs believe that they accomplished outcomes 1-11 (extensions from

ABET outcomes a-k) to the level of achievement expected in the BOK. Some individual programs accomplish one or more of the remaining four outcomes (i.e., outcomes addressing specialized technical knowledge; business and public policy; construction and asset management; and leadership) to a greater or lesser extent. None of the programs, however, address all of these outcomes to the level of achievement expected in the BOK.

The committee concluded that the BOK, except for the outcome regarding technical specialization, can be fulfilled in a four-year undergraduate curriculum. The means by which the outcomes are incorporated can be varied and do not need to be consistent from program to program. The means of fulfilling these outcomes could include required seminars, additional and redesigned courses, and enhancement of content in current courses and formal experience.

The committee also decided that the outcome regarding specialized technical knowledge is best accomplished in a post-graduate program of study. By not including the fulfillment of the technical specialization outcome in the undergraduate program of study, necessary outcomes can be achieved to the required level of achievement without requiring an increase of the undergraduate curriculum beyond four years. Further, this approach facilitates program accreditation by delineating the content of the curricula—that is to say, the outcomes expected to be accomplished at the undergraduate level.

Licensure Committee:

Professional licensure activities for engineers in the United States are extremely splintered with each of the individual states and territories being responsible for their own professional licensing, resulting in a total of 55 licensing jurisdictions. Each of the jurisdictions are free to make their own laws, rules and regulations; however, they are encouraged, but not required, to follow the Model Law format developed by the national umbrella group for licensure, the National Council of Examiners for Engineering and Surveying (NCEES). To further complicate matters, the vast majority of jurisdictions license by profession; therefore, civil engineers are not differentiated from electrical engineers or mechanical engineers, etc. Therefore, in these states, the requirements for licensure are the same for all engineering disciplines while civil engineering educational requirements for licensure must follow the same rules as all the other engineering disciplines.

In spite of the splintering of the licensure process, ASCE has received strong endorsement of the concept of Policy Statement 465 from both the National Society of Professional Engineers (NSPE) and NCEES.

Licensure Committee members have been instrumental in assisting NCEES in initiating discussions and drafting Model Law language that would, in the future, require additional education beyond the bachelor's degree to sit for the Principles and Practice of Engineering examination.

The Committee on Uniform Procedures and Legislative Guidelines (UP&LG) of NCEES began discussions in the spring of 2005 to draft Model Law language. NCEES continued to work with the licensing boards throughout the process. In the summer of 2005, NCEES voted that the Model Law be changed in the future to require additional education. Over the next year, NCEES considered a well-conceived modification to the Model Law to require additional engineering education in the future.

The Licensure Committee of CAP³ was very active in engaging jurisdictions in the NCEES Model Law discussion. Presentations were made by CAP³ members to over ten different licensing boards – and there were numerous communications with individual licensing board members. To expand the network of members working on this issue, letters soliciting help/support were sent to:

- ASCE Members on Licensing Boards (117)
- ASCE Past (national) Presidents (27)
- ASCE Board of Direction Members (33)
- ASCE Honorary Members (174)

At the 2006 Annual Business Meeting of NCEES in Anchorage, Alaska, the delegates approved the modifications to the NCEES Model Law requirements for licensure to require additional education for engineering licensure, with an effective date of 2015. The approved language states that an engineer intern with a bachelor's degree must obtain an additional 30 credits of acceptable upper-level undergraduate or graduate-level coursework from approved providers in order to be admitted to the Principles and Practice of Engineering (PE) examination. A master's or Ph.D. degree from an approved institution would also qualify. The change, to be effective in 2015, is a recommendation to each of the state licensing jurisdictions, which individually will have to adopt it for it to be implemented. The specific language approved by NCEES on September 15, 2006 states:

Licensure by Examination (Effective January 1, 2015). The following individuals shall be admitted to an 8-hour written examination in the principles and practice of engineering:

- (1) An engineer intern with a bachelor's degree, with an additional 30 credits of acceptable upper-level undergraduate or graduate-level coursework from approved course providers, and with a specific record of an additional four years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practice engineering.
- (2) An engineer intern with a master's degree in engineering from an institution that offers EAC/ABET-accredited programs, or the equivalent, and with a specific record of an additional three years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practice engineering.

- (3) An engineer intern with a doctorate in engineering acceptable to the board and with a specific record of an additional two years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practice engineering.
- (4) An individual with a doctorate in engineering acceptable to the board and with a specific record of an additional four years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practice engineering.

The Model Law defines an engineer intern as a graduate of an engineering program of four years or more accredited by the Engineering Accreditation Commission of ABET, or the equivalent, who has passed the fundamentals of engineering (FE) exam.

