



## **Humanities and Social Sciences Outcomes for the Third Edition: Civil Engineering Body of Knowledge**

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# Humanities and Social Sciences Outcomes for the Third Edition: Civil Engineering Body of Knowledge

## Abstract

In the first edition (2004) of the Civil Engineering Body of Knowledge (BOK) fifteen outcomes were identified, however, there were no explicit outcomes for humanities or social sciences. Quickly thereafter, a BOK2 committee was formed and the second edition (2008) was published with twenty-four outcomes and associated levels of achievement. The outcomes were organized in three categories: Foundational, Technical, and Professional. Foundational outcomes included mathematics, natural sciences, and humanities and social sciences. Achievement for all Foundational outcomes was established based on level three of Bloom's taxonomy (application). The BOK2 outcomes were then used in the deliberations regarding proposed changes to the Civil Engineering Program Criteria (CEPC) now published in draft form. While certain BOK2 outcomes influenced the draft Civil Engineering Program Criteria, the explicit influence of the humanities and social sciences outcome is absent from the draft criteria.

This paper explores BOK2 outcomes in humanities and social sciences (H/SS) in an effort to inform those interested in and involved with the preparation of BOK3. Using a survey as well as an online inventory, program outcomes of existing civil engineering departments throughout the country are reviewed to determine current implementation. In addition, the dependence of other BOK2 outcomes upon H/SS is explored. Based on this dependence, the appropriateness of the current BOK2 H/SS outcomes is assessed. The proposed CEPC are examined in light of the need for H/SS to underpin the expectation of the proposed criteria. Finally, recommendations for changes to be incorporated into BOK3 are provided.

## Introduction

The importance of humanities and social sciences studies in civil engineering education is well established.<sup>1-6</sup> ASCE's second Body of Knowledge (BOK2)<sup>7</sup> recognized this importance and added two additional outcomes, one for humanities and one for social sciences. As part of BOK2, the outcomes were reorganized and the four foundational outcomes were mathematics, natural sciences, humanities, and social sciences.

Educational foundations in mathematics (such as algebra, geometry, trigonometry, calculus, and differential equations) and natural sciences (such as chemistry and physics) have obvious connections to civil engineering and were included as outcomes in the original BOK. Further deliberations during the development of BOK2 led to the addition of humanities as a foundational outcome. Subjects that investigate human constructs and concerns (such as art, philosophy, languages and literature) were deemed to underpin the professional practice of civil engineering. Also, deliberations during the development of BOK2 led to the addition of social sciences as a foundational outcome. Social sciences, subjects that deal with the functioning of society and its institutions (such as political science, economics, sociology and psychology) were

also deemed to underpin the professional practice of civil engineering. Social sciences are often data-driven and quantitative while humanities typically employ critical and analytic thinking.

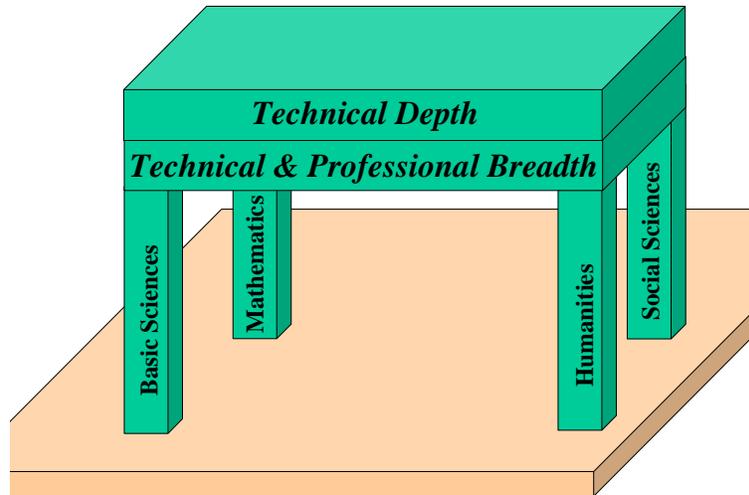
These disciplines are supportive of, and directly tied to, the goals of integrating issues such as sustainability and globalization into the engineering curriculum. Sustainable development requires that economic, environmental and social aspects be equally balanced with respect to engineering design.<sup>8</sup> The current Engineering Accreditation Commission of the American Board for Engineering and Technology, Inc (EAC/ABET) criteria no longer requires a humanities or social science component, but rather humanities and social sciences are meant to be captured under the general education requirement.<sup>9</sup> As a result, there is the opportunity to bring change to the engineering curriculum through humanities and social science (H/SS) components.<sup>5</sup>

