# From Civil Engineering Body of Knowledge To Civil Engineering Curricula

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## Abstract

ASCE's Committee on Academic Prerequisites for Professional Practice (CAP^3) is charged with developing, organizing, and executing a detailed plan for the full implementation of ASCE Policy 465 (Academic Prerequisites for Licensure and Professional Practice). This paper presents the recommendations of CAP^3's Body of Knowledge (BOK) Committee and introduces the subsequent curricula design effort. That effort, which is well underway, includes identifying and working closely with selected, diverse civil engineering departments. Within the framework of their culture, traditions, and strengths, 12 departments are working within the Curricula Committee designing or refining bachelor's plus curricula that, when supplemented with focused pre-licensure experience, would provide the BOK.

## Introduction

### *Background*

*Destiny is not a matter of chance,*
*it is a matter of choice.*
(William Jennings Bryan, statesman)

ASCE created the Task Committee on Academic Prerequisites for Professional Practice (TCAP$^3$) in October 2001 and charged it to "… develop, organize and execute a detailed plan for full realization of ASCE Policy Statement 465." In November 2003, in recognition of the long-term nature of implementing Policy Statement 465, TCAP$^3$ was changed to the Committee on Academic Prerequisites for Professional Practice (CAP$^3$), a permanent Board-level committee.

Policy Statement 465's essence is that ASCE supports the concept of a master's degree or equivalent as a requirement for licensure and the practice of civil engineering at the professional level. CAP$^3$ developed an implementation master plan for which the Body of Knowledge (BOK) was the foundation. As a result, the BOK Committee (See Appendix) was formed in May 2002 and charged to:

*Define the body of knowledge (BOK) needed to enter the practice of civil engineering at the professional level (licensure) in the 21st Century. Address the role of experience in the licensure preparation process. Design and/or identify bachelor's plus master's or 30 credits (B+M/30) programs plus experience that will implement the BOK in the early part of the 21st Century. Describe the role of faculty, practitioners, and students in imparting the BOK by means of B+M/30 programs. Seek input from and support for the preceding from forward-looking academics and practitioners.*

The Committee defined the BOK as the knowledge, skills, and attitudes necessary to become a licensed professional civil engineer. The BOK would be fulfilled by a carefully integrated combination of pre-licensure formal education and pre-licensure experience.

### *Purpose*

The purpose of this paper is to present the recommendations of the BOK Committee and to introduce the curricula design project, the current phase of BOK development. For additional details about the BOK Committee's recommendations and the process by which they were developed, refer to the Committee's 2004 report titled *Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future.* ASCE officially released this report on February 25, 2004 at a briefing conducted at the National Academy of Engineering in Washington, DC. The report is available on the ASCE website at http://www.asce.org/raisethebar.

This paper focuses on the BOK and on curricula design projects and is not intended to address the need for raising the preparation bar for civil engineers. That, and related important topics, are addressed in detail in the 2001 report *Engineering the Future of Civil Engineering*[2] also available on the ASCE website at http://www.asce.org/raisethebar. A similar pan-engineering report was released in 2003 by the Licensure Qualifications Task Force of the National Council of Examiners for Engineering and Surveying (NCEES).[3] That report is available on the NCEES website at http://www.ncees.org.

### *Definition of B + M/30 & E*

The BOK defined in support of ASCE Policy Statement 465 applies explicitly to those civil engineering educational tracks intended to prepare tomorrow's civil engineering student to become practicing (licensed) professional engineers. The committee expects that the majority of BSCE graduates will want to eventually become licensed, and, therefore, will plan their formal education paths to fulfill the BOK.

"Bachelors plus master's or 30 credits" (or "B + M/30") refers to the total post-secondary education that helps to fulfill the BOK required for licensure and entry into the professional practice of civil engineering. Experience (E) is structured and progressive post-baccalaureate engineering experience accomplished before, during, and/or after completion of the M/30. The BOK is to be fulfilled by B + M/30 and E as shown in Figure 1.

**Committee's Approach**

The BOK Committee followed a future-oriented path that tried to envision infrastructure and environmental problems and opportunities decades ahead. The Committee's approach included making a broad interpretation of practice to encompass many roles and functions. Institutional and individual flexibility was stressed. Committee Correspondents were engaged to solicit concerns and ideas and to critique draft materials. Committee members actively participated in numerous conferences and workshops and presented and published many papers and articles to expand interaction with stakeholders.