ASCE's advocacy for this motion was strongly supported by the National Society of Professional Engineers, which has adopted a Professional Policy 168 supporting "additional academic requirements as a prerequisite for licensure and practice of engineering at the professional level." The National Academy of Engineering also influenced the engineering profession by its "Engineer of 2020" report, which concluded that engineering education beyond the baccalaureate level will be necessary in the future for the professional practice of engineering.

Now that NCEES has approved the concept and incorporated it into the Model Law, the Committee on Uniform Procedures and Legislative Guidelines (UP&LG) is working to more precisely define what the additional education should be. UP & LG has been formed and charged with defining terms and considering issues related to implementation. These would be addressed in changes to the NCEES Model Rules (as opposed to the Model Law). Two of the members of the CAP³ Licensure Committee have been asked to serve as advisors to this committee – and CAP³ has been asked to provide an additional non-voting "consultant" to this NCEES committee.

Accreditation Committee:

In the United States, ABET, Inc. is responsible for accreditation activities for engineering programs. ABET is "owned" by a federation of 28 professional societies, including ASCE. ASCE has a proportional voice and vote in ABET, but certainly does not control the overall accreditation activities related to engineering. ABET accredits engineering programs through its Engineering Accreditation Commission (EAC) and accredits other technological programs through its other three commissions (i.e., Computing Accreditation Commission, Technology Accreditation Commission, and Applied Science Accreditation Commission).

Since January 2004, the Accreditation Committee of CAP³ has been actively working on revising the Civil Engineering Program Criteria based upon the Civil Engineering BOK. These new program criteria were first drafted in the spring of 2004. However, at

that time, CAP³ decided that it would delay submitting any new Civil Engineering Program Criteria to the EAC/ABET until June 2006. CAP³ conscientiously planned for this two-year internal review period to ensure that all appropriate stakeholders had an opportunity to review the new criteria and an opportunity to review any major modifications made during this internal review period.

During this two year period, semiannual presentations were made to the major educational groups within ASCE. Presentations were also made to the (1) Civil Engineering Division of the American Society for Engineering Education (ASEE) in June 2004 and June 2005; (2) the national meetings of the Civil Engineering Department Heads in May 2005 and March 2006; and (3) the Criteria Committee of the EAC/ABET in July 2005. "Frequently Asked Questions" (available at www.asce.org/raisethebar) were developed to promote clear, concise, and consistent communications with stakeholders. As a result of this extensive communication and coordination, feedback was received to improve the quality, relevance, and effectiveness of the program criteria. Upon submission to the EAC/ABET in June 2006, CAP³ was confident that the resulting Civil Engineering Program Criteria was broadly known and endorsed by the civil engineering educational community. All major educational committees of ASCE had reviewed and approved the new Civil Engineering Program Criteria.

In June 2006, the Accreditation Committee submitted its new Civil Engineering Program Criteria and Advanced Level General Criteria to the EAC/ABET. The basic level Civil Engineering Program Criteria was unanimously passed by the Engineering Accreditation Commission in July 2006 and consists of two components: curriculum and faculty. Specifically, the criteria are:

Effective for Evaluations during the 2008-2009 Accreditation Cycle

**PROGRAM CRITERIA FOR CIVIL
AND SIMILARLY NAMED ENGINEERING PROGRAMS**

(Passed by the Engineering Accreditation Commission of ABET [on first reading] on July 21-22, 2006)

1. Curriculum

The program must demonstrate that graduates can apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of science, consistent with the program educational objectives; can apply knowledge of four technical areas appropriate to civil engineering; can conduct civil engineering experiments and can analyze and interpret the resulting data; can design a system, component, or process in more than one civil engineering context; can explain basic concepts in management, business, public policy, and leadership; and can explain the importance of professional licensure.

2. Faculty

The program must demonstrate that the faculty members teaching its design courses are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience. The program must demonstrate that it is not critically dependent on one individual.

The Advanced Level General Criteria were also passed by the EAC/ABET and includes the following:

Effective for Evaluations during the 2008-2009 Accreditation Cycle

CRITERIA FOR ADVANCED LEVEL PROGRAMS

(Passed by the Engineering Accreditation Commission of ABET [on first reading] on July 21-22, 2006)

Advanced Level Programs must develop, publish, and periodically review educational objectives and program outcomes. The criteria for an advanced level program are fulfillment of the basic level general criteria; fulfillment of program criteria 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.

It is anticipated that the Civil Engineering Program Criteria will be implemented in time for evaluation during the 2008-2009 accreditation cycle. The Draft Commentary that supports the new basic level Civil Engineering Program Criteria has been completed. This version is a significant improvement over the previous version and it is anticipated that it will be a real asset in the implementation of the new criteria. The criteria and Draft Commentary can be found on www.asce.org/raisethebar.