The primary research objective of this study is to provide recommendations for BOK3 with regard to the humanities and social sciences outcomes. In order to achieve this objective, background literature on the evolution of how humanities and social sciences have been integrated into program criteria was reviewed and critically analyzed. In terms of data collection, a survey and an online inventory approach was used to determine existing program outcomes as well as the opportunities for improvement. Recommendations regarding humanities and social sciences for BOK3 are presented based on the findings of this student. The recommendations are grounded in previously established curriculum guidance including ABET prior to ABET's Engineering Criteria 2000, EAC/ABET 3(a) through 3(k), BOK and BOK2.

### **Integration of Humanities and Social Sciences into BOK, ABET and other Criteria**

There is a large body of literature, going back in time, which provides support for humanities and social science (H/SS) in the education and the practice of engineering.<sup>1-6</sup> There is a common agreement that an engineering education must be supported with a fundamental education in mathematics, natural sciences, humanities and social sciences. The graphic shown in Figure 1 clearly illustrates the notion that education for the practice of engineering is underpinned by education in these four areas. Studies identified on the figure as technical and professional breadth are informed by studies in mathematics, natural sciences, humanities and social sciences. Without all four, the context is incomplete and critical thinking associated with problem solving is constrained.

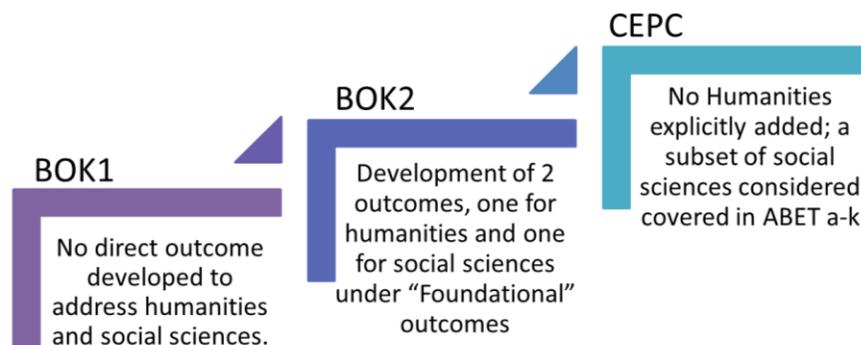
Despite the universal agreement regarding the need for studies in the humanities and social sciences, there is anecdotal evidence to indicate that while the literature speaks with one voice on this issue, engineering educators assign value through their curriculum. In general, rarely more than the minimum required H/SS coursework is required while virtually more engineering coursework is always required beyond the minimum. This fact speaks volumes about the perceived relative importance of H/SS compared with traditional mathematics, natural science and engineering topics.



**Figure 1: Foundations of an Engineering Education<sup>3</sup>**

While there is little debate in the published literature on the value of H/SS, there is less than a clear consensus on how students can be best educated and equipped to properly incorporated knowledge from humanities and social sciences in their practice. For example, programs vary enormously in their approach to H/SS in their curricula. Curricula can be quite prescriptive in requiring students to take specific courses, categories of courses and/or levels of courses. Alternatively, curricula may be wide-open allowing students to choose most any course in the broad category of H/SS. Which is better? Should students be permitted to take any courses in H/SS to fulfill the requirements or should students be directed to certain courses that students might see a stronger connection to engineering? Which approach will produce, in the long term, the better-educated and informed engineer?

In an effort to provide national leadership regarding this issue of humanities and social science integration into the civil engineering curriculum, organizations such as ASCE and EAC/ABET have provided guidance. The following sections describe the process of how humanities and social sciences have been viewed in the civil engineering curriculum, specifically with respect to BOK1, BOK2, EAC/ABET, and Civil Engineering Program Criteria (CEPC). Figure 2 summarizes the integration process.



