

AC 2007-643: AN ASPIRATIONAL VISION OF CIVIL ENGINEERING IN 2025: THE ROLE OF ACCREDITATION

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An Aspirational Vision of Civil Engineering in 2025— The Role of Accreditation

Background

During the summer of 2006, the American Society of Civil Engineers (ASCE) hosted the Summit on the Future of Civil Engineering, bringing together leaders from across the profession to develop an aspirational vision for the year 2025. Summit participants attempted to envision the challenges that humanity will face two decades from now, and then articulated a vision for the civil engineer's role in meeting those challenges. Integral to this vision is a "Profile of the 2025 Civil Engineer," which describes the attributes—the knowledge, skills, and attitudes—that will be required to "create a sustainable world and enhance the global quality of life" in 2025.¹ If the vision is to become a reality, future civil engineers will need to develop these attributes, at least in part, through formal education at both the undergraduate and graduate levels. Thus, attainment of the proposed aspirational vision will depend, to a large extent, on contributions from civil engineering programs at the nation's educational institutions. Given the ambitious nature of the vision, its realization will certainly require changes to existing civil engineering curricula. How can the profession ensure that such changes are actually developed and implemented in a manner consistent with the desired end? The ABET accreditation process is a particularly powerful tool for stimulating and guiding educational reform, yet this tool is also subject to significant limitations.

Purpose

This paper discusses the role of the engineering accreditation process as a tool for attaining the aspirational vision for civil engineering in 2025. The paper begins with an analysis of the ongoing development and promulgation of new civil engineering accreditation criteria, in conjunction with the implementation of ASCE's Policy Statement 465. This analysis is used as the basis for identifying two major limitations inherent in using accreditation criteria as a means of pursuing a strategic vision. The approach that has been used to overcome these limitations in the Policy 465 initiative is described. This same approach is then applied to the proposed "Profile of the 2025 Civil Engineer," resulting in a (somewhat speculative) list of accreditation criteria changes that would be required in order to facilitate the attainment of the aspirational vision for civil engineering in 2025.

The Role of Accreditation in ASCE Policy 465 Implementation

In response to a growing consensus that the bachelor's degree is becoming increasingly inadequate as formal academic preparation for the professional practice of civil engineering, the ASCE Board of Direction adopted Policy Statement 465 in October 1998. This initial version of the policy stated that the Society "supports the concept of the master's degree as the First Professional Degree for the practice of civil engineering at the professional level." As the strategy for achieving this end developed, it became apparent that the policy should more broadly address the academic prerequisites for professional practice and licensure, rather than focusing only on the attainment of a particular academic degree. Thus, in October 2001, the ASCE Board adopted a modified version of Policy Statement 465, indicating that ASCE

“supports the concept of the master’s degree or equivalent as a prerequisite for licensure and the practice of civil engineering at the professional level.”

Charged with implementing Policy Statement 465, the ASCE Committee on Academic Prerequisites for Professional Practice (CAP³) began by analyzing the three fundamental characteristics of a profession—an ethic of service, a professional organization, and a specialized body of knowledge.² The committee’s analysis of the civil engineering profession suggested that only the first two of these three characteristics had been adequately defined. Thus began a broad-based effort to define the Civil Engineering Body of Knowledge.

In January 2004 this endeavor achieved a major milestone with ASCE’s publication of *Civil Engineering Body of Knowledge for the 21st Century*—a report describing the knowledge, skills, and attitudes necessary for entry into the practice of civil engineering at the professional level.³ This report describes the Civil Engineering Body of Knowledge (BOK) in terms of 15 outcomes, the first eleven of which correspond nominally to ABET Criteria 3(a)-(k).⁴ Outcome 12 describes a requirement for knowledge in a specialized area related to civil engineering; and Outcomes 13, 14, and 15 require understanding of professional practice topics such as management, business, public policy and administration, and leadership.

In October 2004, the ASCE Board reinforced the importance of the BOK by modifying the wording of Policy Statement 465 as follows:

The American Society of Civil Engineers supports the attainment of a Body of Knowledge for entry into the practice of civil engineering at the professional level. This would be accomplished through the adoption of appropriate engineering education and experience requirements as a prerequisite for licensure.⁵

With the BOK formally defined and endorsed in ASCE policy, its implementation is now proceeding along four parallel, coordinated paths—accreditation, licensure, fulfillment and validation, and the development of an updated edition of the BOK. Each path is the responsibility of a constituent committee of CAP³. The development and implementation of BOK-compliant accreditation criteria is the responsibility of the CAP³ Accreditation Committee.

