



## Lessons Learned in Developing the Civil Engineering Body of Knowledge, Third Edition

### **Dr. Decker B Hains P.E., Western Michigan University**

Dr. Decker B. Hains is a Master Faculty Specialist in the Department of Civil and Construction Engineering at Western Michigan University. He is a retired US Army Officer serving 22 years on active duty with the US Army Corps of Engineers and taught at the United States Military Academy at West Point (USMA). He earned a Bachelor of Science degree in Civil Engineering from USMA in 1994, Master of Science degrees from the University of Alaska Anchorage in Arctic Engineering in 1998 and Missouri University Science & Technology in Civil Engineering in 1999, and a PhD in Civil Engineering from Lehigh University in 2004. He is a registered Professional Engineer in Michigan.

### **Dr. Kenneth J. Fridley, The University of Alabama**

Kenneth J. Fridley is the Senior Associate Dean for the College of Engineering at The University of Alabama. Prior to his current appointment, Fridley served as Professor and Head of the Department of Civil, Construction and Environmental Engineering at the University of Alabama. Dr. Fridley has been recognized as a dedicated educator throughout his career and has received several awards for his teaching efforts, including the ExCEED (Excellence in Civil Engineering Education) Leadership Award in 2010. At the University of Alabama, Fridley has led efforts to establish several new programs including new undergraduate degree programs in construction engineering, architectural engineering and environmental engineering, a departmental Scholars program allowing highly qualified students an accelerated program to earn their MSCE in addition to their BS degree, the interdisciplinary "Cube" promoting innovation in engineering, and the cross-disciplinary MSCE/MBA and MSCE/JD dual-degree programs.

### **Ms. Leslie Nolen, American Society of Civil Engineers**

Leslie Nolen, CAE, serves as director, educational activities for the American Society of Civil Engineers. She brings over 20 years of association management experience to her work with ASCE's Committee on Education on issues of importance to the undergraduate and graduate level education of civil engineers.

## **Lessons Learned in Developing the Civil Engineering Body of Knowledge, Third Edition**

The American Society of Civil Engineers (ASCE) recently published the Third Edition of the Civil Engineering Body of Knowledge (CEBOK3) in May 2019 [1]. The Civil Engineering Body of Knowledge 3 Task Committee (CEBOK3TC) officially formed in October 2016 and spent approximately two and a half years developing the third edition. The third edition defines the knowledge, skills, and attitudes necessary to exercise responsible charge in the practice of civil engineering which are attained through undergraduate and post-graduate engineering education, mentored experience, and self-development. Like its predecessors, the CEBOK3 features an outcomes-based approach with associated levels of achievement.

The successful processes and the associated lessons learned from the CEBOK3TC must be clearly communicated to those interested in how the CEBOK3 was developed and those who will be involved in future Civil Engineering Body of Knowledge (CEBOK) efforts. The CEBOK3 stands on the foundations created by the previous task committees and much was learned from the experiences in the development of previous editions of the CEBOK. Learned experiences from the CEBOK3TC should also guide the preparation of future editions of the CEBOK and assist in advancing the profession. As Adlai E. Stevenson once said, “We can chart our future clearly and wisely only when we know the path which has led to the present.”

This paper provides a comprehensive overview and summary of lessons learned from the process of developing the CEBOK3. The CEBOK3TC built on the best practices and lessons of the past and the authors capture lessons learned from leading the committee. The paper begins with a discussion on the committee selection process, committee structure (including corresponding members), the committee charge, and the initial plan to complete the charges. The discussion on the comprehensive literature review and constituent survey process follows and includes information on the organization of subcommittee back-briefs and summaries. The committee leadership also introduced the concept of editing task groups to first complete a review of the outcome rubrics, then a review of the outcome explanations, and finally, a comprehensive review of the final completed draft for committee review. The paper concludes with a brief discussion on the final review and copy-editing process, and recommendations for the next CEBOK task committee.

### ***Committee Selection & Structure***

ASCE announced a broad call for members for the CEBOK3TC during the summer of 2016 and received more than 62 applications. The leadership team of the committee, composed of the chair, editor, and ASCE staff liaison, invited 25 of the applicants for a workshop in August 2016 where the applicants explored the process behind developing the first and second editions of the CEBOK as well as the expected process for the CEBOK3. The ASCE staff liaison is critical and for this committee, the support of one staff liaison, who was able to coordinate with other ASCE staff as needed, was appropriate.

Following the August workshop, invitations for membership in the task committee were extended to 15 of the applicants in September 2016 bringing the committee to 17 full members including the chair and editor. The remaining applicants were invited to be corresponding members to the committee, and most accepted the invitation and first engaged in January 2017 after the first face-to-face committee meeting in fall 2016. There were 70 corresponding members, many of whom were quite active in committee work. The committee membership, both full and corresponding, represented a broad and

diverse cross section of the civil engineering profession and the committee leadership deliberately sought members with experience in both academia and practice. In addition, a liaison was appointed between the CEBOK3TC and the Committee on Education, the Task Committee's parent committee.