**Figure 2: Integration of Humanities and Social Sciences into BOK and CEPC**

## Humanities and Social Science in ABET

Interestingly, the ABET<sup>9</sup> General Criteria for the 1999-2000 accreditations cycle provided a statement about the curriculum (I.C.3.d (2)) which included the following:

### *I.C.3.d. (2) Humanities and Social Sciences*

*I.C.3.d.(2) (a) Studies in the humanities and social sciences serve not only to meet the objectives of a broad education but also to meet the objectives of the engineering profession. Therefore, studies in the humanities and social sciences must be planned to reflect a rationale or fulfill an objective appropriate to the engineering profession and the institution's educational objectives. In the interests of making engineers fully aware of their social responsibilities and better able to consider related factors in the decision-making process, institutions must require course work in the humanities and social sciences as an integral part of the engineering program. This philosophy cannot be overemphasized. To satisfy this requirement, the courses selected must provide both breadth and depth and not be limited to a selection of unrelated introductory courses.*

*I.C.3.d. (2) (b) Such course work must meet the generally accepted definitions that humanities are the branches of knowledge concerned with man and his culture, while social sciences are the studies of individual relationships in and to society. Examples of traditional subjects in these areas are philosophy, religious, history, literature, fine arts, sociology, psychology, political science, anthropology, economics, and foreign languages other than English or a student's native language. Nontraditional subjects are exemplified by courses such as technology and human affairs, history of technology, and professional ethics and social responsibility. Courses that instill cultural values are acceptable, while routine exercises of personal craft are not. Consequently, courses that involve performance must be accompanied by theory or history of the subject.*

*I.C.3.d (2) (c) Subjects such as accounting, industrial management, finance, personnel administration, engineering economy and military training may be appropriately included either as required or elective courses in engineering curricula to satisfy desired program objectives of the institution. However, such courses usually do not fulfill the objectives desired of the humanities and social sciences content.*

The governing philosophy was clear: *In the interests of making engineers fully aware of their social responsibilities and better able to consider related factors in the decision-making process, institutions must require course work in the humanities and social sciences as an integral part of the engineering program. This philosophy cannot be overemphasized.*<sup>9</sup>

So what progress has been made in the last 15 years regarding humanities and social sciences in the curriculum? The current ABET<sup>10</sup> general criteria with respect to H/SS state the following:

- *Criterion 3. Student outcomes*
  - *(c) an ability to design a system, component or process to meet desired needs within a realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.*
  - *(h) the broad education necessary to understand the impact of solutions in a global, economic, environmental, and societal context.*

- (j) a knowledge of contemporary issues.
- Criterion 5. Curriculum
  - (c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.

For now, the reader can judge whether civil engineering educational requirements in the humanities and social sciences have been strengthened or weakened by changes in ABET requirements.

### ***Humanities and Social Sciences in BOK1 and BOK2***

BOK1<sup>11</sup> described what a civil engineering student should be taught and learned. In BOK1, there are no direct references to humanities and social sciences although concepts from humanities and social sciences underpin other expectations. In this first edition of the BOK, ABET student outcomes 3(c), 3(h) and 3(j) were adopted in a modified form and three additional outcomes developed. Therefore, the BOK1 outcomes relating to humanities and social sciences included:

- 3. an ability to design a system, component or process to meet desired needs*
- 8. the broad education necessary to understand the impact of solutions in a global and societal context*
- 10. a knowledge of contemporary issues*
- 13. an understanding of the elements of project management, construction and asset management*
- 14. an understanding of business and public policy and administration fundamentals*
- 15. an understanding of the leader and leadership principles and attitudes*

An analysis of these outcomes reveals that, while some understanding of various aspects of the humanities and social sciences are needed to meet the outcome, there are no direct outcomes in the humanities and social sciences.