**BOK Defined by Outcomes**

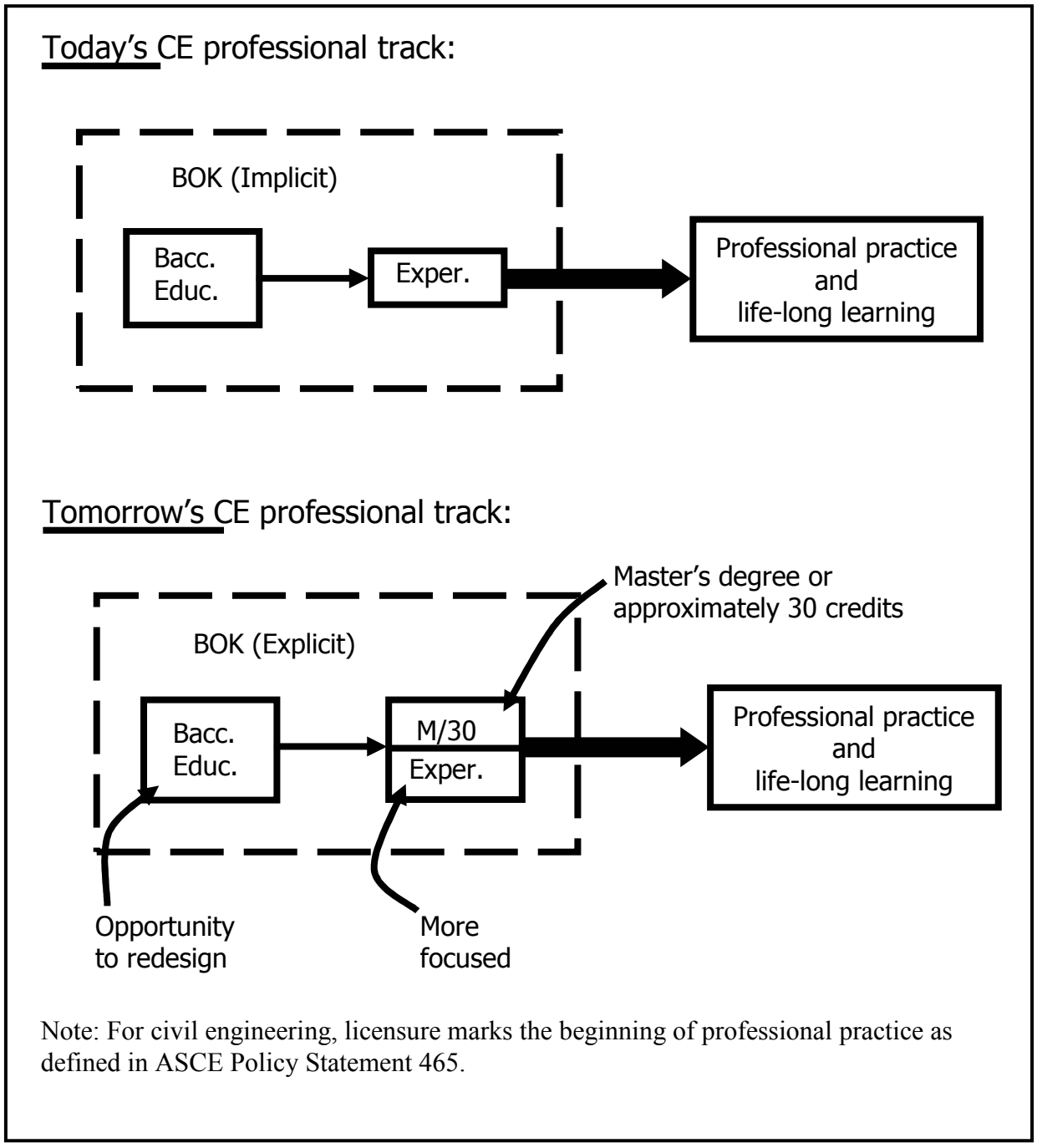
As the starting point for its BOK deliberations, the Committee chose the Accreditation Board for Engineering and Technology's (ABET) 11 outcomes[4] for four main reasons:

- ABET outcomes are consistent with and partially fulfill the intent of ASCE Policy Statement 465.
- The outcome approach recently adopted by ABET places more emphasis on desired quality results and less on prescriptive inputs.
- Considerable effort was invested by the accreditation community in exploring options and moving to the outcomes model. Building on this foundation was prudent as opposed to taking a new track.
- The academic community is familiar with the outcomes approach.

The draft ASCE commentary on program criteria[5] was also reviewed, as was the literature.[8]

Although the Committee began with the ABET outcomes, it was not constrained by them in breadth and/or depth. The Committee soon discovered that carrying out its charge required a broader and deeper statement of outcomes than that provided by the ABET outcomes, even when existing program criteria for civil and similarly named engineering programs were considered. As shown in Figure 2, the final set of desired outcomes builds on the 11 ABET outcomes by adding two technical outcomes, two professional practice outcomes, commentaries, and competency levels.

