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New Civil Engineering Program Criteria: The Rest of the Story

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New Civil Engineering Program Criteria: The Rest of the Story

Abstract

The American Society of Civil Engineers (ASCE) organized the Civil Engineering Program Criteria Task Committee in October 2012 whose charge is to determine if the current ABET Civil Engineering Program Criteria (CEPC) should be changed to reflect one or more of the 24 outcomes of the second edition of the *Civil Engineering Body of Knowledge* published in 2008. After two years of work, a proposed CEPC has been approved by the relevant ASCE committees and forwarded to ABET for approval and incorporation into accreditation criteria. A paper chronicling the committee's efforts through a review of the literature, the committee's methodology and process, and the key issues that emerged was presented at the 2014 ASEE Annual Conference in Indianapolis. This paper updates that effort by presenting the resulting proposed criteria, the changes generated by constituency feedback, progress on the Commentary, the existing gap between the proposed accreditation criteria and the current body of knowledge, and the future work of the committee.

Introduction

The American Society of Civil Engineers (ASCE) developed the first edition of the *Civil Engineering Body of Knowledge* (BOK1) in 2004 defining the knowledge, skills and attitudes required of future civil engineers. Several of the outcomes of BOK1 were incorporated into the ABET Civil Engineering Program Criteria (CEPC) effective with the 2008-2009 accreditation cycle. The CEPC was supplemented with an associated Commentary. The Body of Knowledge is a living document that will continue to be updated and revised. The second edition of the *Civil Engineering Body of Knowledge* (BOK2) was published in 2008 and increased the number of expected outcomes from 15 to 24.

In 2012, ASCE created the Civil Engineering Program Criteria Task Committee (CEPCTC) whose charge is to determine if the current CEPC should be changed to reflect an additional one or more of the 24 outcomes of BOK2. The committee consists of academic faculty and industry practitioners who have been active in both ABET evaluation and ASCE educational activities. The authors shared a review of the literature, the committee's methodology, and the interim results of the committee's work in a paper presented at the 2014 ASEE Annual Conference in Indianapolis.[1]

This paper begins where the last paper left off and will report:

The rest of the story. The CEPCTC shared its draft criteria with all constituencies, gathered their input, and presented the results to the assembled CE department heads at their annual conference from 6-8 April 2014 in Oklahoma City. The committee analyzed the input and revised the criteria in response. The revised criteria were approved by the relevant ASCE

committees and submitted to ABET in June 2014. The criteria are going through the two-year ABET approval process and are expected to go into effect in September 2016. This paper will share the changes that were made to the proposed criteria and the rationale behind them. It will provide additional details on the approval process.

The Commentary. The CEPCTC has developed, published and disseminated a draft Commentary that will accompany the new program criteria. The Commentary helps faculty, program evaluators, and other constituents interpret the program criteria. While a separate paper[2] is being submitted on the details of the Commentary content, this paper will summarize how this Commentary relates to the rest of the committee's work.

The gap. The BOK2 is an aspirational and visionary document which may not account for all of the real-world constraints faced by engineering programs in terms of mandated maximum units in an undergraduate program and additional requirements imposed by a state government or a university. Conversely, the ABET program criteria define the minimum requirements for a program to receive accreditation. There will naturally be a gap between those two standards and this paper will help define the size and extent of that gap.

Future work of the committee. Once the Commentary is revised and approved, the CEPCTC will be dissolved and the implementation of the program criteria will be the responsibility of the ASCE Committee on Accreditation. Such work will not be complete by the submission date of this paper, so the remaining tasks will be described. The committee's work is part of a longer range plan to continuously update both the BOK and CEPC in a systematic manner.

Composition of the Committee

The CEPCTC is comprised of a mix of distinguished civil engineering practitioners and experienced academics with considerable experience in the accreditation process. The committee was rounded out with ASCE staff members who are knowledgeable about education and the accreditation change and approval process.

Task Committee Members:

- **Rich Anderson (Chair)**: Somat Engineering, Inc.; Past-President of ABET; past Chair of the BOK2 Committee.
- **George Blandford:** CE Department Chair at University of Kentucky, past Chair of the Department Head Coordinating Council (DHCC), and active in ASCE educational committees.
- **Phil Borrowman:** Retired from Hanson Professional Services Inc.; Past-President of ABET and retired consulting engineer.
- **Donald Carpenter:** Professor of Civil Engineering and Past Director of Assessment, Lawrence Technological University with extensive experience in preparing ABET Self Studies.
- **Allen Estes:** Architectural Engineering Department Chair at California Polytechnic State University; experienced ABET PEV and active in ASCE Committee on Education and DHCC.

• **Jeff Evans:** Immediate Past CE Chair at Bucknell University; active in ASCE "Raise the Bar" committees.
• **Ken Fridley:** CE Chair at the University of Alabama; active in ASCE educational committees, past Vice-Chair of the BOK2 Committee, and prepared five ABET self-studies.
• **Tom Lenox:** Member of ABET Board of Directors; ASCE Executive VP Emeritus -- retired from ASCE staff after supporting various educational/professional initiatives.
• **Carolyn Merry:** (deceased) CE Past-Chair at The Ohio State University; active in ASCE educational activities and lead on several ABET self-studies.
• **Paul Mlakar:** U.S. Army Corps of Engineers, experienced ABET PEV, and member of ABET/EAC.
• **Ellen Stevens:** Consulting engineer, ABET/EAC PEV, and active in ASCE educational committees.
• **Jim O'Brien:** Ex-officio, ASCE staff, Managing Director, Professional & Educational Activities.

Photo 1: The CEPCTC conducts their second face-to-face meeting as ASCE Headquarters in Reston, Virginia in May 2014. Pictured from left to right are Jim O'Brien, Phil Borrowman, Ellen Stevens, George Blandford, Al Estes, Don Carpenter, Carolyn Merry, Rich Anderson, Ken Fridley, Tom Lenox, and Jeff Evans. Tragically, Carolyn Merry was killed in an automobile accident shortly after this meeting. We will all miss her.

• **Corresponding members** of the CECPTC include Angela Bielefeldt, University of Colorado – Boulder; Joseph Hanus, United States Military Academy; Kenneth Lamb, California State Polytechnic University – Pomona; Daniel Lynch, Dartmouth College; Dennis Truax, Mississippi State University; David Vaccari, Stevens Institute of Technology; and Ronald Welch, The Citadel.

Proposed Criteria

After almost two years of bi-weekly conference calls, careful study, and two face-to-face meetings, the CEPCTC voted to recommend the following Proposed Civil Engineering Program Criteria:

PROGRAM CRITERIA FOR CIVIL AND SIMILARLY
NAMED ENGINEERING PROGRAMS
Lead Society: American Society of Civil Engineers

These program criteria apply to engineering programs that include "civil" or similar modifiers in their titles.

1. Curriculum
The curriculum ~~program~~ must prepare graduates to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science~~, consistent with the program educational objectives~~; apply probability and statistics to address uncertainty; ~~apply knowledge of~~ analyze and solve problems in at least four technical areas appropriate to civil engineering; conduct ~~civil engineering~~ experiments in at least two technical areas of civil engineering and analyze and interpret the resulting data; design a system, component, or process in at least two ~~more than one~~ civil engineering contexts; include principles of sustainability in design; explain basic concepts in project management, business, public policy, and leadership; analyze issues in professional ethics; and 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.

