

## **Is It Time For a Third Edition of the Civil Engineering Body of Knowledge (BOK)?**

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## **Is It Time for a Third Edition of the Civil Engineering Body of Knowledge (BOK)?**

### **Abstract**

It has been eight years since the American Society of Civil Engineers (ASCE) published the second edition of the Body of Knowledge (BOK2) report, and in October 2016 ASCE launched the Body of Knowledge 3 Task Committee (BOK3TC). ASCE charged the BOK3TC to critically reviewing published literature regarding the future of engineering, other disciplines and civil engineering practice; proactively soliciting constituent input; evaluating the ASCE BOK2; determining if a third edition of the Civil Engineering Body of Knowledge report is warranted now; and if warranted, developing the BOK3 report. The intent of this paper is to update the civil engineering community on the progress of the BOK3TC with the specific goal of answering the question of whether a third edition of the BOK is needed at this point in time.

To answer this question, the BOK3TC completed a critical review of published papers, reports, and other documents, answering the following specific questions for each source:

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

This paper provides a summary of the findings of the committee relative to the critical reviews and, based on these findings, provides a well-justified answer to the question “Is it time for a Third Edition of the Civil Engineering Body of Knowledge (BOK)?” This paper concludes with a discussion of the next steps for the committee and an outline of the path forward for BOK3.

### **Introduction**

The American Society of Civil Engineers (ASCE) defines the Civil Engineering Body of Knowledge (BOK)<sup>1,2</sup> as “the necessary depth and breadth of knowledge, skills, and attitudes required of an individual entering the practice of civil engineering at the professional level in the 21st century.” The phrase “entering the practice of civil engineering at the professional level” is further defined as the point when one is first eligible for licensure as a professional engineer (PE) through both formal education and mentored experience.

The second (current) edition of the Body of Knowledge (BOK2)<sup>1</sup> was published in 2008 and outlines 24 foundational, technical and professional practice learning outcomes for individuals entering the professional practice of civil engineering, including recommendations for fulfilling the outcomes through formal education, both at the baccalaureate and post-baccalaureate levels,

and mentored pre-licensure experience. ASCE created the Civil Engineering Program Criteria Task Committee (CEPCTC) in 2013 to consider the BOK2 and develop revisions to the ABET civil engineering program criteria (CEPC). In 2015, the CEPCTC completed its charge and ASCE submitted a proposal to change the CEPC.<sup>3,4,5</sup> The ABET/EAC BOK2-influenced CEPC<sup>6</sup> went into effect for the 2016/2017 accreditation cycle, and the first civil engineering program reviews under the revised criteria occurred in the fall of 2016.

ASCE recognizes the effort involved and time associated with reviewing, revising, and implementing change. ASCE further recognizes the importance of managing change so that the positive effects of change can be realized without overburdening any particular individuals or groups. Therefore, ASCE developed an eight-year cycle of review and possible revision to the Civil Engineering Body of Knowledge and a corresponding eight-year cycle of review and possible revision to the CEPC.<sup>5,7,8</sup> In accordance with this eight-year cycle, ASCE established the BOK3TC in October, 2016. See [http://www.asce.org/civil\\_engineering\\_body\\_of\\_knowledge/](http://www.asce.org/civil_engineering_body_of_knowledge/) for additional details on the BOK, including a full roster of full and corresponding members of the BOK3TC. A listing of the full members of the BOK3TC is also included in Appendix A.

The charge to the BOK3TC is to critically review published literature regarding the future of engineering, other disciplines and civil engineering practice; proactively solicit constituent input; evaluate the ASCE BOK2; determine if a third edition of the Civil Engineering Body of Knowledge report is warranted at this time; and if warranted, develop the BOK3 report. The purpose of this paper is to update the civil engineering community on the progress of the BOK3TC and, specifically, answer the question of whether or not a third edition of the BOK is needed at this point in time.

