AC 2008-46: ASCE POLICY 465 – PROGRESS AND NEXT STEPS

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ASCE Policy 465 – Progress and Next Steps

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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. The American Society of Civil Engineers (ASCE) has been working since 1995 on the concept of additional education to practice at the professional level in the future. ASCE's Board-level committee, the Committee on Academic Prerequisites for Professional Practice (CAP^3) currently has five different constituent committees actively working across the various domains related to engineering educational reform. The purpose of this paper is to discuss ASCE's current plan for implementing these actions including its release of the second edition of the Civil Engineering Body of Knowledge (BOK), modified accreditation criteria, improved civil engineering curricula, refined experience guidelines for engineer interns, and licensure issues.

Background

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. In 1998, the call for action from the CEEC '95 ultimately resulted in the passage of ASCE Policy Statement 465—Academic Prerequisites for Licensure and Professional Practice. ASCE Policy 465 states that, in the future, education beyond the baccalaureate degree will be necessary for entry into the professional practice of civil engineering. In 2002, an ASCE Board-level committee, the Committee on Academic Prerequisites for Professional Practice (CAP^3), was formed to study and implement the actions that would be necessary to achieve this vision for civil engineering. The last six years have produced significant progress in ASCE'S "Raise the Bar" initiative.

The fundamental charge of CAP^3 is to develop, organize, and implement ASCE's "Raise the Bar" initiative. To accomplish this multi-phased goal, CAP^3 has created a master plan for implementation. The purpose of this paper is to discuss ASCE's current plan for implementing these actions including its release of the second edition of the Civil Engineering Body of Knowledge (BOK), modified accreditation criteria, improved civil engineering curricula, refined experience guidelines for engineer interns, and licensure issues.

The Master Plan for Implementing ASCE Policy 465 – Overview

ASCE's complex, multi-dimensional, and integrated master plan for implementing ASCE Policy 465 is based entirely on the ASCE's *Vision for Civil Engineering in 2025* and the *Civil Engineering Body of Knowledge for the 21st Century* (BOK). The vision describes a future desired state for the profession. The BOK implies the need for changes to the educational and licensure processes of the civil engineering profession including the (1) accreditation criteria of engineering programs, (2) university curricula, (3) on-the-job education and training of engineer interns, (4) NCEES Model Law/Rules, and, ultimately (5) state laws and regulations governing the licensure of practicing professional engineers. Figure 1 shows the ASCE master plan for implementing ASCE Policy 465, and Figure 2 shows CAP^3's organizational structure.

The work products associated with this master plan, as well as the committees working on these products, are briefly explained below. For a more detailed explanation, please go to www.asce.org/raisethebar.