### ***Humanities and Social Sciences in BOK2***

Building on BOK1, those deliberating the outcomes for BOK2 elevated humanities and social sciences by establishing them as outcomes. BOK2 also reorganized outcomes and identified mathematics, natural sciences, humanities and social sciences as Foundational outcomes. From the time of the BOK2 deliberations to now, EAC/ABET<sup>10</sup> Criteria 3(a) through 3(k) asks engineers to “consider needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.” In BOK2, for the first time, H/SS was given the importance of an outcome. While all outcomes should not be considered equal, H/SS has been established among other Foundational outcomes such as mathematics and natural sciences. The level of achievement for the Foundational outcomes is the third level, application, of Bloom’s taxonomy.<sup>12</sup>

The explicit outcomes in BOK2<sup>7</sup> were:

- 3. Upon graduation from a baccalaureate program, an individual must be able to demonstrate the importance of the Humanities in the professional practice of engineering.*

4. Upon graduation from a baccalaureate program, an individual must be able to demonstrate the incorporation of social sciences knowledge into the professional practice of engineering.

The explanation of the humanities outcome in BOK2<sup>7</sup> is as follows:

*Humanities: To be effective, professional civil engineers must be critical thinkers with the ability to raise vital questions and problems, and formulate them clearly and appropriately. They must gather and assess relevant information, use abstract ideas to interpret the information effectively and come to well-reasoned conclusions and solutions, testing them against relevant criteria and standards. Professional civil engineers must think open-mindedly within alternative systems of thought, recognizing and assessing, as need be, the assumptions, implications, and practical consequences of their work. They must be informed by not only mathematics and the natural and social sciences, but by the Humanities, the disciplines that study the human aspects of the world such as philosophy, history, literature, visual arts, performing arts, language and religion. Humanities are academic disciplines which use critical or speculative methods to study the human condition. This outcome is intended to guide students to understand the importance of the Humanities on the professional practice of engineering. This understanding is critical to professional delivery of service to people.*

*The formal education process sets the stage for professional achievement. In practice, our profession involves varying degrees of integration of humanities such as ethical, aesthetic, and historical factors. Engineers must be able to recognize and incorporate these human factors into the development and evaluation of solutions to engineering and societal problems. Continued development of professional competence must come from life-long learning, mentorship from senior engineers and practical experience, and involvement with the local community, grounded on a firm foundation in, and recognition of the importance of, the Humanities.*

*The formal education process at the undergraduate level must include the humanities in order for the student to develop an appreciation of their importance in developing engineering solutions. All students cannot study all of the humanities; rather, students first must be able to recognize and identify factual information from more than one area of the humanities. Students should be able to explain concepts in at least one area of humanities in order for them to explain how this can inform and impact their engineering decisions. Students should be able to apply their knowledge of humanities by demonstrating the importance of the humanities on the professional practice of engineering. Examples of opportunities to demonstrate this ability include incorporating application of philosophy in engineering ethics, visual arts in the aesthetics of structures, language in the globalization of engineering, history in the study of the past accomplishments of society through civil engineering.*

The explanation of the social sciences outcome in BOK2<sup>7</sup> is as follows:

*Social Sciences: Engineering services are delivered to society through social mechanisms and institutions. The social sciences are the systematic study of these social phenomena; example disciplines include economics, political science, sociology, and psychology. (Note that some studies in history are categorized as social sciences.) Social sciences are scientific, quantitative, analytical and data driven and use the scientific method including both qualitative and*

*quantitative methods. Professional civil engineers must work within a social framework; understanding it is foundational to effective professionalism, alongside the three other foundational areas (i.e., Math, Natural Science, and Humanities). This outcome is intended to guide students to make connections between their technical education and their education in the social sciences. Effective delivery of professional service depends critically upon these connections.*

*The formal education process sets the stage for individuals to become effective professionals. In practice, virtually all projects and design work involve varying degrees of integration of social sciences knowledge, such as economic and socio-political aspects. Engineers must be able to recognize and incorporate these considerations into the development, delivery, and evaluation of solutions to engineering problems. Continued development of professional competence must come from life-long learning, mentorship from senior engineers and practical experience, grounded on a firm foundation in, and recognition of, the importance of the social sciences and advances in them.*