Although the committee was formally led by the chair and editor who worked closely with the ASCE staff liaisons, the committee made use of several ad hoc subcommittees and groups, often with a designated leader, throughout the process. These included subcommittees to examine the various aspects of the literature, designing and processing constituent survey data, examining appropriate taxonomies, as well as editing task groups, which will be discussed in more detail later in the paper.

As with previous CEBOK task committees, the CEBOK3TC had an aggressive timeline to complete its charges and the committee work involved structured weekly conference calls as well as reading and writing assignments to ensure key milestones were met. A total of 58 teleconferences were held from September 2016 to October 2018. In addition to audio, most of the calls used Abode Connect to show most recent versions of documents and to capture notes, questions, and comments from full and corresponding members.

The CEBOK3TC also conducted four face-to-face meeting at key points in the process and three editing task group meetings to support the committee's work, also at key points in the process. The new, editing task group concept will be discussed later in this paper.

### ***Committee Charge and Initial Plan***

The charge to the Civil Engineering Body of Knowledge 3 Task Committee (CEBOK3TC) was to:

- Critically review published literature regarding the future of engineering, other disciplines, and civil engineering practice.
- Proactively solicit constituent input.
- Evaluate the CEBOK2.
- Determine if a Third Edition of the Civil Engineering Body of Knowledge (CEBOK3) report was warranted.
- If warranted, develop the CEBOK3 report.

The Committee on Education provided draft charges to the CEBOK3TC leadership team who then revised them and obtained final approval from the Committee on Education. This process works well as it helped established ownership of the charges for the CEBOK3TC leadership team, who had previous experience with CEBOK2.

As the charges indicate, the CEBOK3TC was to first affirm the need and necessity for a third edition *before* developing a third edition. This needed to be accomplished quickly so, *if needed*, the bulk of the allotted two-year timeframe for committee work could be focused on the development of the CEBOK3. Quite frankly, a cursory look at the literature yielded that a third edition was warranted; however, the CEBOK3TC was very adamant about documenting this need and leveraging the research in developing the CEBOK3.

The CEBOK3TC leadership team developed an initial plan to accomplish the charges and outlined the key tasks:

1. Conduct literature review including a critical evaluation of CEBOK2.
2. Consider approaches to the CEBOK, i.e. outcomes-based approach and if so, which taxonomies.
3. Determine outcomes and outcome statements in the rubrics.
4. Determine level of achievement for each outcome.
5. Determine typical pathway for achievement.
6. Develop explanations to accompany each outcome.
7. Develop the final report format, chapters, and appendices.
8. Finalize the report with ASCE publications staff.

The team also coordinated early with the ASCE publications staff and determined that for a May 2019 publication, the final draft needed to be completed by November 2018, which fit well with the two-year duration of the CEBOK3TC, i.e. from October 2016 to September 2018. Establishing the deadlines early and developing an initial plan listing the key tasks ensured that the CEBOK3TC stayed focused and productive.

### ***Comprehensive Literature Review***

As noted above, the committee's first charge was to critically review published literature regarding the future of engineering, other disciplines, and civil engineering practice. The focus of the literature review was to examine changes and developments that took place since the publication of the Second Edition of the Civil Engineering Body of Knowledge (CEBOK2) in February 2008 as well as current issues and trends in engineering, engineering education, and the civil engineering profession. This critical review would confirm the need for the CEBOK3 and provide key inputs for the development of CEBOK3.

The CEBOK3TC was very thorough in its approach to the literature review and cast a wide net for papers, reports, and other documents related to the future of engineering, other engineering disciplines, and civil engineering practice. To efficiently conduct the comprehensive review, the committee was divided into four groups, with each group tasked with the review of a particular type of literature. The types of literature were broadly grouped into the following categories:

- Scholarly works
- Body of knowledge reports published by other organizations
- Non-ASCE reports
- Other reference materials

The scholarly works included articles published in venues such as *ASCE's Journal of Professional Issues in Engineering Education and Practice* and the American Society for Engineering Education's annual conference proceedings. Body of knowledge documents published by other organizations included the National Society of Professional Engineers' *Engineering Body of Knowledge* [2], the American Society of Mechanical Engineers' *Vision 2030* [3], the American Institute of Chemical Engineers' *Body of Knowledge for Chemical Engineers* [4], and the American Academy of Environmental Engineers' *Environmental Engineering Body of Knowledge* [5].

Non-ASCE reports included the U.S. Department of Labor's *Professional Competencies for Engineering* [6], the International Engineering Alliance's *Graduate Attributes and Professional Competencies* [7], and the American Society for Engineering Education's *Transforming Undergraduate Education in Engineering* [8]. As noted, the CEBOK3TC relied heavily on the first two of these sources, both of which are internationally recognized engineering competency models and both of which were published after the CEBOK2, when developing the outcomes described in CEBOK3.