The CAP³ Accreditation Committee’s ultimate charge is to foster the development and implementation of BOK-compliant curricula in every ABET-accredited civil engineering program in the U.S. Implicit in this charge is an underlying assumption that the ABET accreditation process is an appropriate mechanism for effecting widespread and reasonably consistent implementation of the BOK. The assumption is well founded. “Engineering Change,” a recent study conducted by the Penn State Center for the Study of Higher Education, clearly demonstrates that accreditation criteria can provide a powerful stimulus for curricular reform.⁶ And once curricular reform is underway, the accreditation process provides an effective quality control mechanism to ensure that changes are being implemented in accordance with the desired end.

In pursuit of its charge, the CAP³ Accreditation Committee engaged in a highly collaborative two-year process of study, deliberation, and critical review, culminating in the submission of proposed new accreditation criteria to ABET in June 2006. These criteria, which have drawn

strong support from across the civil engineering education community, are provided in Appendix 1 of this paper. As of this writing, the criteria have been approved by the Engineering Accreditation Commission on first reading and have been published by ABET for public review.⁴ After their expected final approval in 2007, the criteria will be implemented for accreditation visits occurring during academic year 2008-2009.

Limitations

Although the ABET accreditation process has proved to be an effective mechanism for stimulating broad-based civil engineering curriculum reform thus far, Policy 465 implementation has also called attention to two very significant limitations on the use of this mechanism. First, the ABET accreditation criteria are *not under ASCE's direct control*. More specifically, the three different components of the ABET criteria are subject to significantly different degrees of ASCE influence, but in no case is that influence absolute.

- The Basic-Level General Criteria are applicable to *all* ABET-accredited programs in *all* engineering disciplines. Changing these criteria would require the support of ABET and its 27 member societies. ASCE has little or no capability to gain such support, as most member societies and educational institutions tend to favor stability in the criteria. Thus, in the short term, the ABET Basic-Level General Criteria must be considered largely unchangeable.
- The Advanced-Level General Criteria are also applicable to all engineering disciplines; however, because very few programs are currently accredited at the advanced level, ASCE has been able to exert somewhat more influence over these criteria. Nonetheless, changes to the Advanced-Level General Criteria must still be applicable and acceptable to all engineering disciplines. Discipline-specific additions to these criteria would not be permissible.
- The Basic-Level Program Criteria are applicable only to specific engineering disciplines and are established and maintained by the associated ABET member societies. The Basic-Level Civil Engineering Program Criteria are applicable to “civil and similarly named engineering programs” and are established by ASCE. Because ASCE has considerable authority over them, these criteria must necessarily be the principal accreditation-related mechanism for BOK implementation. Nonetheless, ASCE is not able to exercise complete control over these criteria. All program criteria are subject to ABET approval; and in order to gain approval, proposed criteria must be appropriately outcomes-based and must not be overly prescriptive. In an era when new engineering disciplines are constantly emerging and existing disciplinary boundaries are blurring, program criteria are viewed as an anachronism in some ABET circles. Indeed, some members of the ABET leadership have supported the total elimination of program criteria. In this environment, ASCE's ability to use the Basic Level Civil Engineering Program Criteria as its principal instrument for implementation of curricular reform is significantly constrained.

The ASCE Commentary is also available as an instrument for curricular reform, although it is not (nor can it ever be) a formal part of the ABET criteria. The commentary is an internal ASCE document that provides civil engineering program evaluators with guidelines for conducting accreditation visits under the current ABET criteria—with emphasis on the Basic Level Civil Engineering Program Criteria.⁷ Since the ASCE Commentary is permitted by ABET and is already well known to program evaluators and civil engineering faculty, it represents a powerful means of communication with several of the most important constituencies associated with BOK implementation. Like the Civil Engineering Program Criteria, however, the ASCE Commentary is also subject to significant constraints. Most important, in order to remain acceptable to ABET, the ASCE Commentary may not supplement the ABET criteria in any way. The commentary can provide guidance on how to apply the existing criteria; however, it may not include any provision that might be interpreted as additional evaluation criteria. To emphasize its unofficial status, the ASCE Commentary is now, and will continue to be identified as, a draft document.

