AC 2010-667: ADOPTING THE BOK2: THE QUEST TO SLAY THE MULTI-HEADED HYDRA

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Abstract

In 2008, the American Society of Civil Engineering (ASCE) published the Civil Engineering Body of Knowledge, Second Edition (BOK2), reflecting ASCE's vision of the skills and knowledge the next generation of civil engineers must acquire. The program outcomes set forth in the BOK2 were significantly clearer, specific and detailed than those in the original body of knowledge. The Department of Civil Engineering at Lawrence Technological University decided to adopt the BOK2 in spring 2008 as part of the annual program objectives/outcomes review process. There was extensive debate on the prudence of adopting a new standard just two years before the ABET accreditation visit in 2010. The department's commitment to continuous improvement, however, was the eventual impetus for adoption of the BOK2. This paper provides an overview of the challenges faced and the various approaches taken by the department in its mission to integrate the BOK2 into the civil engineering program. Similar to battling the mythical Hydra, every time it appeared that a question was satisfactorily addressed, two additional questions arose in its place. It became clear that the department's quest to slay the Hydra—fully infusing the program with the BOK2 outcomes—could not be accomplished by selectively tweaking courses. Rather, as this paper discusses, a complete review of every aspect of the program was necessary, including the educational objectives, the program outcomes, and the objectives for each required course. Ultimately, it was a two-year process of program assessment, evaluation and modification to fully implement the BOK2.

I. Introduction

A. Overview of the Department of Civil Engineering

Lawrence Technological University (Lawrence Tech) is located in Southfield, Michigan, a suburb of Detroit. The present-day Department of Civil Engineering (Department) commenced operations in the early 1990's, and was initially accredited as Civil Engineering by ABET in 1993. There are approximately 160 students in the undergraduate program, including approximately 40 civil engineering/architecture dual degree students.

The Department employs eight full-time faculty members, covering six of the subdisciplines. In a given semester, up to four adjuncts will serve as instructors for the undergraduate program.

To graduate, students are required to pass at least one course in each of the recognized civil engineering subdisciplines: environmental, construction, structural, transportation, water resources, geotechnical and surveying. Students may then specialize in one or more of the subdisciplines by enrolling in several available electives. To complete their education, students participate in a two-course capstone design sequence during their senior year.

Historically, a majority of civil engineering graduates find employment in southeastern Michigan. Over the last couple of years, however, a growing number of graduates are accepting

employment with out-of-state engineering and construction firms. Additionally, many students are pursuing advanced engineering and business degrees.

The Lawrence Tech website is located on the Internet at: www.ltu.edu

B. Overview of BOK2

The American Society of Civil Engineers (ASCE), when it published *Policy Statement 465 (PS 465), Academic Prerequisites for Licensure and Professional Practice*[i], committed itself to creating a body of knowledge (BOK). Among other things, the BOK would address the requirements for a baccalaureate degree in civil engineering. ASCE encouraged institutions, such as universities, to support and implement the BOK.

Implementation of PS 465 commenced in earnest with the publishing of the initial Body of Knowledge (BOK1) in 2004. Almost immediately a committee was formed to address input from various stakeholders by creating a second edition (BOK2).[ii]

Although the direct progeny of PS 465 and BOK1, the content of the BOK2 was also strongly influenced by the *ABET Criteria for Accrediting Engineering Programs*, which includes the Program *Criteria for Civil and Similarly Named Engineering Programs*. The ABET criteria covers generic engineering outcomes, such as "an ability to identify, formulate, and solve engineering problems," and also specific outcomes, such as "apply knowledge of four technical areas appropriate to civil engineering."[iii]

The BOK2 Outcomes, as adopted by the Department of Civil Engineering at Lawrence Tech, are attached as Exhibit A.