The final group reviewed other reference materials including the United Nations Educational, Scientific and Cultural Organization's *Youth and Skills: Putting Education to Work* report [9], the National Leadership Council for Liberal Education and America's Promise's *College Learning for the New Global Century* report [10], and the National Academy of Engineering's *Educating Engineers: Preparing 21<sup>st</sup> Century Leaders in the Context of New Modes of Learning* [11].

In all, the CEBOK3TC reviewed more than 50 separate publications during its evaluation of available literature. The ones cited above are the ones that had the greatest influence on the committee's deliberations. To establish a firm basis for the CEBOK and the modifications and updates, a comprehensive literature review is required, and future committees should consider a wide range of sources.

So that the entire committee could consider the entire scope of the comprehensive literature review, each group prepared and presented a summary and review of their scholarly research. The CEBOK3TC leadership team provided a format and asked each group to consider the following questions for each major source:

1. Does this source affirm aspects of the ASCE BOK2? If so what and how?
2. Does this source suggest things that may need to be revised or clarified in the BOK? If so, what, why and how?
3. Does this source suggest things that are missing and should be considered for addition? If so, what, why, and how?
4. Does this source suggest things that should be removed from the BOK? If so, what and why?

This approach worked extremely well and led to rich discussions of reasons for a CEBOK3 as well as ideas for key concepts, outcomes, and frameworks for the CEBOK3. The challenge for the CEBOK3TC involved the timing of this important work. The committee officially formed in early September 2016 and due to the aggressive timeline required during a two-year committee duration, discussed the literature review at its first face-to-face meeting in mid-October 2016. Although the quick turnaround on the analysis was not ideal, the dedicated work of the committee members yielded fruitful discussions and a solid foundation for the development of the CEBOK3.

### ***Constituent Surveys***

A critical element of the CEBOK3TC work was soliciting input from stakeholders at various stages of the process. The CEBOK3TC identified three critical times for constituent surveys:

- Following the literature review
- Following the creation of the initial, pre-draft CEBOK3 outcome rubrics
- Following the first full draft of the CEBOK3 outcome rubrics

Following the CEBOK3TC work on the literature review, the first survey sought input on the CEBOK2 outcomes and 10 possible new outcome topics that were identified through the literature review. This survey ran from January 23 through March 20, 2017 and targeted a wide audience and key constituents with the ASCE membership including civil engineering department heads; ASCE's program evaluator volunteers (PEVs); members of ASCE's Committee on Education and its constituent committee; ASCE Section, Branch, and Region leaders; and members of the ASCE specialty academies. The CEBOK3TC also requested that notices about the survey be placed in several ASCE publications and they were.

Once the CEBOK3TC determined that a third edition of the CEBOK was needed, they developed initial, pre-draft rubrics for the proposed outcomes and designed a second survey which asked constituents to comment on and suggest levels of achievement for these pre-draft CEBOK3 outcome rubrics. In order to have the results back in time for the November 2017 face-to-face meeting, the response time was shorter for this survey which was open from October 23 until November 8, 2017. Invitations were sent to the same groups as for the first survey as well as anyone else who had responded to the first survey. Due to the brief response period, notices were not placed in ASCE publications. In hindsight, the CEBOK3TC should have pressed harder to develop the initial, pre-draft outcome rubrics to allow more time for the constituent survey as the committee would have liked more responses to consider. Nonetheless, a survey open for two weeks is better than no survey. This survey proved critical as it was used by the CEBOK3TC to determine which outcome statements should be revised and to develop the appropriate levels of achievement for the outcomes.

Following the first full draft of the CEBOK3 outcome rubrics, the CEBOK3TC developed and conducted a final survey seeking input on the outcomes. The survey was structured to allow respondents to provide feedback only on the outcomes they wished to review. Once the respondent selected the outcome(s) of interest, they were provided the rubric for the outcome(s), which included the level of achievement and typical pathway, and links to the detailed explanations which included discussion on understanding the outcome, rationale, level of achievement, and typical pathway for fulfillment of the outcome. In addition to quantitative responses, the survey provided an open-ended response box and invitation for further explanation for each outcome rated, especially for the outcomes with lower ratings. The survey also included an overall additional feedback comment box. The full draft of the CEBOK3 outcome rubrics and explanations was also distributed to the ASCE Board of Direction and Society Committees for their review and comment.

A full description of the three surveys and summary of the survey results is included in Appendix D of the CEBOK3 [1] and in the 2019 ASEE paper, "Constituent Input in the Process of Developing the Third Edition of the Civil Engineering Body of Knowledge (CEBOK3)" [12].

There is no doubt that the surveys proved instrumental in development of the CEBOK3 and were critical in both providing input and generating discussion among the committee members. However, the CEBOK3TC was fortunate to have two committee members who had extensive experience with designing and conducting surveys and providing the analysis for the committee. This was not deliberately considered in the selection of committee members for CEBOK3TC. The authors recommend that any future committees that may have extensive survey work, consider experience with designing and conducting surveys as a part of the committee member selection criteria.