Where we last left off

The initial paper[1] documenting the committee's work started with a review of the literature which included ASCE Policy 465[3], both editions of the BOK[4,5], the current CEPC[6], supporting visionary documents[7,8], a description of Bloom's taxonomy[9], and prior publications on these same issues[10,11,12,13]. The methodology of analyzing each BOK2 outcome individually, synthesizing results, prioritizing potential CEPC changes, soliciting feedback, drafting a new CEPC and implementing a communication plan were described in detail. Incorporation of the various BOK2

topics into the CEPC was evaluated in terms of feasibility and importance. The potential changes were prioritized through conference calls and finalized at a face-to-face meeting in Chicago in October 2013. The meeting resulted in the proposed criteria shown in Appendix B. The initial paper described those changes regarding natural science, probability and statistics, risk and reliability, technical breadth, sustainability, ethics, experiments, and project management in detail. Appendix C offers an abbreviated rational for this proposal.

The CEPCTC implemented a communication plan that disseminated the proposed criteria and sought input from the various constituents. The sub-committee identified 25 stakeholder groups ranging from CE Department Heads and ABET Program Evaluators to the ASCE Regional Governors and the ASCE Committee on Education.

Input

Once the draft proposed CEPC was prepared and disseminated in December 2013, the CEPCTC requested email feedback from all constituents. Comments were received from 58 individuals at ceprogramcriteria@asce.com. The complete collection and summary of those comments and the department head survey are provided at the committee website at: http://cms.asce.org/ceprogramcriteria/. Many of the individuals made comments that pertained to multiple areas of the proposed criteria. In total, 151 separate comments were logged. The number of comments in each area were

- apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic natural science consistent with the program educational objectives (20 comments)
- apply principles of probability and statistics to solve problems containing uncertainty (16 comments)
- conduct civil engineering experiments in more than one technical area of civil engineering and analyze and interpret the resulting (13 comments)
- analyze and solve well-defined problems in at least apply knowledge of four technical areas appropriate to civil engineering (15 comments)
- design a system, component, or process in more than one civil engineering context: (0 comments)
- apply principles of sustainability in design (16 comments)
- apply principles of project management (12 comments)
- explain basic concepts in management, business, public policy, and leadership (4 comments)
- analyze issues in professional ethics(12 comments)
- explain the importance of professional licensure (2 comments)
- General Comment(s) not tied to any specific element of the CEPC (41 comments)

The raw number of comments indicated an area of interest but were not necessarily helpful in gaining a consensus. Many of the comments contradicted each other. For example, for the 20 comments received for "applying math and science…", seven were positive toward the criterion, ten were negative and three were neutral in that they made suggestions or asked for clarification. Even such classification was problematic. Some comments were supportive of the spirit of the criterion but objected to a specific element. Those that were clearly opposed or clearly supportive of the criterion had very different rationale for that position. Some comments indicated a misunderstanding of the criterion while other addressed whether or not the requirement should have been in the BOK2. Many of the comments were very helpful to identify areas of confusion or suggested alternative wording.

There were also very differing viewpoints on "applying principles of probability and statistics to solve problems containing uncertainty." Many supported the return of probability and statistics to the program criteria. Others felt that risk and uncertainty were graduate level topics and did not belong in the undergraduate curriculum.

The comments on "conduct civil engineering experiments in more than one technical area of civil engineering and analyze and interpret the results" were also inconclusive. One commenter disapproved of the requirement because civil engineers are not required to conduct experiments and thus did not need to do so in two different areas. Another disapproved because two areas were insufficient; civil engineers should conduct experiments in at least three areas. One commenter stated with certainty that the requirement was innocuous because most programs already do this. Another stated that this was an onerous requirement that most programs would have difficulty meeting.

The most passionate comments came in the sustainability provision. There were many comments lauding the inclusion of this important topic that is of such great interest to ASCE. Others accused the program criteria of being overly prescriptive, lamented that sustainability lacks definition, and stated that the topic is overemphasized and coverage in the general criteria is sufficient.

It was difficult to establish trends from the comments. They were most useful in identifying perspectives the committee had not considered, listing contradictions or mistakes in the criterion, or suggesting a better or clearer way to explain the criterion. The committee felt relief that very few arguments or viewpoints had not already been considered by the committee in its earlier deliberations.

CE Department Heads

The CEPCTC presented the draft criteria to the assembly of approximately 80 CE department heads at their annual conference in Oklahoma in April 6-8, 2014. The department heads provided

valuable feedback during the presentation and through a formal survey. The survey (shown in Appendix D) asked the department heads to rate the line-by-line proposed changes to the existing CEPC in terms of acceptability and feasibility. The acceptability rating addressed whether the criteria makes sense from a pedagogical standpoint and enhances a program. The feasibility rating attempts to distinguish whether the change is logistically possible given the constraints already on a program. For example, a portion of the criterion might be a wonderful addition to a program (high acceptability) but would be so cumbersome to implement that other critical portions of the curriculum would have to be cut (low feasibility). The available ratings for acceptability and feasibility are shown in Table 1.

"ACCEPTABILITY" Ratings	
Rating	Definition
1	Change is acceptable.
2	Change is acceptable with reservation.
3	Change is unacceptable.
0	No opinion regarding acceptability.
"FEASIBILITY" Ratings	
Rating	Definition
A	No curricula change required.
B	Minor curricula change required.
C	Major curricula change required.
O	No opinion regarding feasibility.

Table 1: The acceptability and feasibility rubric for the CEPC survey completed by the Civil Engineering Department Heads.

Each participant was invited to make free-form comments on any of the criteria at the end of the survey. The presentation was interspersed with a lively question and answer session. There was a fair amount of skepticism from the audience in the Q&A session, punctuated with some open hostility to the prospect of more demanding accreditation program criteria. However, the post-session survey results from 59 respondents reflected a more balanced view of this effort.

Figure 1 shows the survey results in terms of percentage of responses for acceptability and feasibility for the 11 areas of the criteria queried (see Appendix D for exact wording of question). The results show that the four areas causing the most concern were the changes associated with Statistics/Uncertainty, Sustainability, Project Management, and Professional Ethics. Only 15% of the participants gave the application of sustainability in design a feasibility rating of "A" ("No curricula change required"), and only one-third gave sustainability an acceptability rating of "1" ("Change is acceptable"). A similar result occurred with applying principles of probability and statistics to solve problems containing uncertainty. Only 30% gave a feasibility rating of "A," and slightly over half gave the top acceptability rating. Not surprisingly, those elements of the CEPC that were unchanged from the existing program criteria were the most acceptable and feasible.