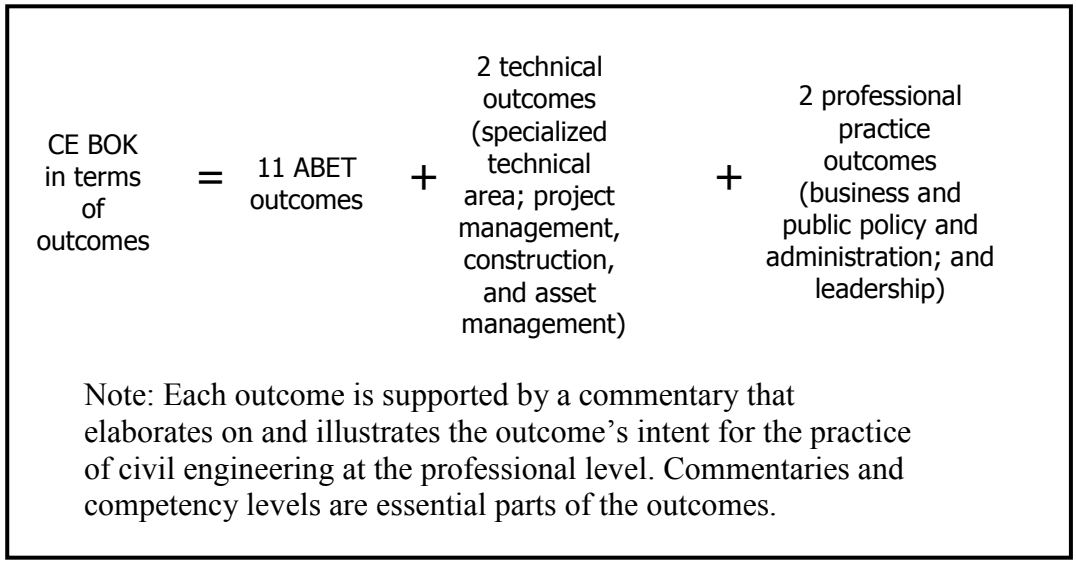
**Figure 1: Tomorrow's civil engineering professional track will include an explicit BOK, a master's or 30 credits, more focused experience, and baccalaureate education redesign.**




Note: For civil engineering, licensure marks the beginning of professional practice as defined in ASCE Policy Statement 465.

The amount of curricula that would be devoted to the two additional technical outcomes and the two additional professional practice outcomes is not proportional to the number of outcomes. Much more of a future civil engineering curriculum would be devoted to the additional technical outcomes than to the additional professional practice outcomes.

**Figure 2. The 15 outcomes in the recommended BOK build on ABET's 11 outcomes.**




**Level of Competence Definitions**

Integrating B+M/30 with E in BOK fulfillment begins with the premise that B+M/30 lays the foundation for all outcomes and builds the superstructure for some. Experience, that is E, builds the superstructure for the other outcomes. The BOK Committee proposed a competency level required for each of the 15 outcomes in order to attain professional licensure.

Knowledge, skills, and attitudes can exist at many different levels of capability and usefulness. The BOK distinguishes the following three broad levels of competence for individuals intending to become licensed professional civil engineers:

- Level 1 (Recognition) represents a reasonable level of familiarity with a concept. At this level, the engineer is familiar with a concept, but lacks the knowledge to specify and procure solutions without additional expertise. For example, an engineer might *recognize* that a particular architectural plan poses significant construction difficulties without having the expertise to devise improved construction or design alternatives.

- Level 2 (Understanding) implies a thorough mental grasp and comprehension of a concept or topic. Understanding typically requires more than abstract knowledge. For example, an engineer with an *understanding* of professional and ethical responsibility should be able to identify and to communicate ethical issues arising from a practical case study.

- Level 3 (Ability) is a capability to perform with competence. An engineer with the ability to design a particular system can take responsibility for the system, identifying all the necessary aspects of the design, and match objectives with appropriate technological solutions. As an engineer develops, the engineer's abilities also develop so that more challenging and difficult problems can be solved.

Although the words recognition, understanding, and ability appear in the ABET outcomes, they are not defined there. The Committee determined that definitions were needed for BOK implementation.

**The 15 Outcomes**

The BOK is presented in this section in the form of outcomes and commentaries developed by the BOK Committee. The parenthetic notation at the end of the first 11 outcomes indicate correspondence to ABET's 11 outcomes.

The purpose of the commentaries is to elaborate on and illustrate each outcome's intent. The commentaries are not intended to be prescriptive. The outcome-commentary format provides what the Committee views as a desirable deliverable for stakeholders; a list of succinct outcomes, each linked, for illustrative purposes, to an explanatory commentary.

Outcomes are viewed as being applicable over a long period of time (e.g., years). In contrast, some illustrative topics mentioned in commentaries will be ephemeral, requiring modification in response to technological advances and other changes.