## ***Collaborative Process***

The collaborative process involved several key elements including the use of subcommittees, formats for various aspects of the work, a commitment to the overall development process, updates at the American Society for Engineering Education (ASEE) Annual Conferences, and updates to the ASCE Committee on Education and Board of Direction.

### *Subcommittees and Outcome Leads*

As the saying goes, “many hands make lighter work” and this is especially true on all volunteer ASCE committees. The CEBOK3TC made full use of subcommittees to accomplish much of the work. Subcommittees usually consisted of 3 to 5 members, occasionally including more active corresponding members. Examples of subcommittees used by the CEBOK3TC include:

- Literature review groups (discussed above)
- Outreach to other constituencies
- Studying and evaluating outcomes-based approaches
- Survey development for all three surveys
- Survey results processing for all three surveys
- Developing the Bloom’s Affective Domain structure
- Editing task groups (discussed in more detail later in this paper)

These subcommittees did extensive research, writing, and/or data processing, and presented findings to the entire CEBOK3TC. Furthermore, numerous committee members stepped up to lead these subcommittees and take on writing responsibilities, especially with the outcomes, including the explanations and comparisons, and key appendices, including constituent engagement through surveys and the application of Bloom’s taxonomy. The use of subcommittees proved instrumental in the success of the CEBOK3 and the use of subcommittees should be considered in future committee work.

### *Formats*

To effectively capture the work of the committee members to facilitate discussion and collaboration, the CEBOK3TC leadership team developed formats for various inputs and documents. Key formats included:

- Literature review
- Outcome statements
- Outcome rubrics
- Outcome explanations
- Outcome comparisons

### Literature Review

As noted above the literature review featured a four-question format that was used to evaluate sources. Teams created Powerpoint® slides, one per question, summarizing the key points from the source evaluation.

## Outcome Statements

The outcome statement format included a basic matrix for both the cognitive and affective domain as shown below:

### **COGNITIVE**

<b>LEVEL</b>	<b>Outcome Statement</b>	<b>Notes</b>
<b>1 Knowledge</b>		
<b>2 Comprehension</b>		
<b>3 Application</b>		
<b>4 Analysis</b>		
<b>5 Synthesis</b>		
<b>6 Evaluation</b>		

### **AFFECTIVE (as applicable)**

<b>LEVEL</b>	<b>Outcome Statement</b>	<b>Notes</b>
<b>1 Receiving</b>		
<b>2 Responding</b>		
<b>3 Valuing</b>		
<b>4 Organizing</b>		
<b>5 Internalizing</b>		

Once these were completed the outcome statements were evaluated by adding the following header information to the matrix:

#### **Outcome Name**

**Importance:** X.XX (from constituent survey, 5-point Likert Scale w/ 5 = very important, 3 = neutral, 1 = not important); XX highest of XX (number of outcomes currently being considered)

**Description:** X.XX (from constituent survey, 5-point Likert Scale w/ 5 = very well described, 3 = neutral, 1 = poorly described); XX highest of XX (number of outcomes currently being considered)

**Outcome Lead:** (name of committee member)

**Version/Date:**

**Level of Editing/Revision:** (substantial, moderate, minor, editorial only, or potential new outcome)



## Outcome Rubrics

The outcome rubrics were consolidated into a single document, oriented in landscape fashion with the outcomes in rows and the levels of achievement in columns. The Bloom's verbs were highlighted in bold and the typical pathway was indicated in parentheses following the outcome statement at each applicable level. Once the outcomes were grouped into four categories, which was a change from the three in CEBOK2, these headings were added to separate the outcomes in the rubric. The CEBOK3TC determined that the outcomes would be better organized by adding a fourth category, engineering fundamentals, which contains outcomes that provide a bridge between the foundational and technical outcomes. Appendix F in the CEBOK3 shows the final outcome rubric format [1].

## Outcome Explanations

The outcome explanations in chapter 2 also featured a distinct sectional format to improve readability. Each outcome explanation includes the following sections:

- Understanding the Outcome: This section simply defined the outcome and included some aspects of the outcome that may not be explicitly part of the outcome statement but are appropriate and relevant to the outcome.
- Rationale: This section defines why the outcome is part of the CEBOK.
- Level of Achievement: This section provided a specific justification for the level of achievement expected for entry into the practice of civil engineering at the professional level.
- Fulfillment of the Outcome: This section provided a brief justification for levels that would be fulfilled through undergraduate education (UG), post-graduate education (PG), mentored experience (ME), and self-directed (SD) learning.

Additional discussion on the format for the explanation of the outcomes is noted in the section on the editing task groups, which provided the impetus for the format.