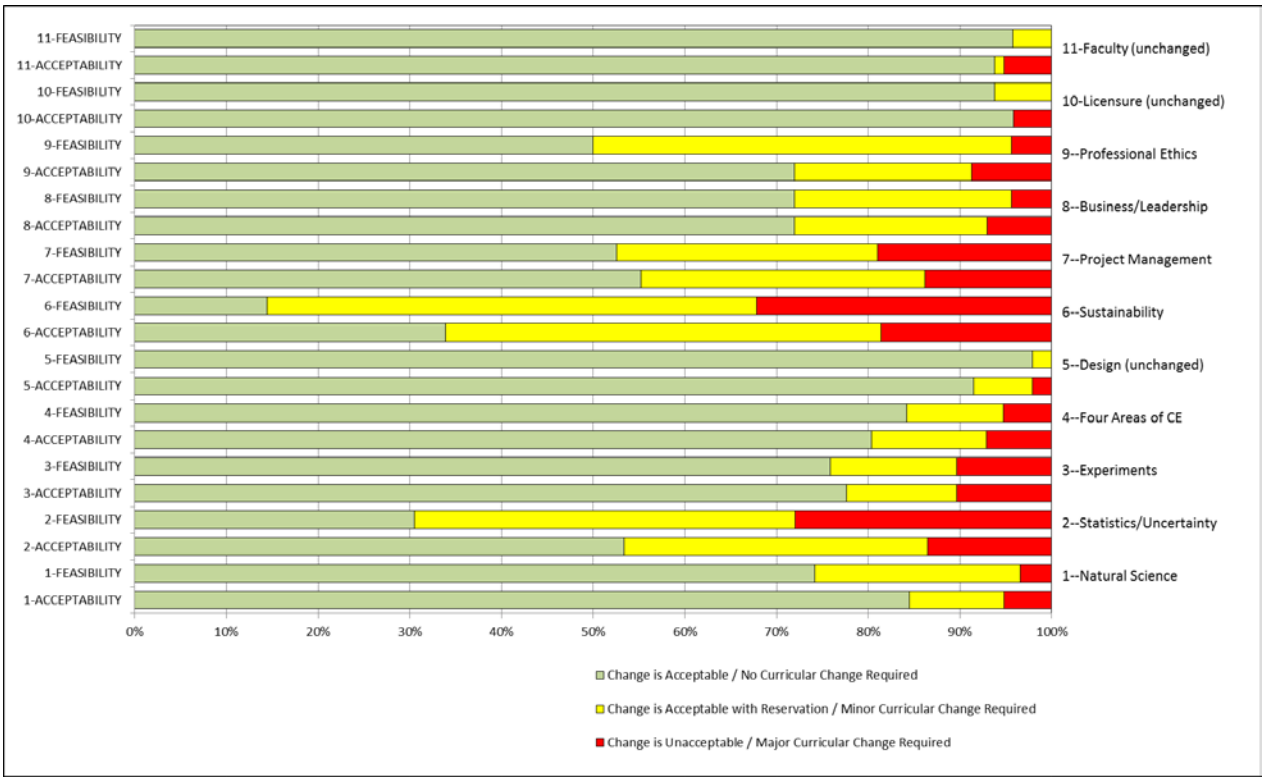

Figure 1: Results of the CEPC CE Department Heads Survey Looking at Percentage of Responses for Feasibility and Acceptability

Figure 2 shows the same results looking at the weighted average of the responses for each element of the CEPC. It becomes even clearer that the four biggest areas of concern were Statistics/Uncertainty, Sustainability, Project Management, and Professional Ethics with feasibility being more contentious than acceptability.

The free-form written comments were similar to the written comments received from constituents at large. They were often contradictory and established no significant trend. They were helpful for additional perspectives to consider.

Changes Made Based on Input Received

The CEPCTC assembled these comments, held some preliminary conference calls, and convened a face-to-face meeting in Reston on May 16-17, 2014. The committee deliberated for two days, analyzed the comments and feedback received, debated potential changes in detail and left with the revised CE program criteria shown at the beginning of this paper. The following changes were made as a result of this meeting and the preceding stakeholder input.

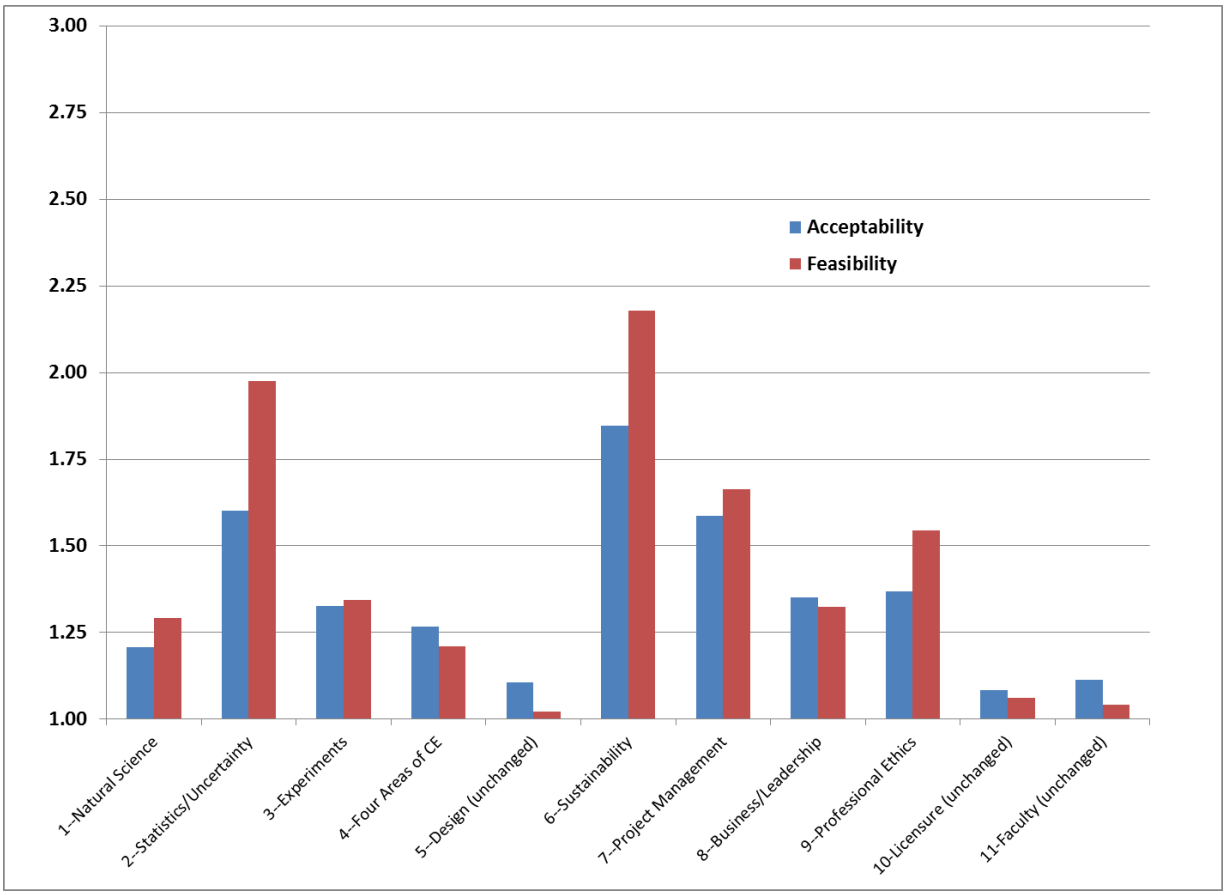

Figure 2: Results of the CEPC CE Department Heads Survey Looking at the Weighted Average of Responses for Feasibility and Acceptability