### **Review of Literature**

To determine whether or not a third edition of the BOK is needed at this time, the BOK3TC completed a fairly comprehensive and critical review of published papers, reports, and other documents. To accomplish this, the BOK3TC was divided into the following four groups, with each group tasked with the review of a particular type of literature:

- (1) Review of non-ASCE Reports, to include the U.S. Department of Labor's Professional Competencies for Engineering,<sup>9</sup> the International Engineering Alliance's Graduate Attributes and Professional Competencies,<sup>10</sup> and the American Society for Engineering Education's Transforming Undergraduate Education in Engineering.<sup>11</sup>
- (2) Review of body of knowledge documents published by other organizations, to include the National Society of Professional Engineers' Engineering Body of Knowledge,<sup>12</sup> the American Society of Mechanical Engineers' Vision 2030,<sup>13</sup> the American Institute of Chemical Engineers' Body of Knowledge for Chemical Engineers,<sup>14</sup> and the American Academy of Environmental Engineers' Engineering Body of Knowledge.<sup>15</sup>
- (3) Review of scholarly works as published, for example, in ASCE's Journal of Professional Issues in Engineering Education and Practice<sup>16,17</sup> and the American Society for Engineering Education's annual conference proceedings.<sup>5,18-25</sup>
- (4) Review of other reference materials such as the United Nations Educational, Scientific and Cultural Organization's Youth and Skills: Putting Education to Work report,<sup>26</sup> the National Leadership Council for Liberal Education and America's Promise's College

Learning for the New Global Century report,<sup>27</sup> and the National Academy of Engineering's Educating Engineers: Preparing 21<sup>st</sup> Century Leaders in the Context of New Modes of Learning.<sup>28</sup>

The BOK3TC reviewed over 50 separate publications during its evaluation of available literature. Only a subset of these are listed above, primarily those that had the greatest influence on the committee's deliberations in determining whether or not a third edition of the BOK is needed at this time.

### **Evaluation of Literature**

After reviewing the literature in small groups, each group out-briefed the full BOK3TC, which then synthesized the findings and developed a consensus response to four questions relative to assessing the BOK2 and determining if a revision is warranted at this time. The summary findings for each question are as follows:

- (1) *Do the reviewed sources affirm aspects of the ASCE BOK2?* The majority of the sources either directly or indirectly affirm various aspects of the BOK2. Sources specific to engineering appear to support many of the premises and outcomes identified in the BOK2. Some sources are silent on some of the "soft skill outcomes" of the BOK2, with one example being humanities. Overall, the committee felt the sources reviewed affirmed most aspects of the BOK2.
- (2) *Do the reviewed sources suggest things that may need to be revised or clarified in the BOK?* Several of the reviewed sources did support the need for revision or clarification of the BOK2 content. For example, many of the peer engineering BOK's more clearly identified the intent of their specific BOK. The intent of ASCE's BOK is to define the knowledge, skills, and attitudes necessary for entry into professional practice. However, the definition of "professional practice" as licensure as a professional engineer is not explicitly defined until the second chapter of the BOK2 report. Any revision should clearly define the intent of the civil engineering BOK and do so earlier in the document.
- (3) *Do the reviewed sources suggest things that are missing and should be considered for addition?* Many of the reviewed sources present the knowledge, skills, and attitudes (some use abilities or attributes in lieu of attitudes) in a manner similar to the 24 outcomes listed in the BOK2. Some of the outcomes presented by other professional groups were unique and specific to the organization that generated the document (e.g., stoichiometry by the American Institute of Chemical Engineers), and as such do not justify addition to civil engineering BOK. Other topics such as research skills, engineering economics, innovation, and safety were fairly common in the reviewed literature. These items, among others, generated significant discussion among the BOK3TC and were identified for possible consideration in any possible future revision of the BOK.
- (4) *Do the sources suggest things that should be removed from the BOK?* Notably, none of the reviewed literature led the BOK3TC to believe that a complete revision or elimination of existing outcomes was immediately obvious. Furthermore, none of the literature

outwardly indicated that any particular outcomes should be removed. However, the notable absence of some outcomes in peer documents, such as humanities, social sciences, and some professional practice outcomes, did lead the BOK3TC to discuss if removal of such outcomes from the civil engineering BOK could be justified.

### **Conclusion of the Committee**

Subsequent to reviewing and synthesizing the literature, the consensus agreement of the BOK3TC was that revisions to the BOK2 were appropriate and justified, and that the committee will begin the process of fully evaluating and developing a third edition of the BOK. While the preponderance of information in the literature led the committee to conclude an update of the BOK is needed, the BOK3TC has not drawn any conclusions or developed any proposals related to any changes, general or specific, that may be part of the third edition. At this point, the BOK3TC simply has concluded that a revision is warranted. The insights and perspectives gained from the literature review, however, have benefited the committee beyond leading the committee to its conclusion that a third edition is needed. The review effort and findings also helped inform the BOK3TC as it initiated subsequent work, to include engagement with various constituent groups.