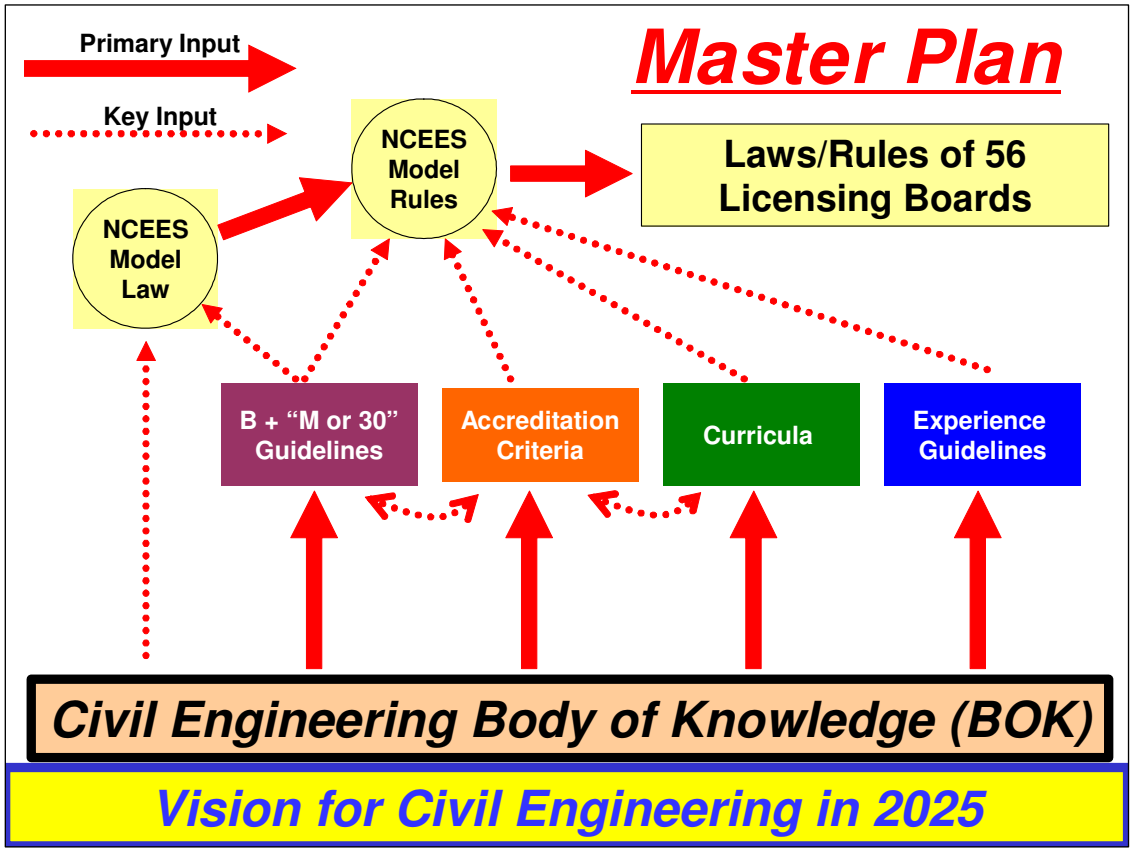

Figure 1. ASCE Master Plan for Implementing Policy 465

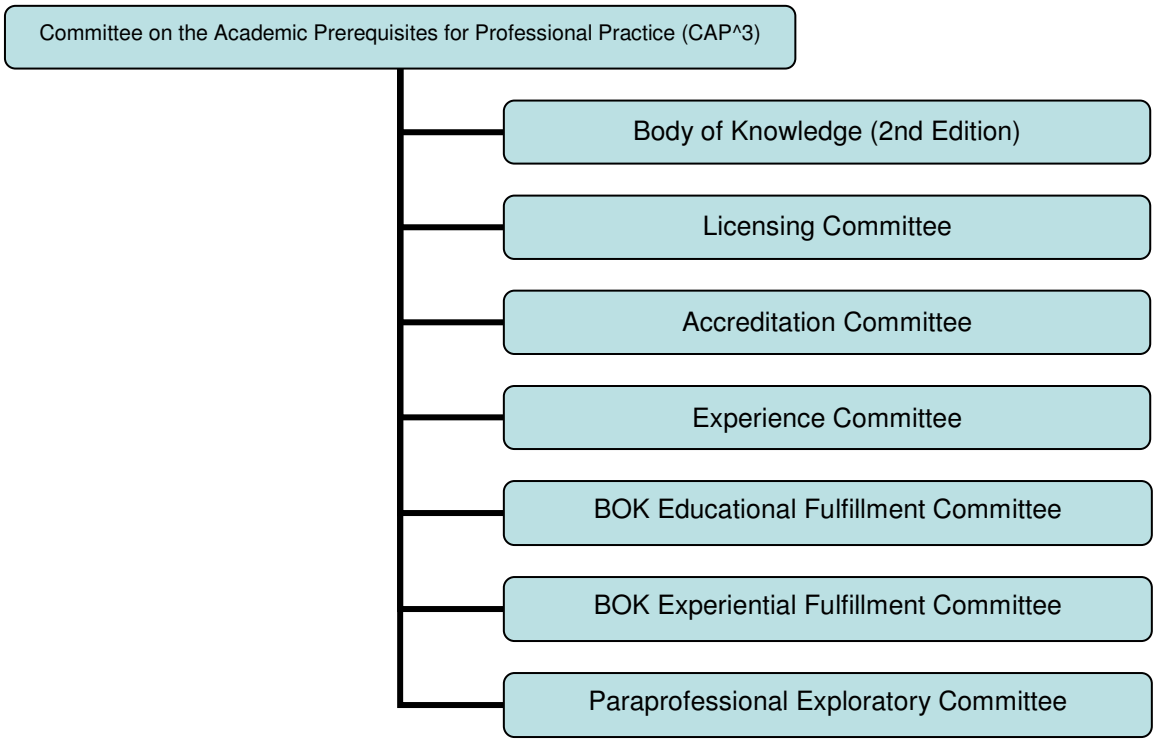

Figure 2. Organizational Structure of CAP^3

The Vision for Civil Engineering in 2025

In June 2006, a diverse group of civil engineering and other leaders, including international participants, gathered to articulate an aspirational global vision for the future of civil engineering. Participants in this Summit on the Future of Civil Engineering saw a very different world for civil engineers in 2025. An ever-increasing global population that is shifting even more to urban areas will require widespread adoption of sustainability. Demands for energy, transportation, drinking water, clean air, and safe waste disposal will drive environmental protection and infrastructure development. Society will face threats from natural events, accidents, and perhaps other causes such as terrorism. An aspirational global vision was developed that sees civil engineers entrusted by society to create a sustainable world and enhance the global quality of life. The 2025 vision is:

Entrusted by society to create a sustainable world and enhance the global quality of life, civil engineers serve competently, collaboratively, and ethically as master:

- **planners, designers, constructors, and operators of society's economic and social engine, the built environment;**
- **stewards of the natural environment and its resources;**
- **innovators and integrators of ideas and technology across the public, private, and academic sectors;**
- **managers of risk and uncertainty caused by natural events, accidents, and other threats; and**
- **leaders in discussions and decisions shaping public environmental and infrastructure policy.**

As used in the *Vision for Civil Engineering in 2025*, "master" means to possess widely-recognized and valued knowledge, skills, and attitudes acquired as a result of education, experience, and achievement. Individuals within a profession who have these characteristics are willing and able to serve society by orchestrating solutions to society's most pressing current needs while helping to create a more viable future.