The second major limitation on the use of ABET criteria as a mechanism for BOK implementation lies in a fundamental difference between the nature of the BOK and the nature of accreditation criteria. Although it was not intended as such, the BOK has many characteristics of a strategic vision. It represents, by its very nature, an ambitious, comprehensive, future-oriented goal—one that all civil engineering programs should aspire to, but one that few programs will ever achieve in all of its aspects. Conversely, accreditation criteria represent only a *minimum standard* of educational attainment. They are grounded firmly in the present; they tend to be narrower in scope; and they must be *reasonably attainable by all programs*.

This difference is illustrated by the tabular comparison provided in Appendix 2. The two left-hand columns of the table list the 15 BOK outcomes along with the specific requirements articulated for each outcome in *Civil Engineering Body of Knowledge for the 21st Century*. The two right-hand columns of the table list the provisions of the current ABET Criteria corresponding to each BOK outcome. An outcome-by-outcome comparison clearly illustrates the fact that the BOK outcomes represent a significantly more ambitious and comprehensive standard than do the ABET criteria. For example, consider BOK Outcome 1, which includes requirements for “biology, chemistry, ecology, geology/geomorphology, engineering economics, mechanics, material properties, systems, geo-spatial representation, and information technology.” The corresponding provision of the Basic-Level Civil Engineering Program Criteria requires only “one additional area of science, consistent with the program educational objectives.”

The sharp difference between the standards communicated in the BOK and the criteria is entirely appropriate, as it reflects the distinctly different nature of these two documents. If the criteria were written at the same level of detail as the BOK, they would be overly prescriptive and largely unattainable. If the BOK were formulated as a minimum standard, consistent with the criteria, it would fail to serve its function as an aspirational goal.

Bridging the Gap

In light of these inherent limitations, ASCE’s approach to stimulating and guiding curricular reform, embodied in the ongoing implementation of Policy Statement 465, consists of two complementary processes:

- Develop accreditation criteria, such that at least one readily identifiable criterion (or portion of a criterion) is associated with each BOK outcome. Each of these criteria should communicate an appropriate *direction* toward attainment of the associated BOK outcome. Taken as a whole, however, the criteria should stop short of prescribing full BOK attainment, because doing so would inevitably limit programs’ curricular flexibility to an unacceptable degree. Appendix 2 provides a comprehensive summary of the associations between the current BOK outcomes and the current BOK-compliant criteria.
- Develop a revised edition of the ASCE Commentary to “bridge the gap” between the minimum standards reflected in the accreditation criteria and the more comprehensive and aspirational BOK outcomes.⁸ This new edition of the commentary is organized in terms of the 15 BOK outcomes, emphasizing that the BOK is the foundation upon which civil engineering accreditation is built. The traditional function of providing Program Evaluators with guidelines for application of the ABET Criteria is retained; however, a new “Beyond the Criteria” section has been added for each BOK outcome. The phrase “beyond the criteria” explicitly recognizes that full, robust implementation of the BOK can only be achieved if programs voluntarily do more than the criteria prescribe. This section of the commentary provides these voluntary measures—curricular content, student learning experiences, and faculty qualifications that go beyond the scope of the accreditation criteria but are nonetheless necessary for BOK fulfillment.

These two processes—and the philosophy underlying them—constitutes ASCE’s model for using accreditation criteria as a stimulus for curricular reform aimed at a strategic vision.

Accreditation and the Aspirational Vision of Civil Engineering

At the heart of the recently developed vision of civil engineering is a Profile of the 2025 Civil Engineer, which identifies the following knowledge, skills, and attitudes that will be demanded of civil engineering professionals in the decades ahead:¹

Knowledge:

- Mathematics, physics, chemistry, biology, mechanics, and materials
- Design of structures, facilities, and systems
- Risk/uncertainty, such as risk identification, data-based and knowledge-based types, and probability and statistics
- Sustainability, including social, economic, and physical dimensions
- Public policy and administration, including elements such as the political process, laws and regulations, funding mechanisms, and the profession’s responsibility to hold paramount public health, safety, and welfare and to often assume a leadership role