The outcomes collectively prescribe the necessary depth and breadth of knowledge, skills, and attitudes required of an individual aspiring to enter the practice of civil engineering at the professional level (licensure) in the 21st Century. Relative to today's basic undergraduate civil engineering programs, the outcomes prescribe significantly more technical and professional practice content. The 21st Century civil engineer must demonstrate:

1. an ability to apply knowledge of **mathematics, science, and engineering.** (ABET a)

   *Commentary:* A technical core of knowledge and breadth of coverage in mathematics, science and civil engineering topics is stressed in this outcome. Underlying the professional role of the civil engineer as the master integrator and technical leader are most of the following: mathematics through differential equations, probability and statistics, calculus-based physics, biology, chemistry, ecology,

geology/geomorphology, engineering economics, mechanics, material properties, systems, geo-spatial representation, and information technology.

Increased exposure to or emphasis on biological systems, ecology, sustainability, nanotechnology and information technology is expected to occur in the 21st century. In imparting the common technical core, students should understand the fundamentals of several recognized major civil engineering areas. (Note: The portion of this commentary which states "students should understand the fundamentals of several recognized major civil engineering areas" differs from ABET Program Criteria for Civil and Similarly Named Engineering Programs[6] which calls for "proficiency in a minimum of four recognized major civil engineering areas."

2. an ability to design and conduct **experiments**, as well as **analyze** and **interpret** data. (ABET b)

   *Commentary:* Civil engineers frequently design and conduct field and laboratory studies, gather data, create numerical and other models, and then analyze and interpret the results. Licensed civil engineers should be able to do this in at least one of the evolving or current major civil engineering areas. Examples are traffic, geotechnical, and water quality investigations.

3. an ability to **design** a system, component, or process to meet desired needs. (ABET c)

   *Commentary*: Critical design methodology and process elements, include problem definition, scope, analysis, risk assessment, environmental impact statements, creativity, synthesizing alternatives, iteration, regulations, codes, safety, security and constructability, sustainability, and multiple objectives and various perspectives.

   Other important design or design procurement elements are bidding versus qualifications-based selection (QBS); estimating engineering costs; interaction between planning, design and construction; design review; owner-engineer relationships; and life-cycle assessment. Understanding large-scale systems is important, including the need to integrate information, organizations, people, processes, and technology. Design experiences should be integrated throughout the professional component of the curriculum.

4. an ability to function on **multi-disciplinary teams**. (ABET d)

   *Commentary:* Licensed civil engineers should be able to lead a design or other team as well as participate as a member of a team. This requires understanding team formation and evolution, personality profiles, team dynamics, collaboration among diverse disciplines, problem solving, and time management and being able to foster and integrate diversity of perspectives, knowledge, and experiences.

5. an ability to identify, formulate and solve **engineering problems**. (ABET e)

   *Commentary:* Assessing situations in order to identify engineering problems, formulate alternatives, and recommend feasible solutions is an important aspect of the professional responsibilities of a civil engineer.

6. an understanding of **professional and ethical responsibility.** (ABET f)

   *Commentary:* The civil engineer is to hold paramount public safety, health, and welfare. A thoughtful and careful weighing of alternatives when values conflict is crucial to the responsible conduct of engineering. Therefore, civil engineers practicing at the professional level need to demonstrate an understanding of and a commitment to practice according to the seven Fundamental Canons of Ethics and the associated Guidelines to Practice Under the Fundamental Canons of Ethics.

7. an ability to **communicate** effectively. (ABET g)

   *Commentary:* Effective communication includes listening, observing, reading, speaking, and writing and requires understanding of the fundamentals of interacting effectively with technical and nontechnical or lay individuals and audiences in a variety of settings. Professional civil engineers need to be versatile with mathematics, graphics, the worldwide web and other communication tools.

8. the broad education necessary to understand the **impact of engineering solutions** in a global and societal context. (ABET h)

   *Commentary:* Professional civil engineers need to appreciate, from historical and contemporary perspectives, culture, human and organizational behavior, aesthetics and ecology and their impacts on society including the history and heritage of the civil engineering profession.

9. a recognition of the need for, and an ability to engage in, **life-long learning.** (ABET i)

   *Commentary:* Life-long learning mechanisms available for personal and professional development include additional formal education, continuing education, professional practice experience, active involvement in professional societies, community service, coaching, mentoring, and other learning and growth activities.

   Personal and professional development can include developing understanding of and competence in goal setting, personal time management, communication, delegation, personality types, networking, leadership, the socio-political process, and effecting change.

In addition to the preceding, professional development can, include career management, increasing discipline knowledge, understanding business fundamentals, contributing to the profession, self-employment, additional graduate studies, and achieving licensure and specialty certification.