The full vision report[1] can be found at http://content.asce.org/vision2025/index.html. Summit organizers and participants intend that this report will guide policies, plans, processes, and progress within the civil engineering community and beyond including around the globe. ASCE has formed a task committee to explore how it will move forward in implementing this bold vision as well as has linked the vision to the on-going strategic planning processes. One critical action is reform in the education and pre-licensure experience of civil engineers through implementing the master plan for the realization of ASCE Policy 465.

Body of Knowledge

The Body of Knowledge is the foundational document of the entire ASCE master plan to implement its Policy 465. The first Body of Knowledge Committee was formed in May 2002 and was charged to define the knowledge, skills, and attitudes needed to enter the practice of civil engineering at the professional level. The committee published the *Civil Engineering Body of Knowledge for the 21st Century* in February 2004 (see www.asce.org/raisethebar[2]. A new Body of Knowledge Committee (BOK2) was appointed in September 2005 to prepare and publish the current (second) edition of the BOK that was released in February of 2008[3].

The BOK2 Committee began its work by reviewing the 15 outcomes comprising the core of BOK1. Also examined were recent National Academy of Engineering Reports,[4,5] which were found to be aligned with the BOK1, and other documents – to include the *Vision for Civil Engineering in 2025*. Outcomes are the heart of the BOK because they define the knowledge, skills, and attitudes necessary to enter the practice of civil engineering at the professional level in the 21st Century.

The original set of 15 outcomes was expanded, after careful deliberation, to 24 outcomes organized into these three categories: foundational, technical, and professional. The evolution from 15 to 24 outcomes further describes the BOK. Rather than adding content, the larger number of outcomes adds specificity and clarity.

The Committee adopted Bloom's Taxonomy[6,7], which is widely known and understood across the education community, as the means of describing the minimum cognitive levels of achievement for each outcome. Figure 3 presents the 24 outcomes and, for each one, the level of achievement that an individual must demonstrate to enter the practice of civil engineering at the professional level.