- **The term natural science was changed back to basic science.** The BOK2 states that undergraduates should be able to solve problems in chemistry, physics and one additional area of the natural sciences. The BOK2 infers that natural science includes physics, chemistry and "natural science disciplines such as biology, ecology, geology/geomorphology, et cetera." The ABET definition of basic sciences from general criterion 5a is "biological, chemical and physical sciences". The committee debated this topic at length and in the first draft version of the CEPC used the term natural science because it was believed to be more precise. Ultimately, the CEPCTC could not think of a single example where an area of science would count for one definition but not the other. To avoid confusion and to maintain consistency with the current ABET general criteria definition, the proposed CEPC uses the term basic sciences.
- **Lowered the threshold for risk and uncertainty.** The first proposed CEPC (as of December 2013 – see Appendices B & C) stated, "apply principles of probability and statistics to solve problems containing uncertainty." The CEPCTC changed the proposed CEPC to read, "apply principles of probability and statistics to address uncertainty." The change is intended to reduce the emphasis on solving problems and focus more on

addressing uncertainty in a qualitative manner, which further reduces the requirement to have a separate course. Furthermore, taking a course in probability and statistics without addressing any of the uncertainty associated with civil engineering would not meet the intent of the criteria. After much discussion, the CEPCTC concluded that risk and uncertainty should go together. The BOK2 states that students at the undergraduate level should be able to "apply principles of probability and statistics to solve problems containing uncertainty." Adding risk at this time would be exceeding the requirements stated in the BOK2. The CEPCTC was not willing to do that. Instead, this input will be provided to the committee working on the BOK3 with the recommendation that risk be included in this outcome.

- **Removed "well-defined" from types of problems to be solved.** The first proposed CEPC (as of December 2013) stated, "analyze and solve well-defined problems in at least four technical areas appropriate to civil engineering." The CEPCTC changed the proposed CEPC to eliminate the words "well-defined". The first proposed CEPC required that students analyze and solve well-defined problems in an attempt to illustrate that this change in cognitive level did not have a real, practical effect on CE curricula. The term "well-defined" caused confusion and produced so many comments from reviewers that it was eliminated in the later version. Comments included that engineers solve open-ended problems, "well-defined" did not soften the increase in cognitive level as intended, and the term "well-defined" had a more derogatory meaning in other educational literature. It is important to note that subsequent to BOK2 being published, the International Engineering Alliance (IEA) developed outcome definitions for engineers, engineering technologists, and engineering technicians. Future authors of BOK3 and changes to the CEPC will need to consider those definitions to assure graduates from civil engineering programs accredited by ABET can remain internationally recognized as engineers.
- **Lowered threshold on sustainability.** The BOK2 level of attainment for sustainability is Bloom's Level 3 – application. The sustainability outcome was rated as being very important by the CEPCTC. ASCE is a recognized leader in this advancing area. Criterion 3(c) of the general criteria lists "sustainability" as one of eight constraints that should be considered in a design. However, these eight constraints are preceded by the words "such as" – commonly interpreted by ABET evaluators as meaning "the following are examples of constraints to be included, but none of these are compulsory." As such, the existing provision of the general criteria lacks the strength to ensure that <u>all</u> civil engineering students will consider the principles of sustainability. The first draft version of the proposed CEPC required students to "apply principles of sustainability in design." Upon further reflection and comments from constituents, this standard may be too difficult to attain without creating a separate course in sustainability. This was not the committee's intent. The proposed CEPC was changed to "include principles of sustainability in design" which allows a more qualitative approach and lowers the

cognitive level required. The CEPC still ensures that sustainability is not neglected by simply being part of a large list of choices.

- **Lowered the threshold on project management.** The first proposed CEPC required students to "apply principles of project management" which would have met the level specified by the BOK2. The CEPCTC considered that examples of project management opportunities in the undergraduate program include design teams for course assignments, capstone design projects, and undergraduate research. These opportunities exist in all of the sub-disciplines of civil engineering. The comments generated from constituents and the survey of the department heads demonstrated that many thought a course in project management would be required and construction management would be mandated as one of the four technical areas of civil engineering. This was not the intent of the CEPCTC, so the cognitive level was lowered to: "…explain basic concepts in project management, business, public policy,…"
- **Focus on curriculum.** The first draft version of the proposed CEPC read "The program must prepare graduates to…". The CEPCTC changed the proposed CEPC to read "The curriculum must prepare graduates to…" When documenting student outcomes in accordance with Criterion 4 of the baccalaureate level general criteria, programs are required to assess and evaluate the extent to which students have attained the Criterion 3 a-k student outcomes and any other outcomes identified by the program. The program criteria are strictly limited to the areas of curricular topics and faculty qualifications. For the curricular topics listed in the program criteria, the program must demonstrate sufficient coverage in the students' curriculum, rather than assessing and evaluating the extent to which the student outcomes are being attained. To make this point even clearer, the CEPCTC changed the proposed CEPC to read, "The curriculum must prepare graduates...." rather than "The program must prepare graduates…."
- **Parallel construction.** There are several instances in the CEPC that require coverage in multiple areas of civil engineering. These include conducting civil engineering experiments in more than one technical area, solve problems in at least four technical areas, and design a system, component, or process in more than one civil engineering contexts. The first proposed CEPC used inconsistent language -- sometimes stating "at least" and sometimes using "more than." To create parallel construction throughout the CEPC, the term "at least" is used to describe the requirement in the revised version.

It is important to note a change that was not made despite being one of the four major concerns cited by the department heads. BOK2 recommends that undergraduates be able to analyze a situation involving multiple conflicting professional and ethical interests to determine an appropriate course of action. This implies a higher level of attainment than just "understanding." While the task committee was comfortable relying on the general criteria for professional responsibility, it believed that ethical responsibility demanded a higher standard for future professional civil engineers. The CEPCTC carefully examined the issue after receiving constituent comments, and still believed that the analysis level was appropriate for ethics. The major concern

from constituent comments that opposed this higher standard was that it was either unattainable at the undergraduate level or would at least require the addition of a separate course on the topic. The CEPCTC noted that these points will need to be clarified and addressed in the Commentary to suggest how a program could attain this level and explicitly state that a separate course in ethics is not required.

In the revised CEPC, the committee addressed all four of the top issues cited by the department head survey: sustainability, risk and uncertainty, project management, and ethics. In three of the cases, the cognitive level required was lowered in order to make compliance less cumbersome and more doable without adding new courses. The committee put considerable thought and effort into the discussion of each area and considered all of the comments.

Approval Process

The revised CE program criteria were approved without change by the ASCE Committee on Accreditation on May 22, 2014. It was supported by the Department Heads Coordinating Council and approved without change by the ASCE Committee on Education on May 26, 2014. The committee's work was presented at a special session of the CE Division at the American Society of Engineering Education Annual Conference in Indianapolis in June 2014. The CEPC was forwarded to ABET on June 3, 2014, approved upon first reading by the ABET-EAC on July 9, 2014, and approved upon first reading by the ABET Board of Directors on November 1, 2014. As of this writing, the proposed changes to the CEPC are in ABET's formal public review period scheduled from November 13, 2014 to June 15, 2015. The second readings are scheduled by the ABET-EAC and the ABET Board for mid-July 2015 and October 17, 2015, respectively. If passed upon these second readings, the proposed CEPC will become effective for the 2016-2017 accreditation cycle.

