The ASCE Raise the Bar Initiative: A New Paradigm Based on Credentialing in the Medical Profession

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Background

For the past two decades, the American Society of Civil Engineers (ASCE) has been pursuing its Raise the Bar (RTB) initiative, for the purpose of better preparing civil engineers to meet the ever-increasing challenges of professional practice. From the inception of RTB through March 2018, the ultimate goal of the initiative was to change state licensure laws, such that a master's degree or equivalent would become the academic prerequisite for licensure as a professional engineer in the U.S. [1]

During this period, the RTB initiative made substantial progress, as reflected in the following accomplishments:

- In 2004, ASCE published the *Civil Engineering Body of Knowledge* (CE-BOK)—a landmark document that, for the first time ever, articulated the knowledge, skills, and attitudes required for entry into the practice of civil engineering at the professional level [2].
- In 2008 [3] and 2019 [4], ASCE published CE-BOK updates that improved the document's usability and addressed changes in ASCE's strategic priorities and in the civil engineering professional environment. In the most recent edition of the CE-BOK, the required knowledge, skills, and attitudes in the cognitive domain are defined in terms of 21 *outcomes*, each with a recommended *level of achievement*, as indicated in Table 1 below. Note that the CE-BOK outcomes in the cognitive domain are to be achieved through a combination of undergraduate education (UG), postgraduate education (PG), and mentored experience (ME)—clearly demonstrating ASCE's contention that the traditional four-year bachelor's degree no longer provides adequate preparation for the professional practice of civil engineering.
- Similarly, ASCE has demonstrated that there is a significant gap between the CE-BOK and the current educational and experiential requirements for professional engineering licensure [5].
- In conjunction with publication of the first two editions of the CE-BOK, ASCE developed, gained approval for, and implemented new ABET accreditation criteria to promote the development of CE-BOK-compliant curricula in U.S. civil engineering programs [6].
- The National Council of Examiners for Engineering and Surveying (NCEES) enacted Position Statement 35 (Future Education Requirements for Engineering Licensure), which advocates the master's degree or equivalent as the academic prerequisite for licensure as a professional engineer in the U.S. [7]

These accomplishments notwithstanding, the ultimate goal of the RTB initiative has *not* been achieved. Although ASCE and NCEES have partnered to promote RTB-compliant professional licensing legislation in several states, no U.S. licensing jurisdiction has adopted such legislation, largely due to opposition from other engineering professional societies [8].

Acknowledging this lack of progress, in March 2018 the ASCE Board of Direction formally initiated a major change in the direction of the RTB initiative [5]. This change was promulgated as a series of requests and directives, two of which are particularly relevant to this paper:

- The Board affirmed an earlier directive that the ASCE Raise the Bar Committee should cease new legislative efforts to require a master's degree for PE licensure.
- The Board authorized the creation of a task committee to examine the feasibility of using *credentialing* as a means of advancing the RTB initiative.

Table 1. The CE-BOK cognitive domain outcomes with associated levels of achievement [4]

Outcome	Cognitive Domain Level of Achievement					
	Level 1 Remember	Level 2 Comprehend	Level 3 Apply	Level 4 Analyze	Level 5 Synthesize	Level 6 Evaluate
Foundational Outcomes						
Mathematics	**UG**	**UG**	**UG**			
Natural Sciences	**UG**	**UG**	**UG**			
Social Sciences	**UG**	**UG**	**UG**			
Humanities	**UG**	**UG**	**UG**			
Engineering Fundamentals Outcomes						
Materials Science	**UG**	**UG**	**UG**			
Engineering Mechanics	**UG**	**UG**	**UG**			
Experimental Methods & Data Analysis	**UG**	**UG**	**UG**	**PG**		
Critical Thinking & Problem Solving	**UG**	**UG**	**UG**	**ME**	**ME**	
Technical Outcomes						
Project Management	**UG**	**UG**	**ME**			
Engineering Economics	**UG**	**UG**	**ME**			
Risk & Uncertainty	**UG**	**UG**	**UG**	**ME**		
Breadth in Civil Engineering Areas	**UG**	**UG**	**UG**	**ME**		
Design	**UG**	**UG**	**UG**	**ME**	**ME**	
Depth in a Civil Engineering Area	**UG**	**UG**	**PG**	**PG**	**ME**	
Sustainability	**UG**	**UG**	**UG**	**ME**		
Professional Outcomes						
Communication	**UG**	**UG**	**UG**	**ME**	**ME**	
Teamwork & Leadership	**UG**	**UG**	**UG**	**ME**	**ME**	
Lifelong Learning	**UG**	**UG**	**UG**	**ME**	**ME**	
Professional Attitudes	**UG**	**UG**	**ME**	**ME**		
Professional Responsibilities	**UG**	**UG**	**ME**	**ME**	**ME**	
Ethical Responsibilities	**UG**	**UG**	**ME**	**ME**	**ME**	

LEGEND:

UG = Undergraduate Education - undergraduate education leading to a bachelor's degree in civil engineering or a closely related engineering discipline, generally from a four-year ABET EAC-accredited program.

PG = Post-Graduate Education - post-graduate education equivalent to or leading to a master's degree in civil engineering or a closely related engineering discipline, generally equivalent to one year of full time study.

ME = Mentored Experience - early-career experience under the mentorship of a civil engineer practicing at the professional level, which progresses in both complexity and level of responsibility.

In response to the latter directive, the ASCE Raise the Bar Committee established and organized the Task Committee on Credentialing to Raise the Bar (TCCRTB), which was given the following charge: "Develop a plan identifying how ASCE can best utilize an internal credentialing program to validate fulfillment of the Civil Engineering Body of Knowledge (CE-BOK)… [9]."