According to PS 465, the BOK will be fulfilled by means of formal education and experience i.e., a bachelor's degree plus a master's degree, or approximately 30 credits, and experience. Two common fulfillment paths were developed, one involving an ABET-accredited bachelor's degree in civil engineering followed by a valid master's degree, or approximately 30 semester credits of acceptable graduate-level or upper level undergraduate courses, and the other using an appropriate bachelor's degree followed by an ABET-accredited master's degree.

Outcome number and title	Level of achievement					
	1 Know-ledge	2 Compre-hension	3 Appli-cation	4 Analy-sis	5 Synthe-sis	6 Evalu-ation
Foundational						
1. Mathematics	B	B	B			
2. Natural sciences	B	B	B			
3. Humanities	B	B	B			
4. Social sciences	B	B	B			
Technical						
5. Materials science	B	B	B			
6. Mechanics	B	B	B	B		
7. Experiments	B	B	B	B	M/30	
8. Problem recognition and solving	B	B	B	M/30		
9. Design	B	B	B	B	B	E
10. Sustainability	B	B	B	E		
11. Contemp. Issues & hist. perspectives	B	B	B	E		
12. Risk and uncertainty	B	B	B	E		
13. Project management	B	B	B	E		
14. Breadth in civil engineering areas	B	B	B	B		
15. Technical specialization	B	M/30	M/30	M/30	M/30	E
Professional						
16. Communication	B	B	B	B	E	
17. Public policy	B	B	E			
18. Business and public administration	B	B	E			
19. Globalization	B	B	B	E		
20. Leadership	B	B	B	E		
21. Teamwork	B	B	B	E		
22. Attitudes	B	B	E			
23. Life-long learning	B	B	B	E	E	
24. Professional and ethical responsibility	B	B	B	B	E	E

Key:

B	Portion of the BOK fulfilled through the bachelor's degree
M/30	Portion of the BOK fulfilled through the master's degree or equivalent (approximately 30 semester credits of acceptable graduate-level or upper- level undergraduate courses)
E	Portion of the BOK fulfilled through the pre-licensure experience

Figure 3. Entry into the practice of civil engineering at the professional level requires fulfilling 24 outcomes to the appropriate levels of achievement (ASCE 2008)

The roles of bachelor's degree, the master's degree or approximately 30 credits, and experience in fulfilling the BOK are shown in Figure 3. A detailed version of the figure, known as an outcome rubric, appears as Appendix I and non-prescriptive explanations for outcomes are presented in Appendix J of the full BOK report. The report can be found at www.asce.org/raisethebar. These two appendices are the heart of this report. The report presents two models for validating the fulfillment of the BOK, one for each of the two previously-mentioned common fulfillment paths.

This report stresses the foundational role of the BOK in implementing the PS 465 Master Plan noting how the CAP^3 Committee and its subcommittees have, are, and will build on the BOK2. Also presented are ways the BOK could be used by prospective civil engineering students, high school counselors, parents, employers, and others.

It is very important to note that, from ASCE's perspective, the BOK represents a strategic direction for the profession. Under today's accreditation and regulatory processes/procedures, some of the elements of the BOK may not be translated into accreditation criteria and licensing requirements in the near term. To say it another way, the BOK describes the "gold standard" for the aspiring civil engineering professional. Since input into the accreditation and licensing processes comes from a considerable number of stakeholders beyond just ASCE, it is unlikely that these processes will reflect all aspects of ASCE's BOK. ASCE is optimistic that the accreditation and licensing processes could change over time to adopt a more BOK-centric approach. As this occurs, a greater proportion of the BOK could be reflected explicitly in accreditation and licensure requirements.

Curricula

As the first edition of the Body of Knowledge was nearing completion in late 2003, CAP^3 organized a group consisting primarily, but not exclusively, of civil engineering faculty to (1) determine the current status of civil engineering education in relation to the formal educational component of the first edition of the BOK and (2) determine the nature of change necessary to support the formal educational expectations of the BOK. The Curricula Committee of CAP^3 was given this charge in September 2003. Their detailed report can be found at http://www.asce.org/files/pdf/professional/curriculacommreportdec2006.pdf.