## Outcome Comparisons

The CEBOK3TC used a specified format for presenting the comparison between the CEBOK2 and CEBOK3 outcomes in Appendix H of the CEBOK3 report. For each outcome, a table depicts the levels of achievement in rows and the CEBOK3 Demonstrated Ability and CEBOK2 Demonstrated Ability in side-by-side columns to explicitly show the differences. Tables for both the cognitive domain, and where applicable, the affective domain, for each outcome were included. A brief "Summary of Changes" section, which describes in more detail the changes from CEBOK2 to CEBOK3, follows each table. The format of the Appendix H adds the readability of the CEBOK3 and provides concise, succinct information on the changes from the second edition for interested readers.

## Overall Format

The committee considered various formats for the CEBOK3 and decided to adopt a simple, concise format with three chapters—introduction, the civil engineering body of knowledge, and summary and conclusion. Appendices were included to capture the basic information (Appendices A, B, and C) and document significant supporting work (Appendices D, E, F, G, and H).

### *Development Process*

The CEBOK3TC committed to a deliberate development process to facilitate discussion and collaboration. After determining the need for the CEBOK3, the CEBOK3TC focused on the outcomes first and then worked on outcome statements. A full outcome rubric was developed for all possible outcomes before any outcomes were eliminated. Outcomes were revised as the outcome statements were revised.

Once a fairly stable set of outcomes and associated statements were established, the CEBOK3TC deliberated on the levels of achievement for each outcome. Large, poster size prints of the outcome rubrics were placed on the walls of the conference room during the November 2017 face-to-face meeting and committee members “voted” by placing adhesive dots directly on the rubric. The dots provided a visual representation and aided in the development of consensus among the committee.

The CEBOK3TC then worked on the explanations with committee members each writing at least one of the initial explanations for the outcomes which were edited by an editing task group in January 2018. These were presented to the full committee during numerous conference calls in early 2018 and updated based on feedback from the committee in preparation for the third survey. The CEBOK3TC finalized the outcomes and rubric at its May 2018 face-to-face meeting and continued the process of updating the explanations and drafting comparisons to CEBOK2.

### *Stakeholder Communications: ASEE Annual Conferences*

The collaborative process also involved outreach and updates at the ASEE Annual Conference through the formal presentation of papers as well as informal networking sessions. Numerous committee members wrote ASEE conference papers and presented at the 2017, 2018, and 2019 ASEE Annual Conferences. Papers written in conjunction with the CEBOK3TC work include:

Proceedings of the 2017 ASEE National Conference, Columbus, OH, June 25-28 2017

- Fridley, Kenneth J., Hains, Decker B., Nolen, Leslie, Barry, Brock E., and Hartmann, Beth Lin. “Is It Time for a Third Edition of the Civil Engineering Body of Knowledge (BOK)?”

Proceedings of the 2018 ASEE National Conference, Salt Lake City, UT, June 24-27 2018.

- Fridley, Kenneth J., Hains, Decker B., Barry, Brock E., Sanford Bernhardt, Kristen L, and Nolen, Leslie. “The Third Edition of the Civil Engineering Body of Knowledge: An Update and Overview.”
- Hains, Decker B., Fridley, Kenneth J., Barry, Brock E., and Nolen, Leslie. “Revising the Civil Engineering Body of Knowledge (BOK): The Application of the Cognitive Domain of Bloom’s Taxonomy.”
- Dennis, Norman D., Hains, Decker B., and Brandes, Horst. “Assessing the Civil Engineering Body of Knowledge in the Affective Domain.”
- Krishnamurthy, Muthusamy, Pezza, David A., Fridley, Kenneth J., and Hains, Decker B. “The Practitioners’ Point of View of the ASCE Body of Knowledge.”
- Hains, Decker B. and O’Conner, Michael. “The Civil Engineering Body of Knowledge: Supporting ASCE’s Grand Challenge.”
- Brandes, Horst, Manous, Joe D., and Fridley, Kenneth J. “Comparison Between the New Bodies of Knowledge for the Civil Engineering Professional and the Civil Engineering Technologist.”

Proceedings of the 2019 ASEE National Conference, Tampa, FL, June 16-19, 2019.

- Hains, Decker B., Fridley, Kenneth J., Lenox, Thomas A., Nolen, Leslie, and O’Brien, Jr., James J. “The Evolution of the Civil Engineering Body of Knowledge: From the First Edition to the Third Edition.”
- Fridley, Kenneth J., Hains, Decker B., and Nolen, Leslie. “The 5Ws of the Third Edition of the Civil Engineering Body of Knowledge.”
- Bielefeldt, Angela R., Barry, Brock E., Fridley, Kenneth J., Nolen, Leslie, and Hains, Decker B. “Constituent Input in the Process of Developing the Third Edition of the Civil Engineering Body of Knowledge (CEBOK3).”
- Dennis, Norman D. and Hains, Decker B. “Achieving the Civil Engineering Body of Knowledge in the Affective Domain.”
- Fridley, Kenneth J., Hains, Decker B., Morse, Audra N., and Nolen, Leslie. “The CEBOK3 and ABET Accreditation Criteria: A Gap Analysis.”
- Fridley, Kenneth J., Bielefeldt, Angela R., Sutterer, Kevin G., and Williamson, Derek G. “Curricular Changes Needed to Conform to the CEBOK3 – Three Case Studies.”
- Delatte, Norb, Barry, Brock E., Morse, Audra N., and Saviz, Camilla M. “Department Head Perspectives on the Current CEPC and the BOK3.”
- Brandes, Horst, Flicker, Eric L., and Dooley, Kelly. “The Role of the Civil Engineering Body of Knowledge in ASCE's Raise the Bar Effort.”