10. a knowledge of **contemporary issues.** (ABET j)

    *Commentary:* To be effective, professional civil engineers should appreciate the relationship of engineering to critical contemporary issues such as multicultural globalization of engineering practice; raising the quality of life around the globe; the growing diversity of society; and the technical, environmental, societal, political, legal, aesthetic, economic, and financial implications of engineering projects.

11. an ability to use the techniques, skills, and modern **engineering tools** necessary for engineering practice. (ABET k)

    *Commentary:* This includes the role and use of appropriate information technology, contemporary analysis and design methods, and applicable design codes and standards as practical problem-solving tools to complement knowledge of fundamental concepts. Also included is the ability to select the appropriate tools for solving different types and levels of problems.

12. an ability to apply knowledge in a **specialized area related to civil engineering.**

    *Commentary:* For a professional civil engineer, specialized technical coursework (or the equivalent) is necessary. Examples of specialized technical areas include environmental engineering, structural engineering, construction engineering and management, public works management, transportation engineering and water resources management. Civil engineering specializations in non-traditional, boundary, or emerging fields such as ecological engineering and nano-technology are encouraged.

13. an understanding of the elements of **project management, construction,** and **asset management.**

    *Commentary:* Efforts of the professional civil engineer often lead, in the context of projects, to construction of structures, facilities and systems which, in turn, must be operated and maintained.

    Project management essentials include project manager responsibilities, defining and meeting client requirements, risk assessment and management, stakeholder identification and involvement, contract negotiation, project work plans, scope and deliverables, budget and schedule preparation and monitoring, interaction among

engineering and other disciplines, quality assurance and quality control, and dispute resolution processes.

Important construction elements are owner-engineer-contractor relationships; project delivery systems (e.g., design-bid-build, design-build); estimating construction costs; bidding by contractors; labor and labor management issues; and construction processes, methods, systems, equipment, planning, scheduling, safety, cost analysis and cost control.

Asset management seeks effective and efficient long-term ownership of capital facilities via systematic acquisition, operation, maintenance, preservation, replacement, and disposition. Goals include optimizing life-cycle performance, minimizing life-cycle costs, and achieving maximum stakeholder benefit. Tools and techniques include design innovations, new construction technologies, materials improvements, geo-mapping, database management, value assessment, performance models, web-based communication, and cost accounting. Including asset management recognizes that civil engineers, during their careers, are likely to be involved with some aspect of capital facilities management.

14. an understanding of **business and public policy and administration fundamentals.**

*Commentary:* The professional civil engineer typically functions within both the public and private sectors which requires at least an understanding of business, public policy, and public administration fundamentals.

Important business fundamentals topics as typically applied in the private, government and non-profit sectors include legal forms of ownership, organizational structure and design, income statements, balance sheets, decision (engineering) economics, finance, marketing and sales, billable time, overhead, and profit.

Essential public policy and administration fundamentals include the political process, public policy, laws and regulations, funding mechanisms, public education and involvement, government-business interaction, and the public service responsibility of professionals.

15. an understanding of the **role of the leader** and **leadership principles** and **attitudes.**

*Commentary*: Leading, in the private and public arena – which differs from and complements managing – requires broad motivation, direction, and communication knowledge and skills. Attitudes generally accepted as being conducive to leadership include commitment, confidence, curiosity, entrepreneurship, high expectations, honesty, integrity, judgment, persistence, positiveness, and sensitivity. Desirable behaviors of leaders, which can be taught and learned, include earning trust, trusting others, formulating and articulating vision, communication, rational thinking,

openness, consistency, commitment to organizational values, and discretion with sensitive information.

The preceding BOK can be summarized by categorizing each of the outcomes as being primarily technical or professional practice. This format emphasizes the intent of ASCE Policy Statement 465 to expand the capabilities of tomorrow's civil engineers practicing at the professional level. Table 1 shows the results of this approach.

**Table 1. The 15 BOK outcomes can be categorized as technical or professional practice.**

| TECHNICAL | PROFESSIONAL PRACTICE |
|---|---|
| Technical core (1) | Inter-disciplinary teams (4) |
| Specialized area of civil engineering (12) | Professional and ethical responsibility (6) |
| Experimentation (2) | Communication (7) |
| Design (3) | Impact of engineering (8) |
| Engineering problems (5) | Life-long learning (9) |
| Engineering tools (11) | Contemporary issues (10) |
| Project management, construction, and asset management (13) | Business and public policy (14) |
| | Leadership (15) |