Another new committee, the BOK Educational Fulfillment Committee (BOKEdFC) was formed in late 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. 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.
3. Review work products of the new Body of Knowledge Committee and provide timely input, feedback, and suggestions.
4. Prepare written annual status reports suitable for briefing the ASCE Board of Direction.
5. Provide a final report documenting the Committee's work and results.
6. Complete the preceding in two years.

Nominations of candidate schools were solicited in an open call to the nation's civil engineering departments. There were eleven full members appointed to the committee – and 25 schools were appointed as corresponding members. Schools participating in the committee include --

Full Members
University of Alabama
University of Arkansas
Bucknell University
Iowa State University
University of Louisiana
Montana State University
North Carolina State University
Northern Arizona University
Rose-Hulman Inst. of Technology
Texas A&M University
University of Southern California

Corresponding Members
California State U -- Sacramento
The Citadel
University of Central Florida
Drexel University
University of Florida

Corresponding Members (con't)
George Mason University
University of Houston
University of Kentucky
Lawrence Technological University
Manhattan College
The University of Melbourne
Merrimack College
Michigan State University
Mississippi State University
North Dakota State University
University of Oklahoma
Purdue University
Seattle University
The University of Texas - Tyler
United States Air Force Academy
United States Military Academy
University of Virginia
Virginia Military Institute
University of Wisconsin-Platteville
University of Wisconsin-Madison

Accreditation Criteria

Using the first edition of the BOK as its primary reference, the Accreditation Committee of CAP^3 crafted new basic (bachelor's) level civil engineering program criteria and new advanced (master's) level general criteria (see http://www.asce.org/files/pdf/professional/criteria_08.pdf). These criteria were approved by the ABET Board of Direction in November 2007. The new criteria will be used for the first time during the 2008-2009 accreditation cycle. The Accreditation Committee also drafted the ASCE Commentary to the criteria (see http://www.asce.org/files/pdf/professional/ASCEcommentaryv3410May07.pdf)[8] This draft Commentary provides civil engineering program evaluators with guidelines for applying the new criteria – and provides civil engineering faculty with recommended measures to ensure full, robust implementation of the BOK. Using these new criteria and this Commentary, civil engineering programs will be accredited within the context of the *Civil Engineering Body of Knowledge for the 21st Century.*

B + "M or 30" Guidelines

Based upon the fulfillment models presented in the first edition of the *Civil Engineering Body of Knowledge for the 21st Century,* the Fulfillment and Validation Committee of CAP[3] began work in September 2004. It explored how alternative education providers, other than universities, could provide creditable post-graduate engineering education. They investigated alternative education providers that could provide academic rigor and individual assessment comparable to traditional universities. This committee also addressed how to validate the "+30" portion of the BOK. The committee's 2005 report (found at www.asce.org/raisethebar) influenced the contents of the Model Law and Model Rules proposed by the NCEES.

Several committees worked, or will be working, on elements related to the B + "M or 30" Guidelines since the 2005 report of the Fulfillment and Validation Committee. This includes the –

1. The Levels of Achievement Subcommittee of the Curricula Committee of CAP^3 whose September 2005 report contained a recommendations regarding "where" (in terms of B, M/30, or E) each Bloom level for each of the 15 outcomes of BOK1 should be fulfilled.
2. The Body of Knowledge Committee which used the framework established by the Levels of Achievement Subcommittee in the BOK2 report to recommend "where" each Bloom level for each of the 24 outcomes of BOK2 should be fulfilled.
3. The Licensure Committee of CAP^3 which is working with the NCEES Bachelor's + 30 Task Force to develop definitions for approved credits and approved course providers for inclusion in the NCEES Model Rules.
4. The BOK Educational Fulfillment Committee (BOKEdFC) which will be reviewing the work products of the Body of Knowledge Committee – particularly the BOK2 rubric and "where" each outcome should be fulfilled.