*Stakeholder Communications: ASCE Board of Direction*

Another significant part of the process was presenting the CEBOKTC3 recommendations to the ASCE Board of Direction (BOD). This was in contrast to the process used for development of the CEBOK2 when the BOD was presented only with the final version of the Task Committee’s work. The CEBOK3TC leadership team and ASCE staff liaison provided regular updates to the ASCE BOD in Fall 2017 and Spring 2018. The CEBOK3TC chair and editor presented the final draft at the October 2018 ASCE BOD meeting.

**Editing Task Group**

The creation and deployment of editing task groups was one of the most beneficial group processes which greatly enhanced the development of the CEBOK3. In addition to the four full committee face-to-face meetings, the CEBOK3TC leadership team formed these editing task groups, composed of the chair, editor, ASCE Staff Liaison and 2-3 members of the committee, at critical points in the CEBOK3 process to provide detailed editing on key documents. The critical points and documents that each editing task group focused on are summarized in table 1 below:

Table 1. Editing Task Groups Activities.

<b>Date</b>	<b>Document Focus</b>	<b>Purpose</b>
September 2017	Outcome Rubric	Prepare rubrics for Full Committee Face-to-Face Meeting in November 2017
January 2018	Outcome Explanations	Prepare explanations for constituent review and third survey (March 5 to May 2, 2018)
August 2018	Full Draft	Finalize final draft for ASCE Board of Direction and constituent review

### *Outcome Rubric Editing Task Group*

Following the first survey and March 2017 face-to-face meeting, which featured initial work on outcome development, the committee worked diligently developing possible outcomes; however, there was a significant need to consolidate the efforts of the full committee and provide consistency in the outcome statements prior to the second constituent survey and face-to-face meeting in November 2017. The goal for the outcome rubric editing task group was to edit the current working draft of the full rubric based on (1) prior discussions of the committee, (2) the results of an internal survey of CEBOK3TC members, and (3) a set of general guidelines.

The outcome rubric editing task group agreed, only with justification, to modify the wording of any outcome, remove/delete an outcome, combine/integrate two or more outcomes into one outcome, split an outcome into two or more outcomes, or take any other action deemed to improve the outcome rubric. The outcome rubric editing task group also agreed to make no efforts to change the meaning of any of outcomes and submitted any edits made to the full committee for review and approval.

The outcome rubric editing task group agreed to the guidelines listed below, which were also reported to the full CEBOK3TC.

1. The Task Group will make every effort not to change the overall intent of the knowledge/skill/attitude being communicated by the outcome.
2. Changing an outcome statement from BOK2 should be justified; outcomes should not be changed simply for the sake of change.
3. The outcome explanation can be used to provide detail/definition that may not be appropriate within the outcome itself.
4. Outcome statements should be written in as succinct manner as possible; outcome statements should be able to be read and understood in a single reading.
5. Shorter outcome statements are better, but care should be taken not to sacrifice meaning for brevity.
6. Only one verb should be used per outcome statement, and the use of “and” should be limited.
7. Only appropriate Bloom’s verbs should be used, and in the case where a verb may be applicable to multiple Bloom’s levels (e.g., “explain”), the outcome editing task group should avoid use of these verbs in multiple levels (i.e., use a verb in one level only even though Bloom’s Taxonomy may allow the verb to be used in multiple levels).

This editing task group concept proved very valuable as the first editing task group, the outcome editing task group, provided an improved, working draft of the outcome rubric for the full CEBOK3TC review in late September and October 2017 prior to the second constituent survey. The editing task group concept was well received by the committee and was integral in providing a consolidated and consistent working product of a key output, the outcome rubric, which formed the foundation of the CEBOK3.

### *Outcome Explanation Editing Task Group*

The next opportunity and need for a focused editing task group was to work on the detailed explanations for the approved first draft of the full rubric. Committee members, assigned as outcome leads, drafted the initial explanations and the outcome explanation editing task group sought to edit

these so that each explanation was presented in a consistent manner, providing the reader with essential explanatory information about each outcome.

The outcome explanation editing task group agreed to the guidelines listed below, which were also reported to the full CEBOK3TC.