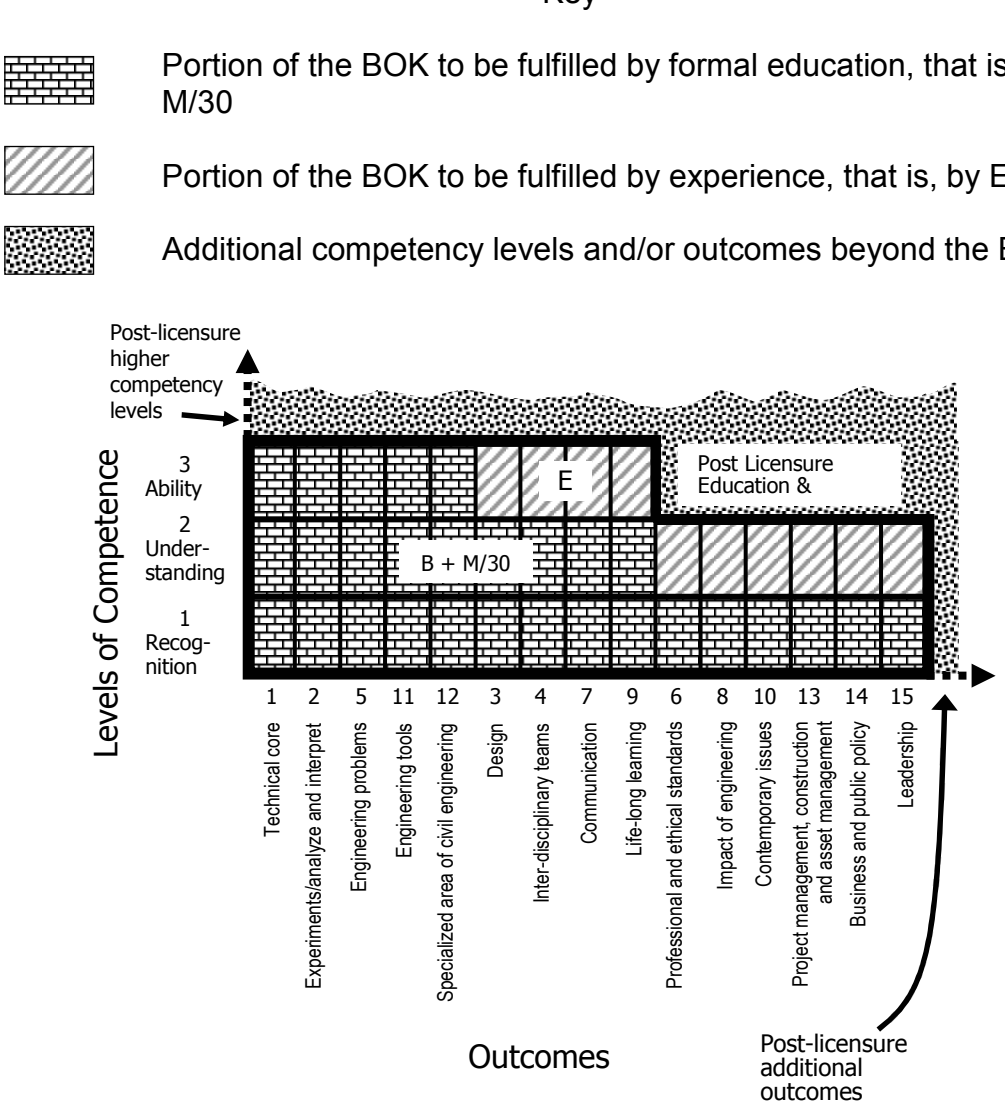
Note: Numbers in parentheses are outcome numbers used in the text.

*Engineers must be society-wise*
*as well as technology-wise.*
(W. J. Viessman, environmental engineer)

**A Graphic Representation of the Civil Engineering BOK and Beyond**

The BOK is displayed graphically in Figure 3 as another means of communicating outcomes, competency levels, and the role of B & M/30 + E.

**Figure 3. This BOK profile integrates outcomes, levels of competence, formal education, and pre-licensure experience.**




Source: Format adapted from Massie[7]

BOK features illustrated in Figure 3 include:

1. All 15 outcomes are to be taken to at least Level 1 (recognition) via formal education. That is, formal education lays the foundation for all 15 outcomes.

2. The brick pattern and cross-hatching (the area below the heavy line) represent the ***what*** dimension of the post-high school, pre-licensure BOK. Of the 15 outcomes, nine (1, 2, 5, 11, 12, 3, 4, 7 and 9) are to be taken to Level 3 (ability) through education and/or experience, and the remaining six (6, 8, 10, 13, 14, and 15) are to be taken to Level 2 (understanding).

3. For five outcomes (1, 2, 5, 11 and 12), the target competencies for the BOK are fulfilled entirely through formal education (B + M/30). This is shown with the brick pattern.

4. For the remaining ten outcomes (3, 4, 7, 6, 8, 9, 10, 13, 14, and 15), the target competencies for the BOK are fulfilled through formal education and experience (B + M/30 and E). The brick and cross-hatching depict education and experience.