Three aspects of this charge statement are worthy of special note:

- Use of the term "*internal* credentialing program" (emphasis added) clearly communicates the Board's desire to use a tool that is *within ASCE's own control* as the principal mechanism for implementing the RTB initiative.
- This ASCE-administered credentialing program will be used *to validate fulfillment of the CE-BOK*—i.e., to ensure that a credentialed civil engineer has achieved all CE-BOK outcomes at the levels indicated in Table 1 above.
- Although the Board has terminated ASCE's efforts to change licensure laws, the TCCRTB charge does not preclude the use of the *existing* licensure system as one component of a larger process for validating CE-BOK fulfillment.

Having received its charge, the TCCRTB has now begun its work.

Disclaimer

Although the authors of this paper are corresponding members of the ASCE Raise the Bar Committee, we have developed this paper independently, for the purpose of contributing to the committee's future deliberations. Thus, this paper reflects only the authors' personal perspectives and should not be regarded as an official product of the Raise the Bar Committee.

Purpose and Scope

The two purposes of this paper are:

(1) to propose and justify a new paradigm for ASCE's RTB initiative, using ASCE-administered credentialing superimposed upon the existing U.S. licensure system as a mechanism for validating fulfillment of the CE-BOK; and
(2) to propose a consistent system of nomenclature for describing and communicating this new paradigm.

We begin our analysis with an overview of the credentialing system currently used in the U.S. medical profession. This comprehensive, highly structured system of licensure and specialty certification quite effectively fulfills its purpose—to validate the attainment of expertise within well-defined medical specialties, according to standards controlled by the profession itself. The effectiveness of this system is greatly enhanced by the medical profession's "carrot and stick" policies for motivating individual practitioners to seek board certification.

We then summarize the corresponding credentialing systems currently available to civil engineers in the U.S., and we assess the suitability of these systems for validating fulfillment of the CE-BOK.

With these analyses as background, we propose a comprehensive developmental model, consisting of four successive credentials—two existing licensure credentials augmented by two levels of ASCE-administered specialty certification. Our model is derived directly from the medical credentialing system but is adapted to accommodate differences in the educational paradigms of the medical and engineering professions, while also incorporating elements of ASCE's existing specialty certification system. We conclude with a series of recommendations intended to facilitate implementation of the proposed model.

Credentialing in the Medical Profession

In considering the use of credentialing as a tool for advancing the civil engineering profession, we find it particularly illuminating to begin with an examination of the highly structured credentialing system used by the medical profession.*

In the U.S., the medical credentialing system is composed of two major components—*medical licensure*, administered by state licensing boards, and *specialty certification*, administered directly by the profession.

To become a *licensed physician*, a candidate must [10]:

(1) complete bachelor's-level premedical education at a college or university (typically 4 years);
(2) earn a medical degree from an accredited medical school (typically 4 years);
(3) complete one year of medical residency experience; and
(4) pass the three-part U.S. Medical Licensing Examination to obtain an unrestricted license to practice medicine from a state.

This credentialing process is depicted graphically in Figure 1 below. In this diagram (and in the three similar diagrams presented later in this paper), note the use of different symbols to denote education, experience, examinations, academic degrees, and earned credentials.

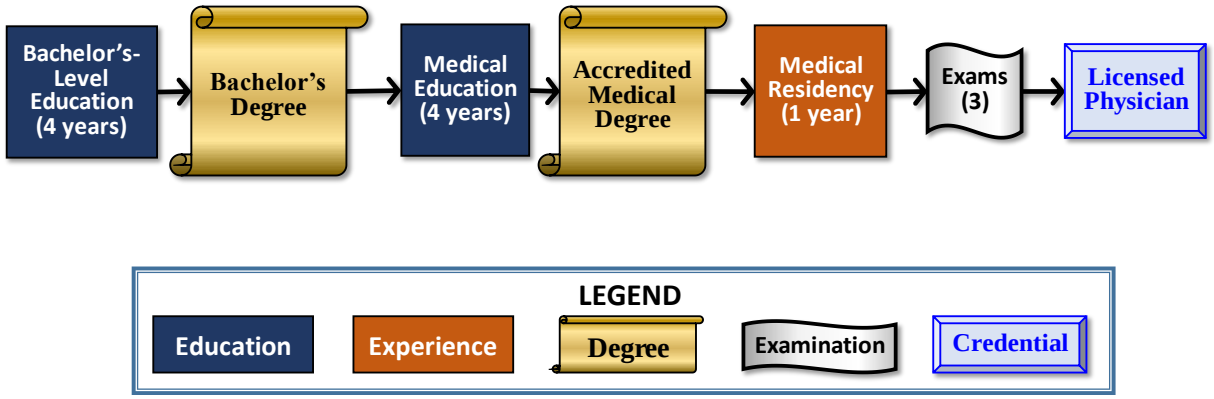

Figure 1. Credentialing process for a licensed physician in the U.S.

* For the purpose of this analysis, the term "medical profession" refers only to the body of individuals who work as Doctors of Medicine. It does not refer to other health care professionals, such as Registered Nurses, Nurse Practitioners, and Physician's Assistants.

The medical specialty certification system builds upon the licensure system. Medical specialty areas are authoritatively defined by the American Board of Medical Specialties (ABMS)—a non-profit organization currently comprised of 24 certifying boards that develop and implement professional standards for the certification of physicians in their declared medical specialties [11]. These boards certify physicians in 39 different medical specialties and 86 medical subspecialties. Examples of medical specialties include Anesthesiology, Dermatology, Internal Medicine, Radiology, and Urology. Some examples of subspecialties of Internal Medicine are Cardiology, Endocrinology, Hematology, Infectious Disease, and Rheumatology [12].