The Commentary

The CEPCTC has written and approved a Commentary[14] to accompany the CEPC. The Commentary helps faculty, program evaluators, and other constituents interpret the program criteria. ABET does not support commentaries. Some ABET leaders consider them to be shadow criteria. As such, commentaries are prepared, approved, and distributed by supporting professional societies but not by ABET. Most ABET engineering member societies do not use them. Nevertheless, ASCE has found its Commentary to be very helpful in (1) providing the rationale behind the criteria and (2) communicating expectations to avoid misunderstandings and provide consistency among visits.

The CEPCTC started working on the Commentary in July 2014 after the proposed CEPC was forwarded to ABET. Through a series of conference calls, the various portions of the Commentary

were debated, revised and approved by the committee. The proposed Commentary was forwarded to constituents for review and comment on December 17, 2014 in a similar manner as the proposed CEPC. All comments are due back by February 20, 2015. The CEPCTC will review the comments and decide whether a third face-to-face meeting of the committee is required. After reviewing the comments and revising the Commentary, if appropriate, it will be forwarded to the ASCE Committee on Accreditation and ASCE Committee on Education for approval. Upon approval, it will be shared with all civil engineering accreditation stakeholders for their information and use.

The Commentary is broken into four parts A through D. Part A describes the purpose of the Commentary. Parts B and C provide a description of the BOK2 and the applicable ABET criteria, respectively. The most essential part is Part D (Understanding the CE Program Criteria) which divides the CEPC into 10 sections and examines each one individually. The ten sections are: 1. Math and Science; 2. Probability and Statistics; 3. Breadth in Civil Engineering; 4. Civil Engineering Experiments; 5. Civil Engineering Design; 6. Sustainability in Design; 7. Project Management, Business, Public Policy, and Leadership; 8. Professional Ethics; 9. Professional Licensure; and 10. Faculty Requirements. Each section is partitioned into sub-sections on Understanding the Criterion and Background/Rationale. The Commentary contains two Appendices: one on Bloom's Taxonomy and one providing the Outcomes Rubric from BOK2.

The CEPCTC's work is almost done. There will probably be some Commentary revision and ASCE approval once the comments are received from constituents. There will be coordination and possible revision associated with the ABET second readings of the CEPC. Continued communication with constituents will be needed as the new CEPC is adopted and implemented. The CEPCTC will be dissolved and the continued responsibility for maintaining the CEPC and the Commentary will reside with the ASCE Committee on Accreditation.

The Gap

With the CEPC completed and moving through the approval process, it is reasonable to assess the gap between the requirements of the BOK2 at the undergraduate level and the proposed CEPC. It must first be recognized that there will naturally be a gap between those two standards. The BOK2 is an aspirational and visionary document that may not account for all of the real-world constraints faced by engineering programs such as mandated maximum units in an undergraduate program and additional requirements imposed by a state government or a university. Conversely, the ABET program criteria define the minimum requirements for a program to receive accreditation.

The body of knowledge needed by the civil engineer of the future is constantly changing. While a few baccalaureate programs have revised their curriculum to include most or all of the BOK2 outcomes, mandating this change for all civil engineering programs over the next decade would be "too much, too fast." The proposed changes to the CEPC reflect a perceived priority of value

gained by the civil engineering profession, a continuation of spirit and intent of "raising the bar," and a recognition that further changes to the CEPC will still be necessary in the future – especially as the next versions of the body of knowledge are developed.

In order to assess whether the gap is reasonable, it must first be defined. Appendix A compares the baccalaureate degree requirements for civil engineering as specified in BOK2 with the ABET accreditation criteria. This ABET accreditation criteria is a combination of the ABET general criteria specified in Criteria 3 (Student Outcomes) and 5 (Curriculum) and the proposed CEPC. As shown in the last column of the table, there is no gap between the BOK2 requirements and accreditation criteria for BOK2 outcomes 1 (Mathematics), 2 (Natural Sciences), 4 (Social Sciences), 7 (Experiments), 8 (Problem Recognition and Solving), 9 (Design), 14 (Breadth in Civil Engineering Areas), 15 (Technical Specialization), 16 (Communication), 17 (Public Policy), 21 (Teamwork), and 23 (Lifelong Learning). The wording of the two standards is almost identical and those BOK2 outcomes should be fully met. There is a partial gap with respect to outcomes 5 (Materials Science), 6 (Mechanics), 10 (Sustainability), 11 (Contemporary Issues and Historical Perspectives), 12 (Risk and Uncertainty), 13 (Project Management), 18 (Business and Public Administration), 19 (Globalization), 20 (Leadership), 22 (Attitudes), and 24 (Professional and Ethical Responsibility). A partial gap typically indicates that the accreditation criteria include a portion of the outcome but not all of it or it requires a lower cognitive level than specified in BOK2. Finally, there is a total gap for outcome 3 (Humanities) meaning that there is nothing in the accreditation criteria that assures attainment of any portion of this outcome.

This does not mean that these outcomes are currently missing from most civil engineering programs. Even with respect to outcome 3 (Humanities), most programs include humanities in their general education requirements and many programs make an effort to relate those humanities to the practice of engineering. There is just nothing in the accreditation criteria that mandates this.

One might ask why there is not a total gap with respect to outcomes 5 (Materials Science) and 6 (Mechanics). There is nothing in the proposed accreditation criteria that specifically mandates courses or course coverage in those areas. The rationale for a partial gap is that the CEPC requires problem solving in four areas of civil engineering and the committee argued that attainment would be impossible without a background knowledge of solid and fluid mechanics. By that rationale, one might question why the gap is partial rather than having no gap. It would be possible to have minimal coverage to solve some civil engineering problems at the undergraduate level but have insufficient coverage to meet the intent of the BOK2 outcome 6 (Mechanics). For example, one could solve problems in the areas of structures, geotechnical, transportation and construction without an extensive knowledge of fluid mechanics.

With respect to outcome 5 (Materials Science), the BOK2 is not sufficiently clear. Because the BOK2 refers to "understanding of materials at the macroscopic and microscopic levels", this

would indicate the need for a materials science course. Many CE programs have a course in Material Science, but admittedly many do not. If a course in Materials Science is required, any potential gap would be greatly reduced. BOK2 further states, "Construction materials with broad applications in civil engineering include such ceramics as Portland cement concrete and hot mix asphalt concrete, such metals as steel and aluminum, and polymers and fibers. Infrastructure often requires repair, rehabilitation, or replacement due to degradation of materials." Most, if not all, civil engineering curricula have some coverage of construction materials. The committee believed that it is impossible to solve problems in four areas of civil engineering and conduct experiments in two areas of civil engineering without significant coverage of materials as described in BOK2. Thus the gap is only partial.

With the first proposed CEPC (as of December 2013 – see Appendices B & C), there would have been no gap with respect to outcomes 10 (Sustainability), 12 (Risk and Uncertainty), and 13 (Project Management). As described in this paper, the cognitive level of these outcomes was lowered in response to constituent feedback and a partial gap was created between the BOK2 and accreditation criteria in those areas.

The partial gap that exists with respect to outcomes 11 (Contemporary Issues and Historic Perspectives), 18 (Business and Public Administration), 19 (Globalization), 20 (Leadership), and 24 (Professional and Ethical Responsibility) are described in Appendix A and the previous paper[1]. The CEPCTC included a number of veteran CE department heads who helped strike a balance between BOK2 compliance and the realities facing civil engineering programs today. The committee prioritized the outcomes to ensure the most important ones were adopted.