5. While ten outcomes are heavily dependent on experience, the other five outcomes will be enriched by experience.

6. Competencies in some or all outcomes may grow, as shown by the dot pattern, to and beyond Level 3 (ability) via post-licensure experience and/or education.

7. The dot pattern also indicates that additional outcomes (beyond 15) are probable after fulfilling the pre-licensure BOK.

**Attitudes**

As stated earlier, the BOK is defined as "the knowledge, skills and attitudes necessary to become a licensed professional engineer." Knowledge, skills and attitudes are the essential components of the ***what*** dimension of the BOK. Individual experiences and review of studies[8,10] prompted the BOK Committee to include attitudes in the BOK.

By attitudes, the Committee means ways in which one thinks and feels in response to a fact or situation. Attitudes reflect an individual's values. A person's suite of attitudes is how he or she "sees" the world, not in terms of sight, but in terms of perceiving, interpreting and approaching. And, as noted by John C. Maxwell,[9] "your behavior follows your attitude. The two cannot be separated."

Attitudes are explicitly mentioned in Outcome 15 ("an understanding of the role of the leader and leadership principles and attitudes"). Many attitudes are listed in the Outcome 15 commentary.

Knowledge and skills are, relative to attitudes, more comfortably and frequently discussed by civil engineers and probably many other professionals. This tendency is probably explained, in part, by the objectivity and specificity of knowledge and skills contrasted with the subjectivity and ambiguity of attitudes.

In spite of subjectivity and ambiguity complications, the BOK Committee is convinced that attitudes must join knowledge and skills as one of the three essential components of the ***what*** dimension of the civil engineering BOK.[8,10] The manner in which a civil engineer views and approaches his or her work is very likely to determine how effectively he or she uses hard-earned knowledge and skills.

### *Which Attitudes?*

Having stated the critical role of attitudes in the civil engineering BOK, a question naturally arises: which attitudes should be included in the BOK? As a partial answer to the question, the Committee assembled the following list of attitudes, that is, value-driven feelings or emotions, possibly conducive to effective professional practice of civil engineering:

- Commitment
- Confidence
- Consideration of others
- Curiosity
- Entrepreneurship
- Fairness
- High expectations
- Honesty
- Integrity
- Intuition
- Judgment
- Optimism
- Persistence
- Positiveness
- Respect
- Self esteem
- Sensitivity
- Thoughtfulness
- Thoroughness
- Tolerance

The idea of professional attitudes might be introduced. That is, a subset of the preceding that are demonstrated by the civil engineer successfully practicing at the professional level. A given civil and environmental engineering department or a particular employer might select a subset and integrate them into their education or development programs. The selected attitudes might be tailored to the department's or employer's principal focus or function such as design, construction, research, or public works.

### *Can Attitudes Be Taught and Learned?*

We can teach about attitudes, just as we can teach about any topic. The essential question, however, can attitudes be learned as a result of the teaching and, furthermore, what does that learning mean?

The curricula design project described later in this paper is addressing attitudes. Within the framework of each institution's culture, traditions, and strengths, those projects are identifying desirable attitudes and explaining how they can be taught and possibly learned within the various institutions via curricular and co- and extra-curricular programs and activities.

The Committee believes that civil engineering departments and employers should adopt the approach that understanding the value and meaning of certain attitudes is a minimum education and development goal. Perhaps some departments and employers will shoot higher, that is, strive to have students understand, internalize and act on constructive attitudes.[11]

**Development of New Undergraduate Plus Additional Education Compatible With the BOK**

*A teacher affects eternity;*
*he can never tell where his influence stops.*
(Henry Adams, educator, traveler, writer)