To become a *board-certified medical specialist*, a candidate must [10]:

(1) become a licensed physician, as described above;
(2) complete a full-time experience in an accredited residency training program in a medical specialty (typically 2 additional years); and
(3) pass an exam created and administered by the certification board associated with the candidate's specialty.

After passing this exam, the individual is certified as a specialist and a diplomate of the specialty board.

The credentialing process for a board-certified medical specialist is shown in Figure 2 below.* A comparison of this diagram with Figure 1 illustrates how the specialty certification process is simply appended to the licensure process.

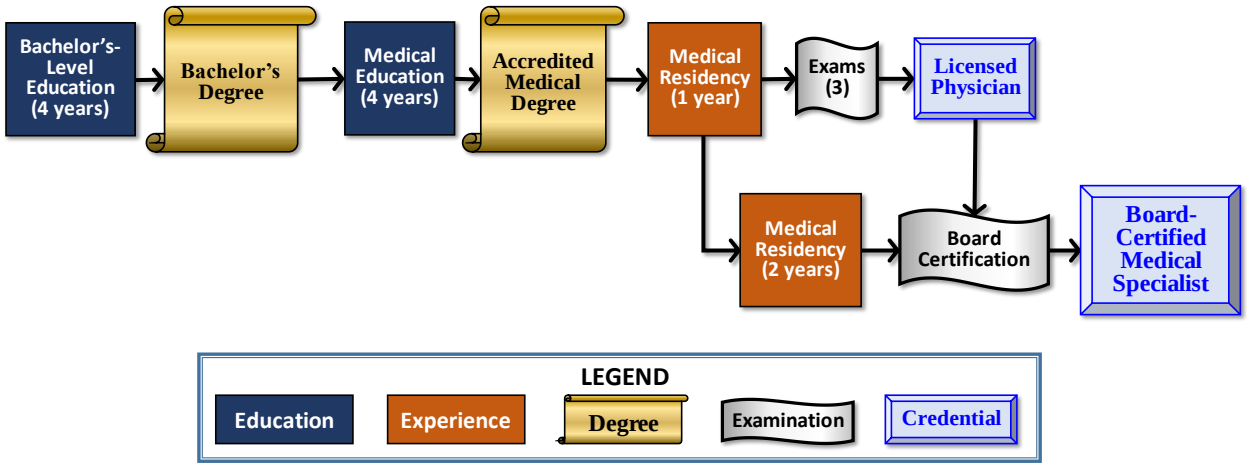

Figure 2. Credentialing process for a board-certified medical specialist in the U.S.

A candidate for certification in a *subspecialty* must:

(1) attain certification in the associated medical specialty;
(2) complete a full-time experience in an accredited residency program in the medical subspecialty (typically 3 years); and

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* Note that the diagram in Figure 2 is based on a *critical path method (CPM) paradigm*, with parallel branches representing concurrent activities—as opposed to a *flowchart paradigm*, in which parallel branches represent alternative pathways.

(3) successfully complete an assessment of knowledge and clinical judgment in the subspecialty discipline.

As outlined above, the time required for preparation to practice medicine as a licensed physician is typically five years beyond the bachelor's degree, while the preparation time for a board-certified medical specialist is typically seven years beyond the bachelor's degree—or ten years if a subspecialty is also pursued. Despite the substantial additional demands associated with specialty certification, approximately 80% of all licensed physicians in the U.S. are board-certified medical specialists [13]. Moreover, many of the remaining 20% are in the process of obtaining board certification.

No doubt, this high percentage reflects the medical profession's collective commitment to providing the public with a high level of specialized expertise; however, it also reflects the system's strong internal incentives for board certification. Most hospitals require board certification to practice in a medical specialty area, and insurance fee reimbursement rates are typically tied to board certification. Furthermore, many hospitals have independently made the decision to require board certification for staff privileges [14]. Thus, from the physician's perspective, certification serves as both a carrot and a stick.

In summary, the credentialing system used by the medical profession is characterized by:

- education, experience, and examination requirements that are rigorous, universally acknowledged, and consistently applied;
- a licensure system that is administered by the states and *does not* attempt to offer credentials in specialty areas;
- a specialty certification system that is administered by the profession through a specially created organization—the ABMS—and serves as an incentive for attaining higher levels of expertise;
- specialty areas that are clearly and authoritatively defined by the profession and are directly reflected in the board-based organization of the ABMS; and
- strong professional and economic incentives for board certification.

Credentialing in the Civil Engineering Profession

The credentials currently available to civil engineers also include both licensure and specialty certification—though the associated credentialing systems lack the consistency, comprehensiveness, and broad acceptance of their medical counterparts.

The principal credentials associated with engineering licensure are Engineer Intern (EI) and Professional Engineer (PE), both of which are administered by the 55 licensing jurisdictions (states and territories) in the U.S. Each jurisdiction has its own unique engineering licensing statute, enacted by the legislature of that jurisdiction [15]. Because of this decentralization, licensure systems and qualifications vary somewhat from jurisdiction to jurisdiction; nonetheless, these variations are relatively minor, due to the influence of the NCEES Model Law and Model Rules, which have been developed and promulgated to "provide greater uniformity of qualifications for licensure… [16]."

According to the NCEES Model Law, the minimum standards for qualification as an Engineer Intern (EI) are as follows:

- earn a degree from a bachelor's or master's program accredited by the Engineering Accreditation Commission (EAC) of ABET *or* meet the requirements of the NCEES Engineering Education Standard; and
- pass the NCEES Fundamentals of Engineering (FE) Exam.

According to the Model Law, the education, examination, and experience requirements for licensure as a Professional Engineer (PE) are as follows:

- earn a degree from an EAC-accredited bachelor's or master's program *or* meet the requirements of the NCEES Engineering Education Standard; and
- pass the NCEES FE Examination and the NCEES Principles and Practice of Engineering (PE) examination; and
- acquire four years of progressive engineering experience.*

The process of attaining PE licensure is depicted graphically in Figure 3 below.