Outcome 22 (Attitudes) was a bit difficult. While there is an overlap with professional and ethical responsibility, the attitudes suggested in BOK2 outcome 22 (Attitudes) include "commitment, confidence, consideration of others, curiosity, entrepreneurship, fairness, high expectations, honesty, integrity, intuition, judgment, optimism, persistence, positiveness, respect, self-esteem, sensitivity, thoughtfulness, thoroughness, and tolerance". Those attitudes are built over a lifetime and are a function of role models, mentors and experiences outside the curriculum. They are very difficult to incorporate into a CEPC that is restricted to curricular issues. Still, it could be argued that this topic is embedded in several existing requirements in both the general criteria and the CEPC. By the time students have functioned on a multidisciplinary team, demonstrated an understanding of professional and ethical responsibility, recognized the need for life-long learning, explained basic concepts in leadership, analyzed issues in professional ethics, and explained the importance of professional licensure, they have met much of this outcome. Nevertheless, a partial gap will probably always be present in this area.

What's next?

There will probably never be a "final" iteration of the CEPC. Civil Engineering is a dynamic profession. Change will always occur. Hopefully, ASCE will make sure that future CEPC are relevant for future civil engineering students. However, it is also important that change is managed in a systematic and responsible manner. ASCE has established an eight year cycle of updating the Civil Engineering Body of Knowledge and a corresponding eight year cycle of reviewing and updating the CEPC[11,12] as shown in Table 2. The current CEPC was last updated effective for the 2008 – 2009 accreditation cycle, reflecting portions of BOK1. The proposed CEPC should be effective for the 2016 – 2017 accreditation cycle, reflecting portions of BOK2. If the current schedule holds, constituents can expect BOK3 to be published in 2019 and a committee to review the CEPC organized in 2020 with its implementation effective for the 2024-2025 accreditation cycle.

Event	BOK 2nd Edition	BOK 3rd Edition	BOK 4th Edition
BOK Committee of CAP[3] organized	Already Accomplished	October 2016	October 2024
BOK finalized		September 2018	September 2026
BOK published		March 2019	March 2027
Accreditation Committee of CAP[3] organized		October 2020	October 2028
Draft CE Program Criteria published		March 2022	March 2030
CE Program Criteria approved by ABET EAC (1st reading)		July 2022	July 2030
CE Program Criteria approved by ABET Board of Directors (1st reading)	October 2014	October 2022	October 2030
Public Review of CE Program Criteria initiated	November 2014	November 2022	November 2030
CE Program Criteria approved by ABET EAC (2nd reading)	July 2015	July 2023	July 2031
CE Program Criteria approved by ABET Board of Directors (2nd reading)	October 2015	October 2023	October 2031
First Reviews Under New CE Program Criteria	September 2016	September 2024	September 2032

Table 2. ASCE schedule for continued eight-year cycle updates of the Body of Knowledge and the Civil Engineering Program Criteria

As the CEPCTC and the BOK committees alternate in accomplishing their duties, historical information and lessons learned need to be communicated between them. The CEPCTC's source document was the BOK2. Hopefully, the BOK3 committee will consider suggestions from the CEPCTC as it starts its work. Some of the CEPCTC recommendations include:

- **Mechanics and Natural Science mismatch.** The discussion of this issue revealed a potential mismatch in standards between BOK2 Outcome #2 (Natural Sciences) which is fairly prescriptive in the amount of natural science required at the undergraduate level and

BOK Outcome #6 (Mechanics) which simply requires undergraduates to solve problems in solid and fluid mechanics. For a constrained CE program that is trying to make tough decisions on what to eliminate from its curriculum, the BOK2 seems to allow flexibility to cut electrical circuits, rigid body dynamics and thermodynamics but offers no flexibility on the additional area of science. Whether this distinction was intentional or not should be addressed by the committee that creates the BOK3.

- **Risk and Uncertainty.** The undergraduate requirement for BOK2 outcome 12 (Risk and Uncertainty) is to "apply the principles of probability and statistics to solve problems containing uncertainties". Although the CEPCTC chose a lower cognitive level for this outcome, it also believes that risk should be included in the outcome statement. The CEPCTC was reluctant to require more than specified in BOK2.
- **Material science** – The committee struggled to determine whether or not a material science course was needed to satisfy the undergraduate requirements of BOK2 Outcome 5 (Materials Science) to "use knowledge of materials science to solve problems appropriate to civil engineering". The BOK3 Committee is encouraged to revise the narrative to make it clearer as to whether a materials science course is needed. The CEPCTC recommendation is that most undergraduate materials problems can be solved without a mandated material science course.
- **Additional area of science.** There remains the potential for significant confusion and misunderstanding for what constitutes an additional area of basic science. It has been well established that computer science, materials science and thermodynamics do not qualify as additional areas of basic (natural) science. The requirement that the additional area of science be disconnected from physics and chemistry is more problematic and open to different interpretations. The CEPCTC recommends that the narrative be more flexible in this area or be more complete to mitigate different interpretations.
- **Well-defined problems**. The CEPCTC recommends that the BOK3 committee remove the words "well-defined" problems from BOK2 outcome 8 (Problem Recognition and Solving) for all the reasons cited earlier in this paper. The BOK3 committee should consider definitions adopted in other venues such as the International Engineering Alliance in its work.
- **Technical specialization**. The BOK2 lists the baccalaureate degree level of cognitive achievement for Outcome 15 (Technical Specialization) as Bloom's Level 1, which is specified as "Define key aspects of advanced technical specialization appropriate to civil engineering." In reality, most baccalaureate degrees also accomplish Bloom's Level 2 ("Explain key concepts and problem-solving processes in a traditional or emerging specialized technical area appropriate to civil engineering.") and Bloom's Level 3 ("Apply specialized tools, technology, or technologies to solve simple problems in a traditional or emerging specialized technical area of civil engineering."). These are currently listed as "M/30" (masters or equivalent) accomplishments. Admittedly, no basic level of achievement in technical specialization is explicitly required in the proposed civil

engineering accreditation criteria. Nevertheless, one could convincingly argue that after an undergraduate student has *analyzed and solved problems in at least four technical areas appropriate to civil engineering, conducted civil engineering experiments in at least two technical areas of civil engineering and designed a system, component, or process in at least two civil engineering contexts*, that student has attained up through Bloom's Level 3 for Outcome 15 (Technical Specialization). The BOK3 could potentially be updated to recognize and reflect this.

- **Revised Bloom's**. Recent literature has recommended a revision to Bloom's taxonomy[15] where the top two cognitive levels of synthesis (design) and evaluation are reversed. The BOK2 uses the original version of Bloom's taxonomy[9] and the CEPCTC consciously made the decision to use the original version in the CEPC and associated commentary. The BOK3 committee should examine the literature and make a separate analysis and decision on the subject.
- **Evaluate the gap.** The BOK3 committee should study the work of the CEPCTC and the resulting program criteria that was adopted. Perhaps the gap between the BOK3 and the CEPC can be reduced by changing the level of achievement at the undergraduate level in the BOK3 in certain areas. Perhaps the gap is inevitable and appropriate and as such, the aspirational vision of the undergraduate education should not be compromised to reduce that gap. The gap should at least be acknowledged and discussed.