*The formal education process at the undergraduate level must include an introduction to social sciences in order for the student to develop an appreciation of their importance in the development of engineering solutions. All students cannot master all of the social sciences; rather, students first must be able to recognize and identify factual information in more than one area of social science. Students should be able to explain the concepts in at least one area of social science in order for them to explain how this area of social science can inform their engineering decisions. Students should be able to apply their knowledge of social sciences by demonstrating its incorporation into the professional practice of engineering. Examples of knowledge from social sciences that might be applied in engineering include economic, safety and security, or environmental considerations. Examples of opportunities to demonstrate this ability includes incorporating application of social sciences in engineering courses such as transportation, environmental engineering, capstone or major design experience.*

### **Humanities and Social Sciences in Civil Engineering Program Criteria (CEPC)**

The current ASCE CEPC<sup>13</sup> states:

*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; apply knowledge of four technical areas appropriate to civil engineering; conduct civil engineering and analyze and interpret the resulting data; design a system, component, or process in more than one civil engineering context; explain basic concepts in management, business, public policy, and leadership; and explain the importance of professional licensure.*

There are no overt references to humanities and social sciences although concepts in management, business, public policy and leadership are grounded in humanities and social sciences.

The American Society of Civil Engineers (ASCE) organized the Civil Engineering Program Criteria Task Committee in October 2012. The committee's charge was to determine if the

current ABET Civil Engineering Program Criteria (CEPC) should be changed in light of one or more of the 24 outcomes of the second edition of the *Civil Engineering Body of Knowledge* published in 2008 (BOK2). BOK2 was identified in the committee charge as the document to guide the revisions. Hence, BOK2 outcomes not already in the CEPC or in EAC/ABET 3(a) through 3(k) were considered for incorporation into revised CEPC. Work by Estes and Lennox<sup>14</sup> is nearly complete and the Draft CEPC are being circulated for comment and have been approved by the ASCE Committee on Accreditation on May 22, 2014. The CEPC was approved upon first reading by the EAC/ABET 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 draft CEPC showing additions and deletions from the current CEPC<sup>13</sup> is as follows:

*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.*

The draft CEPC again contains no overt references to humanities and social sciences. However, humanities and social sciences underpin a new requirement to include principles of sustainability in design while retaining concepts in management, business, policy, and leadership.

The reader might be inclined to ask why, if the new CEPC were to be informed by BOK2, and BOK2 now had explicit outcomes for humanities and social sciences, why then did the new CEPC not reflect the thinking of BOK2? The authors attribute this to two reasons. First, Ressler<sup>15</sup> made the argument that ABET criterion 3(h) discussed above was consistent with BOK2 outcome 3 for social sciences, and therefore, no gap existed between the two documents. With respect to humanities, Ressler<sup>15</sup> noted the opposite, that is, the ABET general education criterion is too nebulous to prescribe anything and there existed a "total gap" between the two documents. As it turned out, the CEPC committee chose not to address this outcome in the new CEPC. Reasons varied including (1) the recognition that there would be limits on the extent of changes possible to the CEPC, and (2) the belief that, while no clear criteria existed, humanities was adequately covered in general education requirements.

### **Humanities and Social Sciences Outcomes in Current Civil Engineering Programs**

In order to assess existing civil engineering program outcomes with regard to humanities and social sciences, two major forms of data collection were used: (1) voluntary survey and (2) online random inventory based on publicly available information. These two methods were used

to develop broad conclusions on the adoption of BOK2 outcomes, with particular interest in humanities and social sciences, by civil engineering programs throughout the nation.

**Survey**

Civil Engineering Department Heads were surveyed to seek out programs that have adopted BOK2 outcomes (including humanities and social sciences) as part of their accreditation process or have other humanities and/or social science outcomes not precisely modeled on BOK2. The survey was conducted through email and participation was voluntary. Table 1 presents the data for programs that provided information in response to the survey.

**Table 1: Programs with Explicit Humanities and Social Sciences Outcomes**

<b>Program</b>	<b>Basis of H/SS requirement</b>	<b>H/SS Outcomes</b>
University of Alabama	BOK2	Explain the importance of (1) humanities, literature, and fine arts; and (2) history and social behavior
Lawrence Technological University	BOK2	Wording identical to BOK2
Lafayette College	Gen Ed	Demonstrate an understanding of, and an ability to evaluate, works and styles of art, important literary, philosophical, or religious texts, or questions raised in the humanities.
University of Arkansas	BOK2	Originally had specifically written outcomes to capture the essence of BOK2 without identical wording of BOK2. Recently reverted back to EAC/ABET 3(a) through 3(k).
University of Wisconsin	Gen Ed	Undergraduate students are required to take a minimum of 16 credits of humanities and/or social sciences as part of their curriculum. A minimum of 6 credits must be from humanities and a minimum of 4 credits must be from an economics course (a social science). Will be asking senior capstone design students to demonstrate the importance of humanities and incorporation of social science knowledge in their design projects.