- Business basics such as legal forms of ownership, profit, income statements and balance sheets, decision or engineering economics, and marketing
- Social sciences, including economics, history, and sociology
- Ethical behavior, including client confidentiality, codes of ethics within and outside of engineering societies, anti-corruption and the differences between legal requirements and ethical expectations

Skills:

- Apply basic engineering tools such as statistical analysis, computer models, design codes and standards, and project monitoring methods
- Learn about, assess, and, as appropriate, master new technology to enhance individual and organizational effectiveness and efficiency
- Communicate with technical and non-technical audiences, convincingly and with passion, via listening, speaking, writing, mathematics, and visuals
- Collaborate on intra-disciplinary, cross-disciplinary and multi-disciplinary traditional and virtual teams
- Manage tasks, projects, and programs so as to provide expected deliverables while satisfying budget, schedule, and other constraints
- Lead by formulating and articulating environmental, infrastructure, and other visions and build consensus by practicing inclusiveness, empathy, compassion, persuasiveness, patience, and critical thinking

Attitudes

- Creativity and entrepreneurship
- Commitment to ethics, personal and organizational goals, and worthy teams and organizations
- Curiosity
- Honesty and integrity
- Optimism in the face of challenges and setbacks, recognizing the power inherent in vision, commitment, planning, persistence, flexibility, and teamwork
- Respect for and tolerance of the rights, values, views, property, possessions, and sensitivities of others
- Thoroughness and self-discipline in keeping with the public health, safety, and welfare implications of most engineering projects and the high-degree of interdependence within project teams and between such teams and their stakeholders

Given the model (described above) that has been used to translate the 15 existing BOK outcomes into BOK-compliant ABET criteria, how might the newly defined Profile of the 2025 Civil Engineer be similarly translated into accreditation criteria? To answer this question, it is necessary to first identify any major differences between the Profile and the BOK, and then to determine if these differences are sufficiently significant to prompt criteria changes. A careful comparison of the BOK outcomes and the Profile of the 2025 Civil Engineer indicates that there is a high degree of consistency between these two sets of attributes; nonetheless, some significant differences are also evident:

- Although both the Profile and the BOK suggest that civil engineers’ core knowledge should include greater breadth in the basic sciences, the BOK specifies a wide range of non-traditional science topics—biology, ecology, geology, geomorphology, and geo-spatial representation—while the Profile specifies only biology.
- Risk/uncertainty is given greater emphasis in the Profile.
- Sustainability is given greater emphasis in the Profile
- The Profile calls for specific knowledge of the social sciences—economics, history, and sociology—without any reference to their application in engineering. The BOK focuses on a different subset of the humanities and social sciences—culture, human and organizational behavior, and aesthetics, all in the context of understanding the impact of engineering solutions.
- The Profile specifies no requirement for designing and conducting experiments or analyzing experimental data.
- The Profile specifies no explicit requirement for lifelong learning.
- The Profile does not emphasize contemporary issues.
- The Profile does not identify an explicit requirement for higher-level specialized civil engineering knowledge.
- Attitudes, though addressed within one outcome of the BOK, are given considerably greater prominence in the Profile.

Based on this comparison, the current BOK-compliant Basic-Level Civil Engineering Program Criteria would logically require the following changes, in order to promote curricular reform in support of the Profile of the 2025 Civil Engineer:

- Replace the current requirement for “one additional area of science” with an explicit requirement for biology.
- Add provisions requiring knowledge of risk/uncertainty and sustainability, specified at an appropriate level of achievement.
- Delete the current requirement associated with the conduct of civil engineering experiments and the analysis of experimental data.

The comparison above would also appear to dictate the deletion of criteria provisions regarding lifelong learning and contemporary issues, as well as changes to criteria provisions regarding the social sciences. However, all of these provisions are contained in the ABET Basic-Level General Criteria and thus cannot be readily changed by ASCE. It should also be noted that deletion of the requirement for experimentation from the Civil Engineering Program Criteria would not result in the removal of experimentation from curricula, because Criterion 3(b) of the General Criteria still requires “an ability to design and conduct experiments,” albeit not necessarily in a civil engineering context.

