
**Preparing Civil Engineers for 2020:
A Curricula Design Project at Iowa State University**

ASEE North Midwest Conference
October 9-11, 2003
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Background:

Today's world is fundamentally challenging the way civil engineering is practiced. Our profession has become more complex with issues such as technological advancements, increased stakeholder involvement, decaying infrastructure, additional environmental regulations, globalization, and population changes. To effectively manage this complexity, the future civil engineer will need additional knowledge, skills, and attitudes. This will require additional education beyond the bachelor's of science in civil engineering to ensure the high standards of the profession are maintained or enhanced.

How do we train this future engineer? To start, we do our best to determine what the future needs and issues will be in our profession. Based on those future demands, we can anticipate the broader and deeper suite of knowledge, skills, and attitudes the newly licensed civil engineer will need to function effectively. Lastly, we develop educational and experiential opportunities to assure their success in the highly challenging civil engineering environment of the upcoming decades.

ASCE Proposed Plan:

Recognizing the need for the future civil engineer to be ready to face new challenges, the American Society of Civil Engineering (ASCE) created a Task Committee on Academic Prerequisites for Professional Practice (TCAP³) to develop a plan that includes future requirements for licensure and the practice of civil engineering at the professional level. One step taken by TCAP³ in carrying out its charge was to form the Body of Knowledge (BOK) Curricula Committee. This constituent committee was, in turn, charged with defining the BOK (knowledge, skills, and attitudes) and developing a plan to provide the BOK required to enter the practice of civil engineering at the professional level in the 21st century. This plan will be used to measure an aspiring civil engineer's preparation for licensure and practice of civil engineering at the professional level. The charge to the BOK Curricula Committee also includes addressing the role of experience and describing the responsibilities of faculty and practitioners in imparting the BOK.

The BOK Curricula Committee has proposed that the 21st century civil engineer at the professional level must have knowledge, skills, and attitudes in the following areas:

1. Technical core
2. Data analysis
3. Problem solving
4. Communicate

5. Engineering tools
6. Design
7. Teamwork
8. Project management/construction
9. Impact of engineering solutions in a global and societal context
10. Life-long learning
11. Professional and ethical responsibility
12. Business principles and public policy
13. Leadership
14. Contemporary issues
15. Specialized area

The proposed BOK includes the eleven Accreditation Board for Engineering and Technology (ABET) outcomes (elements 1-7; 9-10; and 14) and is expanded to include four new outcomes (elements 8; 12; 13; and 15) to address specialization, leadership, project management, construction, business, and public policy and administration.

ISU Involvement:

In November, a paper was presented by CCEE faculty members, Marlee Walton and T. Al Austin, at the 2002 National ASCE Conference which discussed the new Civil Engineering (CE) Integrated Program within the Civil, Construction, and Environmental Engineering (CCEE) Department. Through this presentation, the BOK Curricula Committee members noted that many of the proposed BOK outcomes were currently included in the undergraduate CE Integrated Program. Specifically, the integrated program, which began a phased implementation in the Spring of 2001, already covers:

- The 11 ABET outcomes
- Leadership
- Project management/construction
- Business principles/public policy

While the CE Integrated Program addresses nearly all the elements in the proposed BOK, it is uncertain if the elements are provided at the appropriate level of competency to assure civil engineers are successful in the future. Therefore, the BOK Curricula Committee invited Iowa State University's CCEE Department to be one of the selected institutes to develop a model curriculum to satisfy the BOK at the necessary competency level. To date, Iowa State University, Colorado State University, Western Michigan University, Rose-Hulman Institute of Technology, University of California – Los Angeles, and Case Western Reserve University are the six institutions selected to participate with the BOK Curricula Committee.

ISU Efforts:

To develop a model curriculum, it was necessary to first verify that the proposed fifteen BOK elements were acceptable. An ISU Team, consisting of CCEE faculty and CE Advisory Council members, discussed the proposed BOK. The ISU Team agreed with the proposed fifteen BOK elements.

The next questions facing the team were:

- What level of competency will be needed for each of the BOK elements?
- Where should the BOK elements be taught (BS; MS^{+/}-30; and/or experience)?
- What would a model curriculum to teach the BOK elements look like?

To determine the level of competency needed for the BOK elements, the team used three competency levels. These competency levels, adapted from the BOK Curricula Committee include:

- **Recognition** – represents a reasonable level of familiarity with a concept. At this level, the engineer is familiar with a concept, but lacks the knowledge to specify and procure solutions without additional expertise.
- **Understanding** – implies a thorough mental grasp and comprehension of a concept or topic. Understanding typically requires more than abstract knowledge.
- **Ability** – is a capability to perform with competence. An engineer with the ability to design a particular system can take responsibility for the system, identifying all the necessary aspects of the design, and match objectives with appropriate technological solutions.

The ISU Team members individually ranked the competency level desired for each of the fifteen BOK elements. The results were tabulated and averaged to provide competency levels relative to each element as shown in Table 1.

Table 1. Required Competency Levels for the BOK Elements

Recognition																
Understanding																
Ability																
	Technical core	Data analysis	Problem solving	Communicate	Engineering tools	Design	Teamwork	Project management/ construction	Impact of solutions	Life-long learning	Professionalism and ethics	Business and public Policy	Leadership	Contemporary issues	Specialized area	

According to the results, a civil engineer at the professional level in the 21st century should have ability in the technical core, data analysis, problem solving, communication, design, teamwork, and in project management/construction. These engineers would have an understanding of the impacts of solutions; life-long learning; professionalism and

The table illustrates the high expectations with the bachelor's of science program and work experience. However, additional training is required to prepare the civil engineer of the future.

Future Direction:

The ISU Team still has one question to address – “What would a model curriculum that teaches the fifteen BOK elements look like?” Currently the team members are evaluating options including a modified master's of science program, a modified certificate program, and a dual degree program.

While the ISU Team hopes to complete their tasks within the next year, it is anticipated that the requirement and assessment process for the BOK will not be in place for until 2020. This delay is largely due to the complexities associated with assessing future civil engineers fulfillment of the BOK.

Conclusion:

To effectively manage the complexity of the future in the face of rising uncertainty and ambiguity, civil engineers require additional fundamental knowledge. More education for our future civil engineers means a safer, better future for the public who rely on the value judgment, and services the profession provides. The ISU CCEE Department is excited to participate in a national effort to develop an educational model to meet these challenges of the 21st century.

Reference:

American Society of Civil Engineers (ASCE) Body of Knowledge (BOK) Curricula Committee of the Task Committee on Academic Prerequisites for Professional Practice (TCAP³). 2003. *Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future*