Note that the information contained in Table 1 is based upon a voluntary response to the survey. With that being said, programs with outcomes that have voluntarily gone above and beyond the minimally required EAC/ABET 3(a) through 3(k) have traditionally been justifiably proud of this accomplishment. Therefore, it is likely that the programs that felt comfortable responding to this survey are those that are exceeding the ABET criteria. This data indicated few programs were including BOK2 outcomes in their ABET outcomes. To further validate this finding, an online inventory of programs was conducted as next described.

**Online Inventory**

In addition to the survey, 40 program websites were selected (with a distribution of public versus private institutions, various geographic locations, and differing program sizes) as part of the online inventory of civil engineering curriculum throughout the country (Table 2). While the

information in Table 2 is publically available, the programs are not identified by name but simply by number since the institution did not voluntarily agree to provide information as they did in the prior survey. Two of the programs that voluntarily participated in the survey were also included in online inventory. The program outcomes for each school were reviewed and were identified as one of three options (1) reflective of EAC/ABET 3(a) through 3(k) [11 outcomes], (2) reflective of BOK2 [24 outcomes], or (3) a hybrid of both ABET and BOK2 components.

**Table 2: Online Inventory of Existing Program Outcomes in Civil Engineering**

<u>School #</u>	<u>ABET a- k (11)</u>	<u>BOK 2 (24)</u>	<u>Hybrid (Mix of ABET &amp; BOK2)</u>
1	x		
2	x		
3		x	
4	x		
5	x		
6	x		
7	x		
8	x (+ 2)		
9	x (+1)		
10	x		
11	x		
12	x		
13	x		
14	x (indirect)		
15	x		
16	x (indirect)		
17		x (indirect-16 total)	
18	x		
19	x		
20			x (+4 CE specific)
21	x (+2)		
22	x (indirect-7 total)		
23	x		
24			x (16 total-reflect ABET)
25	x		
26		x	
27			x (15 total)
28	x		
29	x		
30	x		
31	x		
32	x (+1)		
33	x		
34			x (ABET 5 CE discipline specific)
35			x (ABET +8 specific under 3a)
36	x (6 total)		
37	x		
38	x		
39			x (ABET + 4)
40	x		

Throughout the process, information relating to the degree of reflection was noted. For example, if a program had one or two additional outcomes added to the EAC/ABET 3(a) through 3(k) outcomes, this still was determined to be reflective of EAC/ABET 3(a) through 3(k). Also, if phrases or words were reflective, but the actual 3(a) through 3(k) outcomes did not directly match, this was noted as “indirectly” reflective of EAC/ABET 3(a) through 3(k) or BOK2 (depending on the correlation). The hybrid category includes those that reflect a mix of EAC/ABET 3(a) through 3(k) outcomes with additional outcomes reflective of BOK2 (total of 15 outcomes or more). This information was based on a brief search of publicly accessible information from the school’s civil engineering department website. Information that was not located in a publicly accessible location or available from the department webpage was not included. Therefore, the results may not be fully comprehensive or up-to-date as the results are based on the information available at the time of the inventory. Despite these limitations, these data provide a broad picture of the basis for existing program outcomes throughout the country.

The results of the online inventory show that 77.5% of the schools inventoried are following EAC/ABET 3(a) through 3(k) as their primary source for program outcomes. Of these programs, 75% of them directly map and 25% indirectly map to ABET. In contrast, only 7.5% of the schools inventoried directly or indirectly map to BOK2. Note the survey did not ask "why not" for the vast majority of schools that did not incorporate most/all of the outcomes of BOK2 into their program outcomes. Since outcomes need to be assessed, it is speculated that the additional work required to assess additional outcomes is a deterrent to adding outcomes beyond those required by ABET. Lastly, 15% of schools surveyed were determined to be based on a mix of both ABET and BOK2.