Conclusion

With the dissemination of the draft Commentary, the majority of the CEPCTC work is complete. Barring major unforeseen circumstances, the CEPC shown in this paper will go into effect for the 2016-17 accreditation cycle. ASCE will continue to define the knowledge, skills and attitudes required of a civil engineer at the baccalaureate, masters, and professional experience levels through the Body of Knowledge. The accreditation criteria are the most effective means of "operationalizing" the Body of Knowledge at the university level. As new editions of the BOK are published, a committee of practitioners and academic representatives should continue to revise the accreditation criteria that promote BOK-compliance at a level that is reasonable and sustainable given the constraints faced by civil engineering programs. It is a delicate balance that attracts a multitude of input from a variety of constituents. As long as the committee continues to seek constituent input, listens to the feedback, and communicates the rationale for the decisions, the process will be much better received by the community at large.

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Appendix A: Defining the Gap Between the BOK2 Baccalaureate-Level Standard and the Proposed ABET Accreditation Criteria

Civil Engineering BOK2		ABET Accreditation Criteria		
Outcome	BOK Baccalaureate Standard*	General Criteria	Civil Engineering Program Criteria	Existing Gap
1 Mathematics	B3: Solve problems in mathematics through differential equations and apply this knowledge to the solution of engineering problems.	Criterion 3 (a): an ability to apply knowledge of mathematics, science, and engineering Criterion 5(a) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline. Basic sciences are defined as biological, chemical, and physical sciences.	apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science.	No gap
2 Natural Sciences	B3: Solve problems in calculus-based physics, chemistry, and one additional area of natural science and apply this knowledge to the solution of engineering problems.	Criterion 3 (a): one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline. Basic sciences are defined as biological, chemical, and physical sciences.	apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science.	No gap
3 Humanities	B3: Demonstrate the importance of the humanities in the professional practice of engineering.	Criterion 5(c): a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.		Total gap: the general criterion is too nebulous to prescribe anything and CEPC is silent

*Note: the designations B1 through B5 used in the second column of this table indicate the BOK2 goal for baccalaureate-level education using the cognitive levels of Bloom's Taxonomy. The six possible cognitive levels of Bloom's Taxonomy are (1) Knowledge, (2) Comprehension, (3) Application, (4) Analysis, (5) Synthesis, and (6) Evaluation[9]

Civil Engineering BOK2		ABET Accreditation Criteria		
Outcome	BOK Baccalaureate Standard	General Criteria	Civil Engineering Program Criteria	Existing Gap
4 Social Sciences	B3: Demonstrate the incorporation of social sciences knowledge into the professional practice of engineering.	Criterion 3(h): the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context		No gap
5 Materials Science	B3: Use knowledge of materials science to solve problems appropriate to civil engineering.	Criterion 5(b): one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study.	analyze and solve problems in at least four technical areas appropriate to civil engineering	Partial gap Nothing to ensure material science is taught
6 Mechanics	B4: Analyze and solve problems in solid and fluid mechanics.	Criterion 5(b): one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study.	analyze and solve problems in at least four technical areas appropriate to civil engineering	Partial gap Nothing to ensure solid and fluid mechanics are taught
7 Experiments	B4: Analyze the results of experiments and evaluate the accuracy of the results within the known boundaries of the tests and materials in or across more than one of the technical areas of civil engineering	Criterion 3(b): an ability to design and conduct experiments, as well as to analyze and interpret data	conduct experiments in at least two technical areas of civil engineering and analyze and interpret the resulting data	No gap

Civil Engineering BOK2		ABET Accreditation Criteria		
Outcome	BOK Baccalaureate Standard	General Criteria	Civil Engineering Program Criteria	Existing Gap
8 Problem Recognition and Solving	B3: Develop problem statements and solve well-defined fundamental civil engineering problems by applying appropriate techniques and tools.	Criteria 3(e): an ability to identify, formulate, and solve engineering problems and Criterion 3 (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	analyze and solve problems in at least four technical areas appropriate to civil engineering	No gap
9 Design	B5: Design a system or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, constructability, and sustainability.	Criterion 3 (c): an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	design a system, component, or process in at least two civil engineering contexts;	No gap
10 Sustainability	B3: Apply the principles of sustainability to the design of traditional and emergent engineering systems.		include principles of sustainability in design	Partial gap: CEPC only requires comprehension level 2 (B2) attainment

Civil Engineering BOK2		ABET Accreditation Criteria		
Outcome	BOK Baccalaureate Standard	General Criteria	Civil Engineering Program Criteria	Existing Gap
11 Contemporary Issues and Historic Perspectives	B3: Drawing upon a broad education, explain the impact of historical and contemporary issues on the identification, formulation, and solution of engineering problems and explain the impact of engineering solutions on the economy, environment, political landscape, and society.	Criterion 3 (h): the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context and Criterion 3 (j): a knowledge of contemporary issues		Partial gap: Contemporary issues are adequately covered but no requirement to include historical perspectives
12 Risk and Uncertainty	B3: Apply the principles of probability and statistics to solve problems containing uncertainties.		apply probability and statistics to address uncertainty	Partial gap: CEPC only requires comprehension level 2 attainment with respect to uncertainty
13 Project Management	B3: Develop solutions to well-defined project management problems.		explain basic concepts in project management, business, public policy, and leadership	Partial gap: CEPC only requires comprehension level 2 attainment with respect to project management
14 Breadth in Civil Engineering Areas	B4: Analyze and solve well-defined engineering problems in at least four technical areas appropriate to civil engineering.		analyze and solve problems in at least four technical areas appropriate to civil engineering	No gap

Civil Engineering BOK2		ABET Accreditation Criteria		
Outcome	BOK Baccalaureate Standard	General Criteria	Civil Engineering Program Criteria	Existing Gap
15 Technical Specialization	B1: Define key aspects of advanced technical specialization appropriate to civil engineering.	Criterion 3(k): an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. Criterion 5(b): one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study.	analyze and solve problems in at least four technical areas appropriate to civil engineering	No gap
16 Communication	B4: Organize and deliver effective verbal, written, virtual, and graphical communications.	Criterion 3 (g): an ability to communicate effectively		No gap
17 Public Policy	B2: Discuss and explain key concepts and processes involved in public policy.		explain basic concepts in project management, business, public policy, and leadership	No gap
18 Business and Public Administration	B2: Explain key concepts and processes used in business and public administration.		explain basic concepts in project management, business, public policy, and leadership	Partial gap: No requirement for public administration
19 Globalization	B3: Organize, formulate, and solve an engineering problem in a global context.	Criterion 3 (h): the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context		Partial gap: General criteria implies level 2 (B2) attainment while BOK2 requires level 3 (B3)