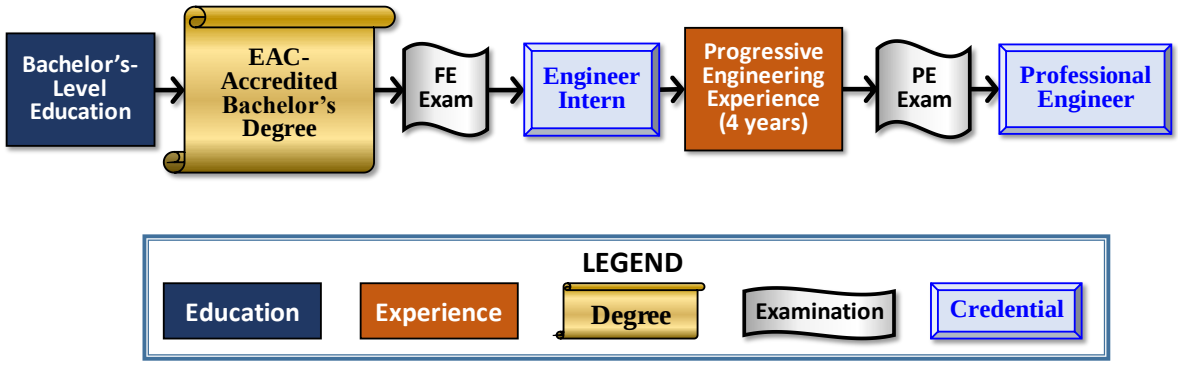

Figure 3. Credentialing process for a Professional Engineer (PE) in the U.S.

Beyond the PE, specialty-area licensure is also available as a post-PE credential—but only in a few jurisdictions and only in two specialty areas:

- In Alaska, California, Oregon, Utah, and Washington, a licensed P.E. can subsequently be licensed as a Structural Engineer (SE) after passing a special 16-hour examination. In these states, the SE license is required to design all structures in specified categories [17].
- The state of California grants the title Geotechnical Engineer (GE) to licensed civil engineers who meet additional experience requirements and pass a special geotechnical engineering exam [18].

In addition, Illinois, Hawaii, and Nevada allow stand-alone SE licensure—a system in which an engineer can earn the SE license without having first been licensed as a PE. [17]

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* The NCEES Model Law allows for reductions in the experience requirement for individuals with advanced engineering degrees under certain circumstances.

As an alternative to specialty-area licensure, ASCE offers specialty certification through Civil Engineering Certification, Inc. (CEC), a corporation created in 2004 by the ASCE Board of Direction and accredited by the Council of Engineering and Scientific Specialty Boards (CESB) [19]. CEC has established three academies, which provide board certification in six specialty areas [20]:

- The American Academy of Water Resources Engineers (AAWRE) offers certification in Water Resources Engineering
- The Academy of Geo-Professionals (AGP) offers certification in Geotechnical Engineering
- The Academy of Coastal, Ocean, Port and Navigation Engineers (ACOPNE) offers certifications in Coastal, Ocean, Port, and Navigation Engineering.

The minimum requirements for these certifications are a PE license (or international equivalent), a master's degree, and 8 years of progressive post-licensure engineering experience. Individuals certified in these specialty areas are awarded the title Diplomate [19].

The Structural Engineering Certification Board (SECB)—a partnership of the National Council of Structural Engineering Associations (NCSEA), the Structural Engineering Licensure Coalition (SELC), and the ASCE Structural Engineering Institute (SEI)—also offers board certification in structural engineering [21]. And the American Academy of Environmental Engineers and Scientists (AAEES) offers certification in environmental engineering [22]. The certification standards and credentials of SECB and AAEES are different from those used by CEC's three academies. For example, there is no requirement for a master's degree, and individuals are not awarded the title of Diplomate.

Overall—in sharp contrast with the medical profession—the civil engineering profession does not have a single, well-managed credentialing system, but rather a *collection of systems* that are incomplete, inconsistent, and poorly integrated. Collectively, these existing systems—as currently organized and managed—are unsuitable for the task of validating fulfillment of the CE-BOK.

The process of awarding EI and PE credentials through the existing licensure system is well-established and reasonably effective; however, because existing standards allow for licensure with only a bachelor's degree, the licensure system alone cannot guarantee achievement of the CE-BOK outcomes that require master's-level education—most notably the outcome on *depth in a civil engineering area* (see Table 1).

Beyond the PE, the existing credentialing systems for advanced civil engineering specialty areas are characterized by severe limitations and inconsistencies:

- SE licensure is available in only eight jurisdictions.
- SE licensure is a post-PE credential in some jurisdictions and a stand-alone credential in others.
- GE licensure is available in only one jurisdiction.
- Board certifications in various civil engineering specialty areas are offered by three different organizations, using different standards.
- Board certifications are not available for all civil engineering specialty areas.

- Existing board certification standards are not calibrated to validate fulfillment of the CE-BOK.
- The existing system lacks a clear incentive for individuals to seek board certification and for both employers and clients to value board-certified engineers.

The existing credentialing systems' applicability to the RTB initiative is further compromised by a more fundamental issue. Unlike the medical specialties and subspecialties, the civil engineering specialty areas have never been authoritatively defined [23].

On the positive side, ASCE already has a well-established organizational infrastructure—CEC and its academies—to support implementation of an enhanced, better-integrated credentialing system.