Second Edition of the Body of Knowledge (BOK) Committee:

Following its formation in the fourth quarter of 2005, the Second Edition of BOK Committee (BOK2) held its first face-to-face meeting in January 2006 in Tampa, Florida. Committee members carefully reviewed and discussed the First Edition of the Body of Knowledge (available at www.asce.org/raisethebar) and *The Engineer of 2020* reports from the National Academy of Engineering (NAE).

Committee members organized 14 subcommittees to review existing outcomes (i.e., technical breadth; communication; specialization; leadership; public policy; and multi-, inter-, and cross-disciplinary teams) in the BOK as well as some new topics (i.e., sustainability; globalization; emerging technologies; history/heritage; attitudes; discover mode; and risk and uncertainty).

Second and third face-to-face meetings were held in May 2006 and August 2006 in Reston, Virginia. Throughout 2006, the committee participated in weekly conference calls and email messaging to work through 30 different educational outcomes that were identified for possible inclusion in the Second Edition of the Civil Engineering BOK. By comparison, the First Edition of the Civil Engineering BOK includes 15 separate outcomes. The committee decided to divide some of the original 15 outcomes in an attempt to more explicitly address some topics that were obscured by the combination of some outcomes within the First Edition of the BOK. In addition, a subcommittee has

been formed to study how humanities and social sciences should be incorporated into the BOK.

The committee remains on track to release a draft of the Second Edition of the Civil Engineering BOK for broad distribution and comment in July 2007. Key differences between the first and second editions of the BOK include: (1) an explicit connection to the aspirational vision for civil engineering (vision report is available at www.asce.org/raisethebar); (2) an increase in the number of outcomes; and (3) a more highly structured approach to the level of achievement expected for each of the outcomes, at various stages of a civil engineer's education, using Bloom's Taxonomy. The Second Edition of the BOK is currently scheduled for release during Engineers' Week in February 2008 at the National Academy of Engineering.

Affective Domain Subcommittee:

ASCE has advanced the concept of the BOK as part of the development of the civil engineering professional in the future. The BOK is expressed in the form of educational outcomes attained through formal education and real world experience. The achievement of the outcomes has been a source of discussion and, in some cases, confusion. The original terminology used was levels of competence (i.e., recognition, understanding, and ability) (ASCE 2004). As faculty tried to use the levels to map the BOK outcomes to their current curriculum, inconsistencies and difficulties arose. This led to the formation of the Levels of Achievement Subcommittee to explore the educational psychology literature to find potential frameworks that might be applicable to the BOK. Specifically, the Subcommittee wanted a relatively simple framework, informed by cognitive and educational research, which could link BOK outcomes to actual learning and achievement. Their report (ASCE 2005) can be found at www.asce.org/raisethebar.

The Levels of Achievement Subcommittee settled on using the original formulation of Bloom's Taxonomy over the revised taxonomy table proposed by Anderson et al. (2001). Bloom's Taxonomy is widely known and understood across the education community and its application to engineering education is well documented in the literature. Bloom's emphasis on the use of measurable, action-oriented verbs facilitates the creation of new outcome statements that will lend themselves to more consistent and more effective assessment.

Bloom's Taxonomy can be characterized by three domains including: (1) cognitive, (2) affective, and (3) psychomotor. These words are defined as follows (Neufeldt 1986):

- Cognitive: of, or arising from, perception, memory and judgment.
- Affective: of, or arising from, affects or feelings; emotional.
- Psychomotor: of, or arising from, the motor effects of mental processes.

Bloom's mapping of verbs to levels of cognitive development has been embraced by the BOK2 Committee. The affective and psychomotor domains, however, have not been fully explored for their possible inclusion in the second edition of the BOK. In both cases, the argument for not doing so is that we cannot easily measure outcomes within these domains. To advance our thinking in the second edition of the BOK, it would appear that both the affective and psychomotor domains are ripe for exploration. Given the limited time and resources that we have, focusing on the affective domain may be the best path to pursue at this time.

The affective domain relates to the emotional component of learning. It emphasizes a feeling, tone, an emotion; or a degree of acceptance or rejection. Affect encompasses a range from simple attention to organization and characterization of complex, but internally consistent, to qualities of character and conscience. In 1964, Krathwohl, Bloom, and Masia developed five levels in the affective domain including (1) receiving, (2) responding, (3) valuing, (4) organization, and (5) characterization by value (see www.cdio.org). There appears to be several outcomes (i.e., humanities, social sciences, project management, and the professional outcomes—communication, globalization, professional and ethical responsibility, teamwork, leadership, lifelong learning, and attitudes) in which there may be both a cognitive and affective level of achievement. A subcommittee has been formed and has the following charge:

1. Review and study research on the affective domain of Bloom's taxonomy. This should also include the current use of the affective domain in developing college-level educational objectives.
2. Provide a short white paper to the BOK2 Committee documenting the issues related to the affective domain and alternative courses of action for their inclusion in the BOK second edition.
3. Complete the preceding in three months.