Experience Guidelines

To explore the work needed in the experience area, a small focused committee, called the Experience Committee was formed in early 2007. The purpose of this committee and its report is to start the process of addressing the **Experience Guidelines** shown in the master plan. Pre-licensure experience is essential to fulfillment of the BOK. The specific charges to the committee were as follows:

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 National Society of Professional Engineers (NSPE) and NCEES throughout the process and discussion.
7. Provide a report to the Committee on the Academic Prerequisites for Professional Practice (CAP^3) documenting the Experience Committee's problem statement and alternative courses of action.
8. Complete the preceding in twelve months.

All of these charges were fulfilled by the committee. The complete final report[10] of the committee can be read and downloaded from www.asce.org/raisethebar. As detailed in their final report, the committee recommended the following courses of action:

Action 1: Develop Pre-Licensure Experience Guidelines

1a) Generalize the BOK experiential outcomes into a generic set applicable to all engineering disciplines.

1b) Develop a matrix for attainment of the BOK experiential outcomes.

1c) Develop, adopt, and disseminate ASCE experience guidelines for the civil engineer intern's attainment, reporting, self-assessment, and self-validation of the BOK experiential outcomes.

Action 2: Promulgate Acceptance and Use of BOK Experience Guidelines Across the Engineering Disciplines (professional/technical society

Action 3: Implement Experience Requirements in the Regulatory Environment

Action 4: Incorporate Experiential Outcomes in Post-Licensure Specialty Certification (ASCE-centric)

Actions 1 – 3 would necessarily proceed sequentially. Action 4 could proceed in parallel with, and independent of, the other actions.

Based upon the work of this committee, it is anticipated that a new committee, the BOK Experiential Fulfillment Committee, will be formed in mid 2008 to prepare pre-licensure experience guidelines. It is also anticipated that ASCE will form one or more committees to address Actions 1a), 1b), and 1c) above. The committee(s) should have strong representation of practitioners, from consulting, industrial, and agency/government environments, possibly in collaboration with NSPE and American Consulting Engineering Companies (ACEC), as well as from representatives of the professional societies from other disciplines, perhaps as corresponding members (Action 1a) in particular requires this representation). The committee(s) should also have representation from BOK2, NCEES, and possibly academe.

Suggested specific charges to the BOK Experiential Fulfillment Committee are as follows:

Charge 1 (Action 1a): Review the response to Charge 3 of the ASCE Experience Committee (July 2007). Recast the ASCE BOK experiential guidelines into a form applicable and acceptable to engineers of all disciplines, while ensuring full compliance with the intent of the BOK outcomes for civil engineers. If necessary, propose additional outcomes/guidelines that naturally accommodate the career paths of civil engineers but may be necessary additions for other disciplines.

Charge 2 (Action 1b): Develop a matrix for attaining the elements of the generic experiential outcomes in an engineer intern's pre-licensure career. If necessary and appropriate, identify those elements that may be unrealistic or unreasonable to attain in pre-licensure career activities.

Charge 3: (Action 1c): Develop a stand-alone set of experience guidelines to be followed by a civil engineer intern during his or her pre-licensure career. These guidelines should include not only the substantive elements of the experiential outcomes, but also provisions for reporting, mentorship, self-assessment, and self-validation of the experience elements.

Model Law, Model Rules, and State Licensing Laws/Rules

ASCE Policy 465 states that the attainment of a Body of Knowledge would be accomplished through the adoption of appropriate engineering education and experience requirements as a prerequisite for licensure. In other words, ASCE has decided that implementation of ASCE Policy 465 should be related to the profession's licensure process. In June 2002, the Licensure Committee of CAP^3 began working with the National Council of Examiners for Engineering and Surveying to change the Model Law to include the "M/30" concept. The work has yielded very positive results. In September 2006, delegates at the NCEES Annual Meeting approved the modifications to the Model Law requirements to require additional education for engineering licensure. The vote to support the Model Law was re-affirmed at the 2007 NCEES Annual Meeting.