A Proposed New Paradigm

In response to the ASCE Board's directive of March 2018, we suggest that it is indeed feasible to validate fulfillment of the CE-BOK using the existing professional licensure system, augmented by an enhanced specialty certification process that is entirely within ASCE's control. We propose a developmental model consisting of four successive credentials—Engineer Intern, Professional Engineer, Board-Certified Civil Engineering Professional (BCCEP), and Diplomate—as shown in Table 2 below.

Table 2. Proposed developmental model for credentialing civil engineers

Credential	Abbrev.	Administered by	Requirements	Business Card
Engineer Intern	EI	Licensing jurisdictions	• ABET EAC-accredited bachelor's degree • FE Exam	*Mary Jones, EI*
Professional Engineer	PE	Licensing jurisdictions	• Enrollment as EI • Progressive engineering experience (typically 4 years) • PE Exam	*Mary Jones, P.E.*
Board-Certified Civil Engineering Professional	BC.CE BC.GE BC.SE BC.TE BC.xx*	Civil Engineering Certification, Inc.	• Licensure as PE • Master's degree or equivalent in the specialty area • Experiential fulfillment of all relevant CE-BOK outcomes	*Mary Jones, P.E., BC.GE*
Diplomate	D.CE D.GE D.SE D.TE D.xx*	Civil Engineering Certification, Inc.	• Certification as a Board-Certified Engineering Professional • Professional accomplishments and experience demonstrating prominence in a specialty area	*Mary Jones, P.E., D.GE*

* The abbreviation xx refers to a specific civil engineering specialty area. For example, BC.GE is a Board-Certified Geotechnical Engineer; D.TE is a Diplomate in Transportation Engineering. The suffix .CE refers to General Civil Engineering.

In this model, the EI and PE credentials are attained through the *existing* licensure system, based on *existing* standards for education, experience, and examination. By incorporating licensure into our proposed credentialing model, we affirm the critical importance of licensure as the legal

basis for engineers' exercise of professional authority and obligation to protect public health and safety.

The Board-Certified Civil Engineering Professional (BCCEP) credential is the most important element of this model, because it corresponds to full attainment of the CE-BOK. As such, the associated board certification process must be capable of verifying that:

- The candidate for certification is a licensed PE.
- The candidate has achieved the postgraduate education requirements specified by the CE-BOK. Specifically, the candidate must have a master's degree or equivalent, with coursework focused primarily on achieving the two CE-BOK outcomes that require postgraduate education *(depth in a civil engineering specialty area* and *experimental methods & data analysis)* as indicated by the "PG" cells in Table 1.
- The candidate has achieved the mentored experience specified by CE-BOK. Specifically, the candidate must have acquired appropriate experiential development in the 14 CE-BOK outcomes that require mentored experience, as indicated by the "ME" cells in Table 1.

The process of attaining the BCCEP credential is depicted graphically in Figure 4 below.* Note that the overall structure of this model—with ASCE-administered credentials augmenting the existing licensure system (Figure 3)—emulates the structure of the specialty certification system used by the medical profession (Figure 2).

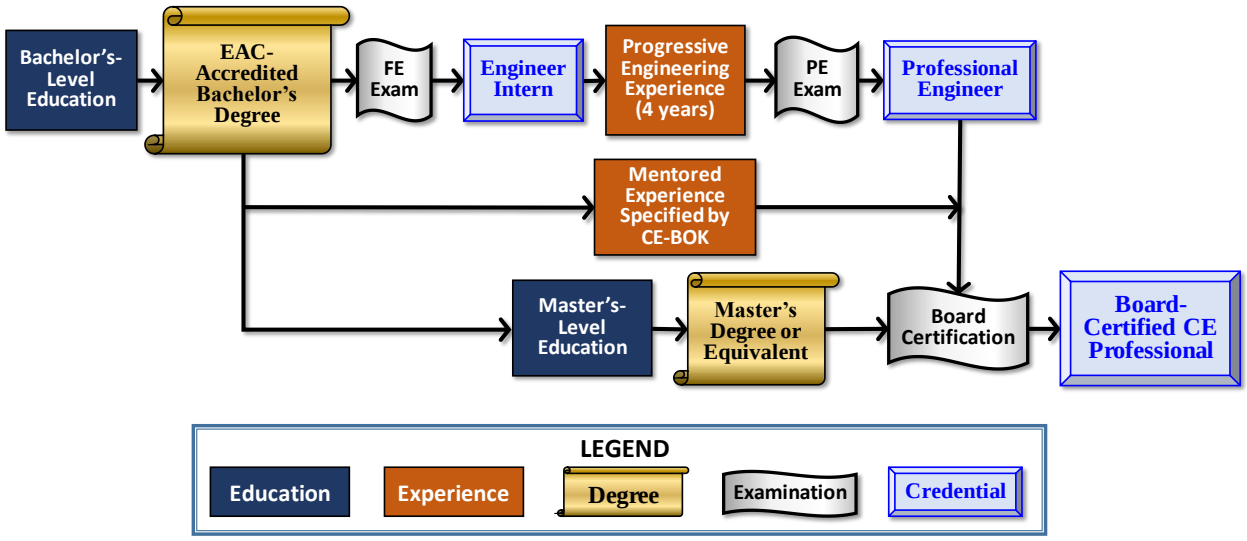

Figure 4. Proposed credentialing process for a Board-Certified Civil Engineering Professional (BCCEP)

As Figure 4 suggests, the sequencing of the master's-level education and mentored experience for the BCCEP should be as unconstrained as possible, to allow for maximum flexibility in career development. For example, it should be permissible for the master's-level education to occur either before or after the PE license is earned; and it should be permissible for the

* Note that the diagram in Figure 4 is based on a *critical path method (CPM) paradigm*, with parallel branches representing concurrent activities—as opposed to a *flowchart paradigm*, in which parallel branches represent alternative pathways.

mentored experience to be acquired at any time between graduation from the EAC-accredited bachelor's degree program and board certification. However, both the postgraduate education and the mentored experience associated with the CE-BOK outcome on *depth in a civil engineering specialty area* must be focused in the same specialty area for which the candidate is seeking certification.