The comparison above would also appear to dictate the addition of a criterion addressing attitudes. The author has chosen not to suggest such a change, because of his personal view that any accreditation criterion addressing attitudes is likely to be problematic, no matter how it might be stated. A criterion requiring graduates of civil engineering programs to *demonstrate specific attitudes* would be viewed by many institutions as unrealistic. Although a few specialized institutions (e.g., military academies) explicitly and purposefully attempt to develop

certain attitudes in their graduates, the developmental process required to do so demands an enormous commitment of time, energy, and resources. Few other institutions could reasonably be expected to make the same level of commitment. Moreover, a criterion requiring that graduates demonstrate specific attitudes would be neither assessable nor enforceable. (How does one measure curiosity? Would the Engineering Accreditation Commission support an unfavorable accreditation action for a program because the program's graduates lacked optimism?) On the other hand, a criterion requiring graduates to simply *know about attitudes* without actually demonstrating them is likely to be viewed as trivial. (Such has certainly been the case in recent deliberations of the ASCE Body of Knowledge Committee.) The importance of attitudes to civil engineering professional practice notwithstanding, the author suggests that their inclusion in accreditation criteria would be largely symbolic.

Conclusion

This paper has presented an analysis of the recently developed vision for civil engineering in 2025, resulting in the identification of likely changes to current ABET accreditation criteria that would be required to pursue the vision. The analysis is based on a model that emerged during the development of BOK-compliant accreditation criteria, in conjunction with the implementation of ASCE Policy 465.

The ABET criteria changes derived above are, of course, highly speculative. They are based on a report that, as of this writing, still exists only in draft form.¹ They do not reflect an intent to change the current ABET accreditation criteria; rather, they are presented here as a means of illustrating a *process*—the translation of a comprehensive, ambitious, future-oriented vision to a set of specific, attainable accreditation standards that nonetheless provide a stimulus for curricular reform oriented toward the attainment of that vision.

References

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Appendix 1
Proposed Changes to the Criteria for Accrediting Engineering Programs
Effective for Evaluations during the 2008-2009 Accreditation Cycle

PROGRAM CRITERIA FOR
CIVIL
AND SIMILARLY NAMED ENGINEERING PROGRAMS

1. Curriculum

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

2. Faculty

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

CRITERIA FOR ADVANCED LEVEL PROGRAMS

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

Appendix 2
Comparison of BOK Requirements and ABET Criteria

| Civil Engineering Body of Knowledge | | ABET Engineering Criteria | |
|---|---|---|--|
| Outcome Statement | Specific Provisions or Requirements | General Criteria | BOK-Compliant CE Program Criteria |
| 1. An ability to apply knowledge of mathematics, science, and engineering | Breadth of coverage in mathematics, science and civil engineering topics | 3(a) An ability to apply knowledge of mathematics, science, and engineering | Apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of science, consistent with the program educational objectives; apply knowledge of four technical areas appropriate to civil engineering. |
| | 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 | | |
| | Understand fundamentals of several recognized major civil engineering areas | | |
| 2. An ability to design and conduct experiments, as well as to analyze and interpret data | Design and conduct field and laboratory studies, gather data, create numerical and other models, and then analyze and interpret the results—in at least one of the evolving or current major civil engineering areas | 3(b) An ability to design and conduct experiments, as well as to analyze and interpret data | Conduct civil engineering experiments and analyze and interpret the resulting data |
| 3. An ability to design a system, component, or process to meet desired needs | Problem definition, scope, analysis, risk assessment, environmental impact statements, creativity, synthesizing alternatives, iteration, regulations, codes, safety, security, constructability, sustainability, and multiple objectives and various perspectives | 3(c) An ability to design a system, component, or process to meet desired needs | Design a system, component, or process in more than one civil engineering context |
| | Bidding versus qualifications-based selection; estimating engineering costs; interaction between planning, design and construction; design review; owner-engineer relationships; and life-cycle assessment | | |
| | Understanding large-scale systems, including the need to integrate information, organizations, people, processes, and technology | | |
| | Design experiences integrated throughout the professional component of the curriculum | | |
| 4. An ability to function on multi-disciplinary teams | Lead a design team or other team | 3(d) An ability to function on multi-disciplinary teams | |
| | Participate as a member of a team | | |
| | Team formation and evolution, personality profiles, team dynamics, collaboration among diverse disciplines, problem solving, time management, and being able to foster and integrate diversity of perspectives, knowledge, and experiences | | |