Two general conclusions can be drawn from Table 2. First, the number of programs that have decided to model their program outcomes after BOK2 is small. Second, while programs may find the outcomes in BOK2 worthy, adoption of these outcomes to be part of the ABET process on a voluntary basis is limited. From the data, it is concluded that in order to increase the number of programs, and thus the number of students that explicitly connect the students education in the realms of humanities and social sciences to their education in engineering, there must be explicit ABET expectations delineated.

### **Humanities and Social Sciences in BOK3**

As stated in the introduction, this paper explores outcomes in humanities and social sciences in an effort to inform those interested in and involved with the preparation of BOK3. Therefore, based on the reviews of the literature, ABET, BOK1, BOK2, survey results, and online inventory, three recommendations are made with regard to humanities and social science outcomes in BOK3. These three recommendations are alternatives that can be incorporated into the preparation of BOK3 and are mutually exclusive (meaning that one or all of these recommendations could be adopted).

Recommendation 1- Enhance the level of student learning of the humanities and social science objectives by raising the level of student achievement from application (level 3) to analysis (level 4) in Bloom’s taxonomy. Based on BOK2<sup>7</sup>, the application level requires that the students “demonstrate the importance of the humanities/social sciences in the professional practice of

engineering” while the analysis level requires that the students “analyze a complex problem informed by issues raised in the humanities/social sciences and apply these considerations in the development of a solution to the problem.”

Recommendation 2- Connect the Foundational outcomes directly with the Technical and Professional outcomes that correlate to humanities and social science disciplines. Professional outcomes (such as sustainability, contemporary issues and historical perspectives, risk and uncertainty, project management) as well as Technical outcomes (including communication, public policy, business and public administration, globalization, leadership, teamwork, attitudes, lifelong learning, and professional and ethical responsibility) can be directly in support of the need for humanities and social sciences (Table 3).

**Table 3: Professional and Technical Outcomes Relevant to Humanities and Social Sciences**

Category	Outcome #	Outcome Name	Examples of Relevant Humanities and Social Science Disciplines
Professional	10	Sustainability	Anthropology, Environmental Studies, Economics, Law
	11	Contemporary Issues and Historical Perspectives	History, Religion, Law
	12	Risk and uncertainty	Economics
	13	Project management	Law, Economics
Technical	16	Communication	Linguistics, Language, Media, Literature, Performing Arts
	17	Public Policy	Law, Politics, Political Science, Economics
	18	Business and Public Administration	Law, Political Science, Economics
	19	Globalization	Cultural Studies, International Relations, Religion, Classics
	20	Leadership	Politics, Psychology
	21	Teamwork	Sociology, Psychology
	22	Attitudes	Psychology, Philosophy
	23	Lifelong Learning	Education
	24	Professional and Ethical Responsibility	Criminology, Law, Psychology, Philosophy

Recommendation 3- Connect the humanities and social science outcome to the ASCE Vision 2025 statement. The ASCE Vision 2025<sup>16</sup> statement begins with the phrase “entrusted by society to create a sustainable world and enhance the global quality of life, civil engineers serve competently, collaboratively, and ethically as master...” and continues with five objectives shown in Table 4. The phrases in the vision statement can be directly supported by humanities and social science disciplinary areas.

**Table 4: ASCE Vision 2025 and Relevant Humanities and Social Science Disciplines**

<b>Phrase from ASCE Vision 2025<sup>15</sup> Statement</b>	<b>Keywords</b>	<b>Examples of Relevant Humanities and Social Science Disciplines</b>
Entrusted by society to create a sustainable world and enhance the global quality of life, civil engineers serve competently, collaboratively, and ethically as master...	Sustainable Society Global Ethically	Sociology, Law, International Relations, Economics, Philosophy, Languages, Cultural Studies
planners, designers, constructors, and operators of society's economic and social engine-the built environment;	Planners Designers Economic Social	Law, Economics, Political Science, Sociology
stewards of the natural environment and its resources;	Environment Resources Stewards	Environmental Studies, Economics
innovators and integrators of ideas and technology across the public, private, and academic sectors;	Technology Innovators Public Private Academic	Education, Public Administration, Economics
managers of risk and uncertainty caused by natural events, accidents, and other threats; and	Risk Uncertainty Managers Natural events Accidents Threats	Economics, Law, Political Science, Public Administration
leaders in discussions and decisions shaping public environmental and infrastructure policy.	Leaders Public Environmental Policy Decisions	Public Administration, Environmental Studies, Law, Economics, Sociology