The Diplomate credential should be regarded as an *optional* higher-level element of the proposed model, because it is not associated with attainment of the CE-BOK. The availability of board certification as a Diplomate would incentivize and reward the attainment of prominence in a civil engineering specialty area; nonetheless, if the cost and administrative overhead associated with implementing this high-level credential is found to be overly burdensome, then this component of the model can be omitted without adversely affecting fulfillment of the TCCRTB's charge.

As Table 2 indicates, we recommend that ASCE should leverage its existing expertise and experience in specialty certification by assigning responsibility for administering the certification processes for both the BCCEP and Diplomate credentials to CEC. To fulfill this responsibility, the CEC organization would require augmentation—most likely in the form of additional academies to support certification in all civil engineering specialty areas.

Finally, it must be emphasized that a fundamental prerequisite for implementation of our proposed model is formal, authoritative definition of the civil engineering specialty areas and their relationship to the civil engineering discipline.

Questions and Answers

In developing the credentialing model described above, the authors have attempted to achieve:

- consistency with the key concepts and terminology used in the CE-BOK;
- consistency with the terminology used in the U.S. licensure and ABET accreditation systems;
- internal consistency;
- consistency with the medical credentialing system, where appropriate;
- flexibility;
- continuity with the existing ASCE specialty certification system; and
- appropriate recognition of the key role played by the ASCE technical institutes in managing the civil engineering specialty areas.

Many nuances in the model's design reflect these considerations. Below, we explain the rationale for these nuances through a series of questions (**Q:**) and answers (**A:**).

Q: How will the proposed board certification process for the BCCEP ensure that candidates for certification have actually fulfilled the CE-BOK?

A: As shown in Table 1, the CE-BOK outcomes in the cognitive domain are achieved through undergraduate education (UG), postgraduate education (PG), and mentored experience (ME).

The proposed board certification process would validate the achievement of these outcomes as follows:

- By verifying that the candidate is a licensed PE, the board certification process can *indirectly* validate achievement of the UG component of CE-BOK. This is the case because: (1) the UG component of CE-BOK is attained through the candidate's successful completion of an ABET EAC-accredited civil engineering bachelor's degree program; (2) the EAC-accredited bachelor's degree is linked to the CE-BOK through ASCE's purposeful development of CE-BOK-compliant accreditation criteria (as noted previously in this paper); and (3) the EAC-accredited bachelor's degree is also the educational prerequisite for PE licensure.
- The board certification process must *directly* validate achievement of the PG component of CE-BOK, through a review of the candidate's postgraduate transcript.
- The board certification process must *directly* validate achievement of the ME component of CE-BOK, through a review of documentation submitted by the candidate.

Q: The educational requirement for the BCCEP credential is a master's degree *or equivalent*. What would qualify as an educational experience equivalent to a master's degree? Why is this option allowed?

A: Given the increasing availability of alternative educational delivery systems, and given that many civil engineering professionals are likely to pursue board certification while also working full-time, we recommend that the ASCE credentialing system allow for as much flexibility as possible in satisfying the educational requirement for the BCCEP credential. In defining equivalence to a master's degree, we recommend adoption of the verbiage used in NCEES Position Statement 35—"30 additional semester credit hours of upper-level undergraduate or graduate-level coursework in engineering or topics relevant to the practice of engineering [7]."

Q: In the BCCEP process, how will the content of a candidate's postgraduate education (PG) be assessed?

A: It is quite possible that the *character* of the technical requirements for professional practice in a specialty area might vary from specialty to specialty. For example, in one specialty area, coverage of specific topics might be deemed essential; in another, greater flexibility might be warranted. Thus, we suggest that the specific postgraduate education requirements for a given specialty area should be determined individually by the responsible academy, in close collaboration with the associated ASCE technical institute.

Q: In the BCCEP process, how will a candidate's mentored experience (ME) be assessed? How much *additional* experience (beyond the four years of progressive engineering experience required for the PE) will be needed for board certification?

A: First, it is quite possible that the amount of focused specialty-area experience might vary from specialty to specialty (as is the case in the medical profession). Thus, we suggest that the experience requirements for a given specialty area should be determined individually by the responsible academy, in close collaboration with the associated ASCE technical institute.

Second, for a given candidate, *some or all* of the progressive engineering experience required for the PE license might also contribute to the mentored experience (ME) required for CE-BOK fulfillment. For example, pre-licensure design experience that contributed to the candidate's qualifications for the PE might also contribute to achievement of the CE-BOK outcome on design. In our view, this sort of "double-counting" should be permitted. The fundamental requirement for the BCCEP credential is that the experiential (ME) component of all relevant CE-BOK outcomes must be fulfilled. It is immaterial whether this experience (or any portion of it) occurred before licensure or after it.

In the board certification process, it should be the *candidate's responsibility* to submit evidence—on an outcome-by-outcome basis—demonstrating that the experiential (ME) component of all relevant CE-BOK outcomes has been fulfilled. This evidence would most likely take the form of a portfolio [24].

Q: Why is the term "specialty area" used in reference to subdivisions of civil engineering (geotechnical engineering, structural engineering, transportation engineering, etc.)?

A: In the current U.S. licensure system, the term "discipline" is consistently used in reference to the major fields of engineering—civil engineering, mechanical engineering, electrical engineering, etc. [25] Thus, it would be confusing to use "discipline" in reference to subdivisions of civil engineering. We suggest that the term "specialty areas" be used for these subdivisions, for consistency with both the CE-BOK and the medical profession, and because the process of validating expertise in these areas is called "specialty certification" in many professional fields. This choice of terminology also allows for the future possibility of certification in subspecialty areas (e.g., highway engineering as a subspecialty of transportation engineering), as is currently done in the medical profession.