The approved language states that an engineer intern with a bachelor's degree must have 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 degree or PhD from an approved institution would also qualify. The change, to be effective in 2015, is a recommendation to each of the state jurisdictions, which individually will have to modify their state laws and/or rules to reflect the new NCEES Model Law/Rules. Up-to-date information concerning changes to the NCEES Model Law/Rules can be found at www.ncees.org/licensure/licensure_exchange/.

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.

To understand the above, it is important to note that the Model Law defines an engineer intern as a graduate of an engineering program of four years or more accredited by EAC/ABET, or the equivalent, who has passed the fundamentals of engineering (FE) exam.

In 2006, after NCEES approved the concept and incorporated it into the Model Law, the Committee on Uniform Procedures and Legislative Guidelines (UP&LG) began working to define more precisely what the additional education should be. UP &LG was 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). The task turned out to be overwhelming given that UP&LG receives multiple charges per year.

In 2007, NCEES, given the challenge and complexity to defining the Model Rules formed the Bachelor's +30 Task Force with the following charge:

1. Consider the bachelor's plus 30 requirement to ensure that activities are outcomes based. Provide recommendations as appropriate.
2. Develop definitions for approved credits and approved course providers for inclusion in the Model Rules as appropriate. Consider comments and recommendations provided during 2007 Zone Meetings and the 2007 Annual Meeting.
3. Evaluate the provisions of the Model Rules that allow credit towards the experience requirement for candidates with advanced degrees. Provide recommendations as appropriate.
4. Propose revisions as necessary to ensure that the Model Rules are consistent with revisions to the Model Law concerning the bachelor's plus 30 requirement.
5. Ensure that the significant issues of the task force are presented to the Council at each zone meeting by either a committee member in attendance or by the zone vice president.

It is anticipated that the Task Force will work on this issue for several years given the complexity of the assignment.

Other Initiatives—Exploring A More Robust Workforce

Some key ASCE leaders believe that, while we should continue to encourage individuals to enter engineering, the engineering community may have lost focus on expanding the number of technicians and technologists. Some engineering leaders believe that if we increase technicians and technologists, they can be employ them as "para-engineers" -- allowing professional engineers more time to perform functions more appropriate with

their advanced educational and experiential credentials. This could improve the overall productivity on a per engineer basis.

In order to pursue this issue, CAP^3 has proposed forming another constituent committee to conduct some initial investigative research into this issue. It is proposed that there be a new "Paraprofessional Exploratory Committee (PEC)" to identify issues that ASCE should address related to the integration of paraprofessionals into the civil engineering design and construction team -- and the civil engineering community. The draft charge of the committee includes:

1. Define paraprofessional (a) in general and (b) in the context of the civil engineering professional.
2. Provide examples of paraprofessionals in other non-engineering professions. For these examples, identify (a) the appropriate credential for entry into practice and (b) the educational, experience, and examination requirements for this credential.
3. Provide current examples of paraprofessionals and paraprofessional work in the civil engineering profession.
4. Identify and explain some of the specific issues that ASCE should address to properly integrate paraprofessionals into the civil engineering design team and the civil engineering community.

As implied in the above, the committee is charged to focus on issues related to individuals who are committed careers as paraprofessionals within the civil engineering community – and who do not necessarily aspire to careers as professional civil engineers.

Conclusions:

The CAP^3 is actively engaged on many fronts as the implementation plan for Policy Statement 465 moves forward. Referring to the masterplan 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) review the second edition of the BOK via the BOK Educational Fulfillment Committee and the BOK Experiential Fulfillment Committee; 3) implement changes to accreditation criteria for basic level Civil Engineering Program Criteria and continue the dialog regarding dual level accreditation prohibition; 4) create more detailed experience guidelines that support the fulfillment of the BOK; 5) engage civil engineering faculty through dialog, discussion, and implementation of the BOK; 6) explore how we can create a more robust workforce in civil engineering; and 7) start a process to identify champions in each licensing jurisdiction to promote increasing engineering educational requirements in the future..

With the Vision and BOK, civil engineering is looking into the future in a proactive manner. We are defining the 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 for leadership positions in the technological world of the future.

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