### **Next Steps for the Committee**

After concluding that a third edition of the BOK was needed, the BOK3TC divided into two subgroups. The first group focused on constituency input and was charged with reviewing and updating the list of constituency groups from the BOK2 committee for use by the BOK3TC, creating a survey to seek input from the constituency groups for consideration in developing BOK3, and developing a standard presentation to be used to inform constituency groups and seek their direct input on the BOK. The second group studied formatting issues and was charged with reviewing the development of the outcomes-based format used in the BOK2, reviewing other format options to be considered for the BOK3, and developing a proposal for the BOK3 format that the BOK3TC will consider.

*Constituent Input.* The BOK has a significant presence within the practice of civil engineering and beyond. As such, when changes are considered, the implications of a broader impact must be considered. Critical to this is both defining the constituents and soliciting input from the identified constituents. To solicit input, a web-based survey was designed and all identified constituent groups were invited to complete the survey. The survey included a simple explanation related to the survey's purpose followed by an option for the participant to read additional background information. The participant also had the option to utilize links embedded in the survey that would open up a full PDF version of the BOK2<sup>1</sup> and ASCE's Policy Statement 465.<sup>2</sup> Both of those links open content in a separate window allowing the survey participant to continue with the survey with background information open simultaneously. The survey was structured so as to seek participant input on each of the 24 existing BOK2 outcomes, including both the importance of each outcome to the practice of civil engineering at the professional level and the specific knowledge, skills, and attitudes characterized for each outcome. The survey also sought participant input on a series of items that are not currently listed in the BOK2, but were identified by the BOK3TC during the critical review of available literature, including research skills, engineering economics, and information technology. Participants also had the opportunity to provide other items to be considered during the BOK3 revision. Finally, questions related to

basic demographic information were included, although no personally identifiable information was required from the survey participant.

The survey was opened to the constituent groups for over six weeks beginning January 23, 2017. At the close of the survey, 258 surveys were completed and the demographic data was reviewed to determine if the survey included appropriate levels of participation from all key constituencies. It was determined that additional input from the academic community was desired, so the survey was reopened for a two-week period and specifically promoted to the academic community through the ASCE Department Heads Council. An additional 45 responses were received, bringing the total number of responses to 303 with 29% coming from the academia, 26% industry, 16% from government, and 29% split among a variety of other areas. The full results of the survey will be reported to the civil engineering community separately by the BOK3TC.

*Format.* The format of the civil engineering BOK has systematically evolved since the first edition was published in 2004. The first edition of the BOK<sup>29</sup> used three levels of achievement: recognition, understanding, and ability. These three levels were not based on any established system or taxonomy. In fact, just one year later, ASCE published the Level of Achievement Report<sup>30</sup> which found the three-level approach used in the BOK1 to be unworkable and recast the BOK1 outcomes using Bloom's Taxonomy for the cognitive domain.<sup>31</sup> The BOK2 also adopted Bloom's Taxonomy for the cognitive domain; however, the BOK2 also acknowledged "several outcomes ... would be enhanced by descriptions in ... affective domain."<sup>1</sup> Following a review of various other learning taxonomies and alternative approaches to presenting bodies of knowledge, the BOK3TC decided the BOK3 would continue to use Bloom's Taxonomy for the cognitive domain, but it will explore the feasibility and use Bloom's Taxonomy for the affective domain<sup>32</sup> for an appropriate subset of outcomes. The affective domain describes emotional or character development and defines the manner in which individuals deal with interests, values, appreciation, enthusiasm, motivation, and attitudes.

### **Path Forward for the Committee**

The BOK3TC is on schedule to complete its charge within its two-year timeline. It has completed a comprehensive review of published literature regarding the future of engineering, other disciplines, and civil engineering practice, determining a third edition of the BOK is warranted. The committee is now critically evaluating the BOK2 and is proactively soliciting constituent input on the BOK2 and potential changes or revisions for the BOK3TC to consider. In the summer of 2017, the BOK3TC will begin the process of formally proposing and seeking constituent input on draft revisions to the BOK. This will continue through the fall of 2017 and first half of 2018, with a finalized BOK3 expected to be published in the fall of 2018. The BOK3TC will also consider innovative ways to present the BOK3 in addition to a traditional report.

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## **Appendix A: Committee Roster**

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Norbert Delatte, Oklahoma State University  
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Ryan Giles, Stony Brook University  
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David Pezza, Old Dominion University  
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