Q: What are the civil engineering specialty areas?

A: The CE-BOK lists seven traditional specialty areas—construction engineering, environmental engineering, geotechnical engineering, structural engineering, surveying, transportation engineering, and water resources engineering [4]. However, this list is *not authoritative* for three reasons:

- The seven traditional civil engineering areas were originally defined to describe the full breadth of the traditional civil engineering undergraduate curriculum [23]; they were not defined with specialty certification in mind and thus might not be entirely applicable to specialty certification. (As evidence of this issue, note that the existing ASCE board certifications in Coastal Engineering, Ocean Engineering, Port Engineering, and

Navigation Engineering do not correspond to any of the seven traditional civil engineering areas.)

- New specialty areas might have emerged since the traditional seven civil engineering areas were defined—or might emerge in the future.
- The civil engineering specialty areas have never been formalized in any ASCE policy statement.

An essential precondition for implementing a certification-based credentialing system is that the civil engineering specialty areas must be formally defined. There should also be a system for periodically reviewing and updating the specialty areas in the future.

Q: Should it be possible to become board-certified in General Civil Engineering?

A: Yes. Given the likely market demand for well-qualified civil engineering generalists, we strongly recommend that General Civil Engineering be included as a "specialty area" for the purpose of board certification. This recommendation is supported by the availability of numerous existing master's degree programs in general civil engineering [26] and by the CE-BOK, 3rd Edition, which notes that "Some civil engineers pursue a general civil engineering practice, requiring advanced education and experience across a broad range of civil engineering subjects [4]." It is also worth noting that recognition of General Civil Engineering as a specialty area is roughly equivalent to the medical profession's recognition of Family Medicine and Internal Medicine as specialties.

The credentials BC.CE and D.CE in Table 2 reflect this recommendation.

Q: Why is the format BC.xx and D.xx used for the two board certification credentials?

A: The format D.xx is currently used in ASCE's board certification system and should be preserved, simply for continuity. We suggest the use of BC.xx for consistency between the BCCEP and Diplomate credentials.

Q: Why are the proposed credentials specialty-specific? Wouldn't it be simpler, for example, to use BC.CE as the *only* BCCEP credential, rather than awarding a different credential for each specialty area (e.g. BC.GE, BC.SE, BC.TE)?

A: Compared with a single generic credential, specialty-specific credentials will communicate more information to candidates' colleagues, employers, clients, and the public—and thus will be more useful. We also expect that specialty-specific credentials will be more highly valued by the candidates themselves, because the credential will reinforce one's professional identity as an engineering specialist. If the credential is perceived to be more useful and valuable, it is more likely to be embraced by the profession.

Q: Why is a PE license required for BCCEP certification?

A: Our intent is to use specialty certification to supplement and reinforce the existing licensure system, not to replace it. This mutually supporting relationship between licensure and certification is appropriate from legal, practical, political, and policy perspectives:

(1) Just as in the medical profession, engineering licensure and specialty certification should complement each other. Licensure represents a legal authorization to exercise professional authority, granted by a government entity; certification represents the profession's internal validation of specialized expertise. A system that does not have both of these elements is conceptually incomplete. If the PE were not a prerequisite for the BCCEP credential, then ASCE would be board-certifying civil engineers who *cannot legally perform professional civil engineering work in any U.S. jurisdiction*. The medical equivalent—for example, a board-certified surgeon who is not a licensed M.D.—is not permitted under any circumstances.

(2) The current licensure system would also support the board certification process by validating attainment of the undergraduate education component (UG) and portions of the experiential component (ME) of the CE-BOK. Thus, if licensure were not a prerequisite for the BCCEP credential, the certification process would need to be far more extensive.

(3) From a practical perspective, if the PE were not a prerequisite for the BCCEP credential, administration of the system would likely become more complicated and more expensive, because the built-in quality control check associated with the licensure process would no longer be available. Without the PE as prerequisite, the credentialing process would require an exam that is at least equivalent to the PE exam in scope and rigor—thus requiring duplication of the substantial effort that NCEES currently devotes to development and administration of the exam. We suggest that, if a candidate has earned an EAC-accredited civil engineering degree, has passed the PE exam, and has earned a master's degree, an additional exam is not necessary—or might only be necessary for addressing ethics and similar non-technical topics.

(4) From a political perspective, if the PE were not a prerequisite for the credential, substantial opposition could be expected from the licensure community, because the BCCEP credential would be viewed as a potential "work-around" for engineers seeking to avoid licensure. Implementation of the proposed credentialing system will likely be less contentious if ASCE and the licensure community remain on the same team.

(5) Existing ASCE policy supports post-PE credentialing but not pre-PE credentialing. As stated in ASCE Policy Statement 524 [27]:

> *Obtaining a post-PE credential should require the engineer to demonstrate attainment of an appropriate body of knowledge in that specialty area. ASCE advocates that an individual should first obtain a license as a professional engineer, followed, if desired, by subsequent post-PE credentials such as licenses, licensing board designations, specialty certifications, and/or titles.*

Q: Why is an examination not required for the BCCEP credential?

A: An examination *could* reasonably be added as a requirement for the BCCEP credential. Doing so would undoubtedly provide a rigorous quality-control check on attainment of expertise in the specialty area and perhaps in other areas as well. However, we maintain that an examination is *not essential*, as long as both the master's degree (or equivalent) and specialty-area experience are focused on the specialty area for which the BCCEP credential is being sought. Our concern with adding an examination requirement to the certification process is that developing and administering exams across all specialty areas could create an overwhelming administrative burden that would hinder implementation of the system.