1. The Task Group will not make any substantive changes to the wording of any rubric or change levels of achievement. The Task Group did identify several outcomes that it recommended that the CEBOK3TC consider modifying prior to the next survey.
2. The Task Group may correct any typographical or other editorial errors but will report any such changes back to the CEBOK3TC and will indicate any corrections in a revised full rubric.
3. The outcome statements are written in as succinct manner as possible. The explanations can be used to provide additional detail and definition that may not be appropriate within the outcome itself but that can help readers understand the outcome and relate it to civil engineering. The explanations, however, should not expand or narrow the scope or focus of the outcome, or imply specific or prescriptive interpretations of the outcome.
4. The explanations should provide essential information that will help the reader understand the outcome, the reasoning behind why it is part of the CEBOK, and how it can be fulfilled, but not by listing specific courses or delivery mechanisms. The explanations should avoid extraneous or unnecessary information that may be confusing or be misinterpreted as prescriptive.
5. The explanations may include definitions or the reasoning behind the Bloom's verbs used in the outcomes if it will help in understanding the outcome.
6. The explanations should include citations as appropriate, particularly to support the reader's understanding of and rationale for the outcome.
7. The explanations include the following sections:
  - a. Understanding the Outcome: This section simply defines what the outcome is (and, perhaps, what it is not). This section may include some aspects of the outcome that may not be explicitly part of the outcome statement, but that may be appropriate and relevant to the outcome. Care must be taken, however, not to prescribe additional components to the outcome through the explanation.
  - b. Rationale: This section defines why the outcome is part of the CEBOK. [It is important to note that originally, this section was to address, for outcomes that were part of the CEBOK2, what changes were made and why, and for outcomes that are new to the CEBOK, this section would provide the CEBOK3TC's reasoning for their inclusion. The Task Group, however, decided this was not appropriate for the explanations, and it would be better to include a separate appendix that specifically addressed what changed from the CEBOK2 to the CEBOK3. Another subcommittee was established to write a draft of this appendix in the CEBOK3. This recommendation demonstrates the value of having a smaller group of committee members take a holistic view of the work.]
  - c. Level of Achievement: This section should define and justify the level of achievement expected for entry into the practice of civil engineering at the professional level. The justification should be specific to the level of achievement, not the outcome in general or anything related to the pathway to fulfillment.

- d. Fulfillment of the Outcome: This section should describe and provide a brief justification for levels that would be fulfilled through undergraduate education (UG), post-graduate education (PG), mentored experience (ME), and self-directed (SD) learning. It should not include reference to specific courses or other mechanisms for students or early career civil engineering to develop the competency defined by the outcome.
8. For outcomes with both a cognitive and an affective domain rubric, the narratives will be combined within each section listed above.
9. The explanations will address only the levels of achievement within the CEBOOK. In other words, no discussion or reference to higher levels, i.e. above the line, will be included in the explanations.
10. The explanations will only address the pathway that is included in the rubric, as this pathway is considered a typical pathway the CEBOOK3TC determined. Discussion of any alternate pathways in the explanations may confuse the reader.
11. Terms or phrases that may imply specific ties between the CEBOOK and professional licensure will be avoided since the CEBOOK is applicable to all civil engineers, not only those who have career paths that include licensure. The terms professional engineer and engineer intern are not used.
12. Reference to ABET, accreditation, or accreditation criteria will not be included in the explanations. Many misunderstand the CEBOOK and equate it to accreditation or ABET.
13. The Task Group will also make a variety of editorial decisions with the goal of having the explanations written in a consistent manner.

The result of the outcome explanation editing task group were outcome explanations for all 21 outcomes in the cognitive, and as appropriate, the affective domain. These were reviewed and discussed during conference calls in February 2018 prior to the launch of the third constituent survey in March 2018. Once again, the focused effort of a subset of the committee provided a valuable, consolidated, and consistent product for the entire committee to review.

#### *Final Report Editing Task Group*

Following the May 2018 face-to-face meeting, the CEBOOK3TC worked diligently to finalize the outcome rubrics and explanations, which formed the essence of the CEBOOK and began work on the other aspects of the report, including the appendices. The CEBOOK3TC editor also began work on the table of contents, list of tables, list of figures, and keeping the document and versions updated.

To finalize the report and prepare it for final editing by the CEBOOK3TC editor, a third editing task group met in August 2018 to prepare the final draft. The final report editing task group focused its work on each chapter and appendix and focused on ensuring consistency throughout the CEBOOK3 report. This effort greatly assisted the CEBOOK3TC editor in preparing the draft for the ASCE Publications Staff copy-editing and proofing process.

Specific recommendations from an editing perspective include:

- Maintain separate document files for each chapter and appendix. The title page, table of contents, preface, list of figures and tables, and executive summary were contained in one file, which was named "Front Matter". These Microsoft Word® files can be easily

combined in Adobe Acrobat into a single pdf file for distribution as a draft and the ASCE Publication Staff worked with the original Microsoft Word® files.