| Civil Engineering Body of Knowledge | | ABET Engineering Criteria | |
|---|---|--|--|
| Outcome Statement | Specific Provisions or Requirements | General Criteria | BOK-Compliant CE Program Criteria |
| 5. An ability to identify, formulate and solve engineering problems | Assessing situations in order to identify engineering problems, formulate alternatives, and recommend feasible solutions | 3(e) An ability to identify, formulate and solve engineering problems | |
| 6. An understanding of professional and ethical responsibility | Hold paramount public safety, health, and welfare | 3(f) An understanding of professional and ethical responsibility | Explain the importance of professional licensure |
| | Thoughtful and careful weighing of alternatives when values conflict | | |
| | understanding of and 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 | Listening, observing, reading, speaking, and writing | 3(g) An ability to communicate effectively | |
| | Fundamentals of interacting effectively with technical and non-technical or lay individuals and audiences in a variety of settings | | |
| | Versatility 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 | Appreciate, from historical and contemporary perspectives, culture, human and organizational behavior, aesthetics and ecology and their impacts on society | 3(h) the broad education necessary to understand the impact of engineering solutions in a global, and societal context | |
| | History and heritage of the civil engineering profession | | |
| 9. A recognition of the need for, and an ability to engage in, life-long learning | Life-long learning mechanisms—additional formal education, continuing education, professional practice experience, active involvement in professional societies, community service, coaching, mentoring, and other learning and growth activities | 3(i) A recognition of the need for, and an ability to engage in, life-long learning | |
| | Personal and professional development—developing understanding of and competence in goal setting, personal time management, communication, delegation, personality types, networking, leadership, the socio-political process, effecting change, career management, increasing discipline knowledge, understanding business fundamentals, contributing to the profession, self-employment, additional graduate studies, and achieving licensure and specialty certification | | |

| Civil Engineering Body of Knowledge | | ABET Engineering Criteria | |
|---|--|--|--------------------------------------|
| Outcome Statement | Specific Provisions or Requirements | General Criteria | BOK-Compliant CE Program Criteria |
| 10. A knowledge of contemporary issues | 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 | 3(j) A knowledge of contemporary issues | |
| 11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | <p>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</p> <p>Ability to select the appropriate tools for solving different types and levels of problems</p> | 3(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | |
| 12. An ability to apply knowledge in a specialized area related to civil engineering | Specialized technical coursework (or equivalent) in such areas as environmental engineering, structural engineering, construction engineering and management, public works management, transportation engineering and water resources management | <p>One academic year of study beyond the basic level</p> <p>Ability to apply advanced level knowledge in a specialized area of engineering</p> | |
| 13. An understanding of the elements of project management, construction, and asset management | <p>Project management—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.</p> <p>Construction—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.</p> <p>Asset management—effective and efficient long-term ownership of capital facilities via systematic acquisition, operation, maintenance, preservation, replacement, and disposition.</p> | | Explain basic concepts in management |

| Civil Engineering Body of Knowledge | | ABET Engineering Criteria | |
|---|--|---------------------------|--|
| Outcome Statement | Specific Provisions or Requirements | General Criteria | BOK-Compliant CE Program Criteria |
| 14. An understanding of business and public policy and administration fundamentals | Business—legal forms of ownership, organizational structure and design, income statements, balance sheets, decision (engineering) economics, finance, marketing and sales, billable time, overhead, and profit | | Explain basic concepts in business and public policy |
| | Public policy and administration—political process, public policy, laws and regulations, funding mechanisms, public education and involvement, government-business interaction, and public service responsibility of professionals | | |
| 15. An understanding of the role of the leader and leadership principles and attitudes. | Leading—broad motivation, direction, and communication knowledge and skills | | Explain basic concepts in leadership |
| | Attitudes—commitment, confidence, curiosity, entrepreneurship, high expectations, honesty, integrity, judgment, persistence, positiveness, and sensitivity | | |
| | Behaviors—earning trust, trusting others, formulating and articulating vision, communication, rational thinking, openness, consistency, commitment to organizational values, and discretion with sensitive information | | |