Q: Is there an adequate and clear distinction between the current PE license and the proposed BCCEP credential, such that candidates will be motivated to seek the BCCEP credential and employers and clients will value it?

A: Yes. The requirements for the BCCEP credential include a master's degree or equivalent in the specialty area, experiential fulfillment of all relevant CE-BOK outcomes, and possibly an examination in the specialty area. Satisfying these requirements will generally entail the acquisition of substantial expertise and experience beyond the PE. Thus the BCCEP credential will represent substantial added value beyond the PE.

Q: Why not use specialty licensure rather than specialty certification as the mechanism for implementing the ASCE RTB?

A: The ASCE Board of Direction explicitly requested that the mechanism for validating fulfillment of the CE-BOK be *entirely within ASCE's control.* As ASCE's experience over the past two decades has demonstrated, state licensing boards are not open to changing their standards and processes in response to the ASCE's needs.

Q: Will availability of the proposed BCCEP credential reduce candidates' motivation to attain the Diplomate credential?

A: No—provided that the qualifications for the Diplomate credential are appropriately defined. Just as the success of the BCCEP credential will require that candidates, employers, and clients perceive a clear distinction between the PE license and the BCCEP, so the future success of the Diplomate credential will require that these constituents perceive a clear distinction between the BCCEP and the Diplomate. To achieve this latter distinction, qualifications for the Diplomate credential must include expertise and experience standards that demonstrate a high level of prominence in the specialty area.

Q: In the current ASCE certification system, the typical requirements for the Diplomate credential are (1) a PE license or international equivalent, (2) a master's degree, and (3) eight years of progressive post-licensure engineering experience. Wouldn't it be more efficient simply to adopt this existing Diplomate system (perhaps with some small adjustments) as the new paradigm for ASCE's RTB initiative?

A: Adopting the existing Diplomate system as the new paradigm for RTB might be *efficient*, but it is unlikely to be *effective*. According to the ASCE Board, the purpose of the proposed credentialing system is to validate fulfillment of the CE-BOK—and therefore to certify that an individual is prepared for *entry* into the professional practice of civil engineering. Our proposed BCCEP credential fulfills this purpose; the existing ASCE Diplomate credential does not. Since its establishment fifteen years ago, the Diplomate credential has been awarded to experienced engineering professionals who have achieved prominence in a civil engineering specialty area. It is not an entry-level credential, nor is it based upon fulfillment of the CE-BOK. To fulfill the ASCE Board's purpose, the existing Diplomate credential would require fundamental and substantial changes to its focus and standards. Yet even if such changes were made, assigning the well-established name "Diplomate" to this fundamentally different credential would cause considerable confusion both within and outside of the professional community. It would also do a great disservice to current Diplomates, whose well-earned credential would no longer reflect their attainment of prominence in the field. These issues would significantly impair implementation and acceptance of the new system.

In short, adopting the existing Diplomate system might be convenient, but convenience should not be the governing criterion in the implementation of a major strategic initiative.

Creating Incentives for Specialty Certification

For specialty certification to serve effectively as a means of ensuring that practicing civil engineers fulfill the CE-BOK, it will be necessary for *most* licensed civil engineers to seek certification—just as most licensed physicians seek certification today. Achieving this outcome will undoubtedly be a challenge. Why would a licensed professional engineer commit substantial time and resources to attaining the BCCEP credential when there is no legal requirement to do so? Based on the successful example provided by the medical profession, it is clear that the system and the industry must provide strong incentives for participation in the board certification process.

To this end, we offer the following recommendations:

- The board certification process should set high standards and enforce them rigorously, such that attaining the credential is viewed as a noteworthy professional achievement—and therefore is highly valued by practitioners, employers, clients, and the public.
- The standards for board certification must remain stable over time. Given that the education and experience required for certification will be acquired over an extended period of time, frequently changing standards would be perceived as a "moving target" and thus would provide a strong disincentive for participation in the process.

- The board certification process should be flexible in implementation, such that these standards can be achieved through a variety of alternative paths. It should be possible for a busy professional to pursue board certification while also working full-time.
- Most important, employers and clients must be encouraged to "buy in" to the credentialing system. Just as hospitals require board certification for professional practice in a medical specialty area, the companies and government agencies that hire engineers can require board certification for professional practice in the civil engineering specialty areas. And just as a savvy patient might insist on being treated by a board-certified physician, so a client might insist on procuring the services of a board-certified engineer as a guarantee of quality.

The potential payoffs for employers include increased prestige, ease of vetting new hires, and, most importantly, greater assurance of quality in the delivery of engineering services.

Conclusions

In response to the ASCE Board's directive of March 2018, we conclude that it is indeed feasible to validate fulfillment of the CE-BOK using an enhanced specialty certification process that is entirely within ASCE's control. We propose a developmental model consisting of four successive credentials—Engineer Intern, Professional Engineer, Board-Certified Civil Engineering Professional, and Diplomate—the last being non-essential and therefore optional. The overall structure and many details of this model derive from the highly successful credentialing system used by the U.S. medical profession but have been adapted to accommodate the substantial differences in the educational paradigms of the medical and engineering professions.

Successful implementation of this model will require:

- no change to the existing professional licensure system;
- formal, authoritative definition of the civil engineering specialty areas and their relationship to the civil engineering discipline, as well as a process for reviewing and updating the civil engineering specialty areas in the future;
- an expansion of the CEC organization, most likely through the establishment of new academies corresponding to all civil engineering specialty areas;
- establishment of specific education and experience standards for each specialty area through close coordination between the academies and the corresponding technical institutes;
- establishment of specific board certification processes for evaluation of candidates' applications for certification; and
- a comprehensive ASCE strategic communications campaign to encourage "buy in" from practitioners, employers, and clients.

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