Civil Engineering BOK2		ABET Accreditation Criteria		
Outcome	BOK Baccalaureate Standard	General Criteria	Civil Engineering Program Criteria	Existing Gap
20 Leadership	B3: Apply leadership principles to direct the efforts of a small, homogenous group.		explain basic concepts in project management, business, public policy, and leadership	Partial gap: CEPC only requires comprehension level 2 attainment with respect to leadership
21 Teamwork	B3: Function effectively as a member of an intra-disciplinary team	Criterion 3(d): an ability to function on multidisciplinary teams		No gap
22 Attitudes	B2: Explain attitudes supportive of the professional practice of civil engineering.	Criterion 3 (f): an understanding of professional and ethical responsibility		Partial gap: General criteria only touches on elements of this outcome.
23 Life-long Learning	B3: Demonstrate the ability for self-directed learning.	Criterion 3 (i): a recognition of the need for, and an ability to engage in life-long learning		No gap
24 Professional and Ethical Responsibility	B4: Analyze a situation involving multiple conflicting professional and ethical interests to determine an appropriate course of action.	Criterion 3 (f): an understanding of professional and ethical responsibility	analyze issues in professional ethics; and explain the importance of professional licensure.	Partial gap: CEPC covers level 4 attainment (B4) with respect to ethics but is silent on professional responsibility. General criteria only hits level 2.(B2)

Appendix B

SIDE-BY-SIDE COMPARISON
EXISTING CEPC vs PROPOSED CEPC
DRAFT AS OF DECEMBER 20, 2013

EXISTING CEPC	PROPOSED CEPC
1. Curriculum	1. Curriculum
The program must prepare graduates to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science consistent with the program educational objectives;	The program must prepare graduates to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of ~~basic~~ natural science ~~consistent with the program educational objectives~~;
	apply principles of probability and statistics to solve problems containing uncertainty;
apply knowledge of four technical areas appropriate to civil engineering;	analyze and solve well-defined problems in at least ~~apply knowledge of~~ four technical areas appropriate to civil engineering;
conduct civil engineering experiments and analyze and interpret the resulting data;	conduct ~~civil engineering~~ experiments in more than one technical area of civil engineering and analyze and interpret the resulting data;
design a system, component, or process in more than one civil engineering context;	design a system, component, or process in more than one civil engineering context;
	apply principles of sustainability in design*;*
	apply principles of project management*;*
explain basic concepts in management, business, public policy, and leadership;	explain basic concepts in ~~management,~~ business, public policy, and leadership;
	analyze issues in professional ethics*;*
and explain the importance of professional licensure.	and explain the importance of professional licensure.
2. Faculty	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.	No change

Underlined indicate additional wording relative to existing version. ~~Strikethrough~~ indicates deletion relative to existing version. Experiment phrase moved to right after probability and statistics.

Appendix C:
Proposed CEPC and Brief Justification (as of December 20, 2013)

DRAFT CEPC	BRIEF JUSTIFICATION
1. Curriculum.	
The program must prepare graduates to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of ~~basic~~ natural science ~~consistent with the program educational objectives~~;	"Natural science" is a broader term than "basic science" allowing programs greater flexibility with the additional area of science. ABET requires the program to prepare graduates to attain the program educational objectives, and it is redundant to include the similar phrase in the program criteria.
apply principles of probability and statistics to solve problems containing uncertainty*;*	Beyond having a mathematical knowledge of (or course in) probability and statistics, civil engineers must deal with and manage risk and uncertainty.
conduct ~~civil engineering~~ experiments in more than one technical area of civil engineering and analyze and interpret the resulting data;	Adding an experimental breadth requirement to the criteria recognizes (1) the apparent reduction in high school and other experimental experiences of students entering engineering and (2) the trends in higher education to reduce laboratory experiences in curricula.
analyze and solve well-defined problems in at least ~~apply knowledge of~~ four technical areas appropriate to civil engineering;	"Analyze and solve" is considered to be a more accurate description of what programs are currently doing to meet the existing criteria; that is, to apply knowledge most programs already have students analyze and solve problems.
design a system, component, or process in more than one civil engineering context;	*No changes proposed.*
apply principles of sustainability in design*;*	ASCE is a recognized leader in this advancing area. While Criterion 3(c) of the general criteria lists "sustainability" as one of eight constraints that should be considered in a design, these eight constraints are preceded by the words "such as" and thus lacks the strength to ensure that *all* civil engineering graduates can apply the principles of sustainability.

apply principles of project management*;*	Rather than requiring "management," as in the current criteria, "project management" is considered more appropriate for civil engineering programs. The application of project management principles is applicable to all sub-disciplines of civil engineering. As such, this criterion does *not* imply that a specific sub-discipline (e.g., construction management) must be covered.
explain basic concepts in ~~management,~~ business, public policy, and leadership;	*No changes other than removing "management."*
analyze issues in professional ethics*;*	General Criterion 3(f) requires an understanding of ethical responsibility, which falls short of addressing ethical decision-making and, more importantly, ethical and professional behavior. This implies a higher level of attainment than just "understanding." While the general criteria adequate addresses professional responsibility, ethical responsibility demands a higher standard for civil engineering graduates.
and explain the importance of professional licensure.	*No changes proposed.*
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.	*No changes proposed.*

Appendix D: Civil Engineering Department Head Survey

Name: _____ (optional)

Institution: _____ (optional)

Survey of Civil Engineering Department Heads/Chairs (April 2014)

The purpose of this survey is to obtain feedback from the nation's civil engineering department heads/chairs on the proposed changes to the Civil Engineering Program Criteria (CEPC) that could be effective as early as the 2016-2017 accreditation cycle. The Civil Engineering Program Criteria Task Committee, the committee charged with developing any needed changes to the CEPC, will review this feedback.

Listed below in the second column are the line-by-line proposed changes to the existing CEPC. For each proposed change, please use the following statements to rate the "Acceptability" (in the third column) and the "Feasibility" (in the fourth column) of the proposed change. In addition, please feel free to comment on your ratings – **especially "Acceptability" ratings of "2" or "3."**

"ACCEPTABILITY" Ratings			**"FEASIBILITY" Ratings**		
Rating	Definition		Rating	Definition	
1	Change is acceptable.		A	No curricula change required.	
2	Change is acceptable with reservation.		B	Minor curricula change required.	
3	Change is unacceptable.		C	Major curricula change required.	
0	No opinion regarding acceptability.		O	No opinion regarding feasibility.	

#	Item	ACCEPTABILITY Rating (1, 2, 3, 0)	FEASIBILITY Rating (A, B, C, O)	Comments or Explanation
1.	**1. Curriculum.** The program must prepare graduates to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of ~~basic~~ natural science ~~consistent with the program educational objectives~~;			
2.	apply principles of probability and statistics to solve problems containing uncertainty;			
3.	conduct ~~civil engineering~~ experiments in more than one technical area of civil engineering and analyze and interpret the resulting data;			
4.	analyze and solve well-defined problems in at least ~~apply knowledge of~~ four technical			

#	Item	ACCEPTABILITY Rating (1, 2, 3, 0)	FEASIBILITY Rating (A, B, C, O)	Comments or Explanation
	areas appropriate to civil engineering;			
5.	design a system, component, or process in more than one civil engineering context; *[NOTE: **Unchanged**]*			
6.	apply principles of sustainability in design*;*			
7.	apply principles of project management*;*			
8.	explain basic concepts in ~~management,~~ business, public policy, and leadership;			
9.	analyze issues in professional ethics*;*			
10.	and explain the importance of professional licensure. *[NOTE: **Unchanged**]*			
11.	**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. *[NOTE: **Unchanged**]*			

Please provide any additional comments and/or feedback on any aspect of these proposed changes to the Civil Engineering Program Criteria.