- Use chapter numbering for tables and figures so that any additions, deletions, or modifications affect a smaller part of the work and do not require more significant editing. For example, use Table 1-1 for the first table in Chapter 1 and Table 2-1 for the first table in Chapter 2.
- Keep cited sources numbered within each chapter. The ASCE Publications Staff updated the reference style by removing the numbering system for the final report; however, keeping the sources within each chapter and appendix proved essential to keeping the work organized and it improves readability by keeping the reference listing closer to the work. The numbering system works well for all draft and committee work.
- Add a watermark “DRAFT” to ensure readers know that the versions distributed for review and comments are drafts and not the finalized CEBOK.

### ***Final Review and Coordination with ASCE Publications Staff***

Early coordination with the ASCE Publications Staff proved critical to the success of meeting the publication deadline. The CEBOK3TC decided to leverage the copy-editing and proofing services of the ASCE Publications Staff. The CEBOK3TC leadership team and ASCE staff liaison initially met with the ASCE Publications Staff in May 2018, approximately a year in advance of the publication to discuss cover design, establish deadlines for submission of the final draft, and to discuss the process of copy-editing and proofing. The CEBOK3TC planned for a six-month lead time for publication, meaning a May 2019 publication date required a final draft by November 2018.

Due to the diligent efforts of the CEBOK3TC, the final draft was submitted on November 1, 2018 for initial copy-editing and proofing. This process took approximately 75 days, including the December holidays, and the first round of copy-editing was completed and returned to the CEBOK3TC editor on January 15, 2019. This began a series of approximately two-week cycles between the ASCE Publications Staff and the CEBOK3TC editor to finalize the copy for publication. The CEBOK3TC editor submitted final corrections on March 5, 2019, the CEBOK3 was finalized on April 10, 2019 and officially published in May 2019.

Early coordination with the ASCE Publications Staff is absolutely critical and the editor must plan for an approximately 60-day initial copy-editing period (depending on the time of year) and a subsequent 45-day period of more frequent interactions with the ASCE Publications Staff to work the final details prior to publication. Detailed exchanges between the editor and ASCE Publications staff, including the use of tracked changes in Microsoft Word®, comment boxes in Adobe Acrobat®, and summary comments explaining the details of changes with specific page references are required in the process.

### ***Recommendations***

Based on the experiences leading the CEBOK3TC, the authors make the following recommendations for future committee work, especially for future CEBOK Task Committees:

1. Select the committee leadership early and conduct an orientation workshop for the final pool of applicants. Both were done with the CEBOK3TC and proved beneficial to structuring the committee work.

2. Allow more time for the literature review, perhaps as long as six months. This may require the committee to have a 2.5-year duration; however, this would greatly benefit the work and ensure that all relative sources are considered. At a minimum, the relative sources should be gathered and organized by the CEBOK3TC leadership team and supporting ASCE staff as was done with the CEBOK3TC. Nonetheless, the committee had limited time to consider the literature prior to its first face-to-face meeting.
3. Maximize use of constituent surveys and ensure the timing and duration of the surveys are carefully considered. Constituent input is extremely important for achieving a broad acceptance of the CEBOK. For the CEBOK3TC, the timing of the three surveys worked well; however, the limited duration of the second survey was not ideal. Nonetheless, a limited duration survey is better than not conducting a survey.
4. Select committee members with experience in designing and conducting surveys. As noted above, the CEBOK3TC was fortunate to have two members who were experienced with survey design and had the tools to perform the analysis. This should be a more deliberate consideration for any committee who expects to conduct constituent surveys as a part of their work.
5. Consider using editing task groups for editing and consolidating key committee work products. The three editing task groups in the CEBOK3TC proved critical to the success of the committee and the CEBOK3. They greatly assisted with providing consistency and support to the CEBOK3TC editor.
6. Continue to provide updates at the ASCE Annual Conferences and work with other ASCE areas to provide updates at ASCE events, such as the National Convention, to broaden the opportunities for constituent feedback. During a CEBOK update cycle, a dedicated Civil Engineering Division CEBOK session at the ASCE Annual Conference, or a session which features several CEBOK-related papers, allows the publication and presentation of key committee work in progress and serves as a mechanism for constituent input.
7. Consider using simple formats for reports and specifically, the editing recommendations listed previously in this paper. Leveraging the expertise of the ASCE Publications Staff for producing the CEBOK is critical. The CEBOK is a document of strategic importance to the profession and having it professionally proofed and copy-edited is essential.
8. Conduct more deliberate planning for the delivery of the CEBOK3 companion materials that promote and explain the significance of the CEBOK to targeted audiences. The CEBOK3TC deliberately chose not to incorporate sections focused on advice to such audiences as students, faculty, interns, mentors, etc., reasoning that this would be better accomplished through separate companion pieces. These companion materials could also include interactive web and promotion-like materials. Although work continues on this important work communicating and promoting the strategically important CEBOK, more deliberate planning and resourcing may have led to quicker development of the companion materials.

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