Pre-licensure Experience to Fulfill the CE BOK:

A new committee, focused upon pre-licensure experience guidelines to fulfill the CE BOK, will be formed in early 2007. The initial charge to the committee includes:

1. Search for existing engineering/civil engineering experience guidelines published by private or public entities – national and international.
2. Search for experience guidelines in other professions such as medicine and law.
3. Study the recommendations regarding pre-licensure experience contained in the draft *Civil Engineering Body of Knowledge (2nd Edition)*. Provide feedback to the Body of Knowledge Committee.
4. Define what constitutes progressive experience.

5. Prepare a statement that explains the “problem to be addressed” by the American Society of Civil Engineers (ASCE). Propose alternative courses of action that could be pursued by ASCE to address the problem.
6. Engage and coordinate with NSPE and NCEES throughout the process and discussion.
7. Provide a report to the Committee on Academic Prerequisites for Professional Practice (CAP³) documenting the Experience Committee’s problem statement and alternative courses of action.
8. Complete the preceding in twelve months.

Educational Fulfillment of the BOK:

Another new committee will be formed in early 2007 to focus upon education fulfillment of the BOK. The committee will be reviewing the second edition of BOK in detail. The charge of the committee includes:

1. Foster the creation of a learning community of scholars interested in civil engineering education reform. Representatives from a diverse mix of civil engineering programs should be included in the committee.
2. Review the new basic level Civil Engineering Program Criteria resulting from the first edition of the BOK and the Draft Commentary. Identify issues related to implementing the new criteria that need to be addressed. Review “going beyond the criteria” sections in the Draft Commentary.
3. Document how programs are incorporating the BOK into their curriculum. Compile best practices on how to fulfill the formal education requirements of the BOK to include how the outcomes can be assessed, how to improve the effectiveness of general education requirements in BOK attainment, and how co- and extra-curricula activities can support the fulfillment of the BOK.
4. Develop examples detailing how students entering with an un-accredited BS in civil engineering can fulfill the BOK.
5. Review work products of the new Body of Knowledge Committee and provide timely input, feedback, and suggestions.
6. Review proposed changes to accreditation criteria resulting from the publication of the Second Edition of the Body of Knowledge Report including the basic level Civil Engineering Program Criteria, Advanced Level General Criteria, and the ASCE Draft Commentary.

7. Prepare written annual status reports suitable for briefing the ASCE Board of Direction.
8. Provide a final report documenting the Committee's work and results.
9. Complete the preceding in two years.

Conclusions:

Throughout the 20th century, there has been a significant amount of discussion regarding engineering education. Conferences have been held, papers presented, and extensive studies have been conducted. However, very little has been accomplished in the way of significant reform. Engineering adheres to the thought that a four-year baccalaureate degree, with 10 to 20 percent less credit hours, is still as adequate now as it was in 1905. ASCE and the authors of this paper believe that this preparation is no longer adequate.

The American Society of Civil Engineers has elected to move forward and proceed under the premise that the current four-year bachelor's degree is becoming inadequate formal academic preparation for the practice of civil engineering at the professional level in the 21st century. ASCE has received validation of this premise from the recent studies conducted by the NAE as well as by the endorsements of NSPE and NCEES. The NAE stated the following in the Summary of the 2005 report:

"It is evident that the exploding body of science and engineering knowledge cannot be accommodated within the context of the traditional four year baccalaureate degree. Technical excellence is "the" essential attribute of engineering graduates, but those graduates should also possess team, communication, ethical reasoning, and societal and global contextual analysis skills as well as understand work strategies. Neglecting development in these arenas and learning disciplinary technical subjects to the exclusion of a selection of humanities, economics, political science, language and/or interdisciplinary technical subjects is not in the best interest of producing engineers able to communicate with the public, able to engage in a global engineering marketplace or trained to be life long learners." (NAE 2005)

The CAP³ is actively engaged on many fronts as the implementation plan for Policy Statement 465 moves forward. Referring to the master plan and the description of the current and on-going committee, we have five broad goals to accomplish over the next five years. The goals are:

1. Secure a state to adopt B+30 for the educational requirements to be licensed;
2. Publish the Second Edition of Civil Engineering Body of Knowledge by February 2008;

3. Implement changes to the criteria for basic level civil engineering programs and advanced level programs -- and engage in dialog regarding the removal of the prohibition on dual level accreditation of engineering programs;
4. Create more detailed experience guidelines that support the fulfillment of the BOK; and
5. Engage civil engineering faculty in curricula reform through dialog, discussion, and implementation of the BOK.

Civil engineering is looking ahead and anticipating what the engineer of 2025 and beyond will need in the way of knowledge, skills, and attitudes for the successful professional practice of civil engineering. ASCE believes that the reformation of civil engineering education will prepare civil engineering to assume leadership positions in the technological world of the future.

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