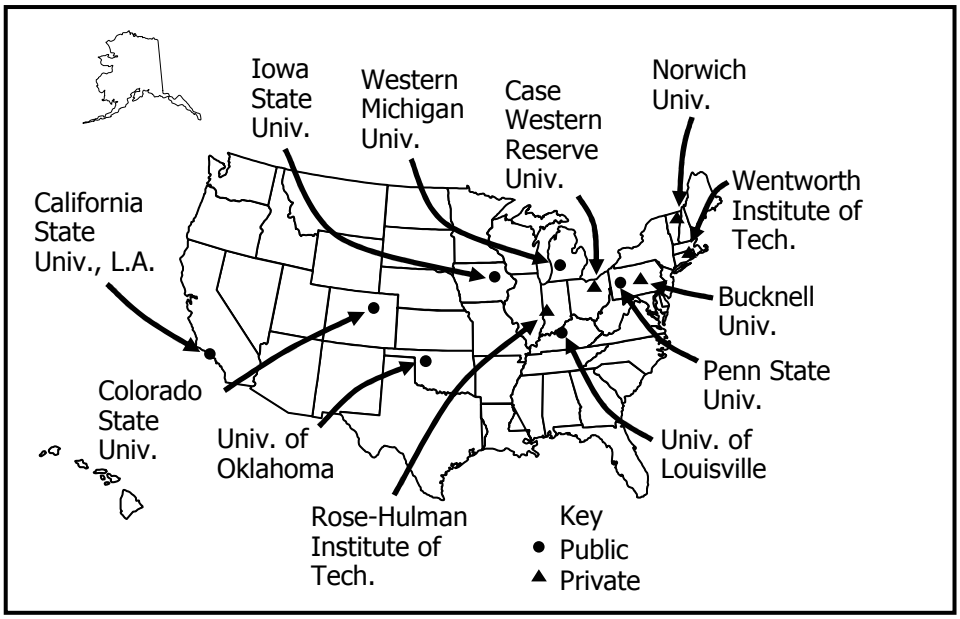
The BOK Committee started the process of engaging civil engineering faculty, other faculty, and administrators who want to be leaders in educational innovation and reform. With the conclusion of the work of the BOK Committee, it was disbanded in late 2003. The curricula design projects are now the principal responsibility of the Curricula Committee, a CAP^3 constituent committee formed in September 2003. CAP^3 is working with ASCE Institutes to ensure that Outcome 12, the technical specialization outcome, is addressed and integrated into the specialty certification effort that is on-going within ASCE.[12]

Education leaders are being asked to evaluate the BOK, determine how much of it is or could be included in their bachelor's programs, and design "on paper" the additional education necessary to fulfill the BOK, when supplemented with pre-licensure experience. These leaders are also being asked to identify challenges, barriers and opportunities associated with BOK implementation. Understandably, the preceding is occurring within the framework of each institution's culture, traditions, and strengths.

The Curricula Committee's strategy is to work closely with interested, varied civil engineering departments and then widely disseminate their curricula designs to serve as examples of how to provide much of the BOK. Partner institutions are shown in Figure 4 along with their public or private status. The 12 participating institutions include public and private institutions that are either research-oriented or primarily undergraduate institutions. As of the March 2004 completion of this paper, discussions were underway or scheduled with potential curricula design partners.

As a condition of participating, partner institutions were asked to widely disseminate their curricula designs to serve as examples of the process followed and results obtained. Several papers have been presented and many are planned for this and other conferences.

**Figure 4. Public and private universities across the U.S. are participating in the curricula design project.**




## The Next Steps and an Invitation

While the charge to the BOK Committee is complete, the civil engineering BOK, as described in this paper, is dynamic and, as such, will evolve. That evolution will be stimulated primarily by the curricular design projects being conducted under the leadership of the Curricula Committee.

The BOK is also supporting other initiatives needed to implement ASCE Policy Statement 465. These important efforts are being led by the Accreditation, Licensure, and Fulfillment-Validation Committees. The BOK is also being used in the implementation of ASCE's specialty certification program. The civil engineering BOK, as presented in this report, is the foundation on which implementation of Policy Statement 465 is being built.

Implementation of ASCE Policy Statement 465 is a major, largely volunteer effort. Much remains to be done and additional volunteers are most welcome. Example tasks are reviewing and commenting on the BOK report, serving as a member or correspondent member of one or more committees, participating in a curricula design project, and arranging a presentation or workshop. If interested, please contact the author at stuwalesh@comcast.net.

*When we build, let it not be for present use alone.*
*Let it be such work as our descendants will thank us for.*
(John Ruskin, philosopher)

## Acknowledgements

The author thankfully acknowledges the contributions of other members of the BOK Committee (See Appendix) and assistance from correspondents and members of CAP[3] and of the Accreditation, Licensure, and Curricula Committees.

The BOK Committee was profoundly influenced by and willingly built on the work of others. Many individuals and groups, working creatively and persistently over decades, developed, documented and passed on influential ideas and information. Engineering education and practice literature record these efforts. The BOK Committee gratefully acknowledges assistance received from the earlier and contemporary contributions of others.

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**Appendix: Members of the Body of Knowledge Committee**

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Thomas A. Lenox, PhD
James J. O'Brien, PE
Dale W. Sall, PE, LS
John S. Shearer, PE, DEE
Thomas Siller, PhD
John Tawresey, PE
Stuart G. Walesh, PhD, PE (Chair)
Marlee A. Walton, PE, LSI

Brandon Pierce, EIT, and Amrou Atassi, EIT, provided special assistance to the committee. Their service is appreciated.

**Biography**

Independent consultant STUART G. WALESH, PhD, PE (stuwalesh@comcast.net) provides leadership, management and engineering services to private and public organizations drawing on experience as project manager, department head, discipline manager, marketer, professor and engineering dean. He authored many papers and several books, the most recent of which is *Managing and Leading: 52 Lessons Learned for Engineers*, ASCE Press, 2004.