### **Discussion of Recommendations**

These three recommendations are alternatives for emphasizing humanities and social sciences in the engineering curriculum. The first recommendation enhances the level of achievement in order to strengthen student learning in these areas while the second and third recommendation provide context for how the disciplines can be linked to civil engineering goals and objectives.

In terms of implementation methods within curricula, schools vary between a very prescriptive set of courses that achieve the general education requirements versus a more broad set of requirements that ultimately allow the student to make a choice of how their general education courses will fulfill the requirement. The choice of approach is best left to the individual programs such that the programs can build upon the resources available. Adoption of any or all of these recommendations, or the development of alternative approaches, can only result in civil engineering graduates that are better equipped to incorporate social and humanistic considerations in solving multidisciplinary engineering problems.

## Conclusions and Recommendations

The essential nature of humanities and social sciences to the practice of civil engineering was briefly reviewed. ABET originally stated a philosophical need for humanities and social sciences and developed specific curricular requirements about this philosophy. In the subsequent move to an outcome-based ABET criteria, expectations for humanities and social sciences were diminished. BOK1 and BOK2 were analyzed for their handling of humanities and social science outcomes. The original BOK had no explicit humanities or social science outcomes although had other professional outcomes that build upon a foundation of humanities and social sciences. BOK2 reorganized and added outcomes including specific outcomes for both humanities and social sciences. These two outcomes were collected with those for mathematics and natural sciences into a category named Foundational outcomes. Since then, a committee was charged to revise the CEPC in light of BOK2 and draft CEPC criteria were developed. Outcomes from BOK2 were adopted either directly or with modification where deemed appropriate by the committee. Any reference to direct humanities and/or social science outcomes in the new draft CEPC are conspicuously absent although certain new requirements, such as sustainability, are founded upon concepts in the humanities and social sciences. While the focused audience of this paper are the future participants in the BOK3 efforts, the fact that there are no explicit humanities or social sciences expectations in the current ABET General Criteria suggests the need to strengthen ABET criteria in this regard.

In order to investigate existing program outcomes, a survey of programs and the program outcomes of nearly 40 randomly selected civil engineering programs were examined with a specific focus on the influence of BOK2 upon their ABET outcomes. Adoptions of outcomes from BOK2 into ABET outcomes are optional and few programs have directly adopted the BOK2 outcomes. In contrast, virtually all programs have adopted the required 3(a) through 3(k) outcomes. The lack of humanities and social science outcomes does not provide definitive commentary on how these outcomes are valued; say as compared to mathematics and natural sciences. It is believed the lack of humanities and social science outcomes in current programs can be attributed to two reasons:

1. Programs are reluctant to take on more responsibility for direct assessment and tracking of results than absolutely necessary.
2. Programs do not value humanities and social sciences in the same way as they value mathematics and natural sciences and thus do not feel the need to elevate their importance by having humanities and social science outcomes.

Even with explicit BOK2 outcomes in the humanities and social sciences, it is clear that until these are adopted by ABET as general education outcomes or included in CEPC, few programs will adopt them voluntarily.

As a result, specific recommendations for BOK3 with regard to humanities and social sciences are provided. These recommendations include (1) raising the level of achievement of the humanities and social sciences outcomes, (2) linking the Foundational outcomes directly with the Professional and Technical outcomes, and (3) connecting humanities and social sciences outcomes with ASCE's Vision 2025. In general, it must be acknowledged that most programs, to one degree or another, attempt to make connections between student's coursework in the humanities and social sciences and the student's education in civil engineering. The importance

of these efforts should be acknowledged and efforts to raise the bar with respect to outcomes in humanities and social sciences within individual programs should be encouraged.

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