II. Initial Skirmishes: Glimpses of the Hydra

A. Initial Adoption of BOK2

In 2004 the Department, in conjunction with the review of its program educational objectives, published its revised Program Outcomes, as set forth below:

> *The Civil Engineering Department at Lawrence Technological University will offer a program in which our graduates have:*
>
> *(a) an ability to apply knowledge and principles of mathematics, science, and engineering in the solution of civil engineering problems*
> *(b) an ability to design and conduct experiments, as well as to analyze data and interpret results*
> *(c) an ability to design a civil engineering system, component, or process to meet desired project needs*
> *(d) an ability to function on multi-disciplinary teams including participation in a senior-level design project sequence*
> *(e) an ability to identify, formulate, analyze, and solve engineering problems*

(f) an understanding and appreciation of all aspects of professionalism including ethical responsibility, participation in professional organizations, and service
(g) an ability to communicate effectively developed through report writing and in-class presentations
(h) the broad education necessary to understand the impact of engineering solutions in a global, sustainable, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) an ability to apply the fundamentals of civil engineering to the analysis of an existing project component
(m) an understanding of the benefits of passing the FE exam and becoming a licensed professional

The framework for the Department outcomes was borrowed from the familiar ABET (a)-(k) program outcome criteria. Based on input from various program stakeholders, such as faculty, the Civil Engineering Advisory Board (Advisory Board) and program alumni, the Department built on this framework to create outcomes that were geared more towards a contemporary civil engineering curriculum.

While a few of the ABET outcomes were adopted with their original wording, most were revised to one extent or another. For example, to make the outcomes less generic, the term "civil engineering" was inserted in (a) and (c). More subtle revisions were also made: in (b), "results" was used in lieu of "data"; in (h), "sustainable" was substituted for "economic." Based on significant constituent input, the Department adopted two additional outcomes: (l) was created to again place more emphasis on the civil engineering discipline, rather than generic engineering, and (m) was an acknowledgement of the importance of professional licensure.

Early in 2008, during the regularly scheduled programmatic review, faculty discussed the possibility of revising the program outcomes to include ABET Civil Engineer Program Criteria, which would align the outcomes with the ASCE BOK1. The outcomes were subsequently revised and expanded, and disseminated as part of the constituent review process.

A member of the Advisory Board, who was intimately familiar with the ASCE BOK Committee and ABET, encouraged the Department to consider adopting the BOK2. Although it was still in draft form, the BOK2 was scheduled for release later in the year.

The Department agreed to conduct an initial review; at that time, however, most faculty members did not fully appreciate the amount of time and effort required to fully implement the BOK2. Indeed, the most crucial concern was how the updated program outcomes would affect the ABET accreditation visit, tentatively schedule for fall 2010. The concern was three-pronged: the first two prongs were generally internal considerations, while the third prong was external to the Department.

1. *Could the Department fully implement the BOK2 in the available time frame, with sufficient thoroughness to improve the curriculum?* Under normal circumstances, engineering faculty have a multitude of responsibilities with respect to their courses, research and university service. Adding the adoption of BOK2, which almost doubles the number of program outcomes previously reviewed, seemed a daunting task.

2. *Could the Department implement the BOK2 with sufficient understanding and thoroughness to satisfy ABET criteria?* Even in perfect situations, most civil engineering departments would be overcome with trepidation when preparing for an ABET accreditation visit. The faculty's dread was magnified at the thought of attempting to satisfy ABET criteria with freshly minted program outcomes.

3. *Would the ABET evaluator be knowledgeable on BOK2?* Since the BOK2 was so recently published, there was a distinct possibility that ABET may not have an evaluator knowledgeable on the BOK2, much less experienced at reviewing programs employing the BOK2. Like a newly passed law that has not been tested in court, the BOK2 would likely not have been invoked more than a few times, if at all. Moreover, extending the simile, an untested law is susceptible to varying interpretations, as well might the BOK2 outcomes.

Faculty recognized that it had varying degrees of control over the answers. For numbers one and two, the response simply was to do whatever it took to make it happen; full commitment was required by each member. Question number two, however, was still somewhat subject to evaluator interpretation. Faculty believed, however, the adoption of BOK2 demonstrated continuous improvement, and as such would trump any perceived weakness in fully satisfying all outcomes.

Question number three was recognized as the consideration most out of the Department's control. There was no guarantee that any particular evaluator would have extensive knowledge of the BOK2. Thus, the only way to mitigate this potential circumstance was to request an evaluator who had the requisite experience. If no such evaluator existed, the faculty was resigned to having to educate the evaluator on all salient aspects of BOK2.

B. Revision of Civil Engineering Program Educational Objectives

The Department assessment plan requires review of the program educational objectives (PEOs) every three years. In general, the review process commences with faculty, if it deems changes are necessary, proposing changes. At the annual meeting of the Board, the proposed PEOs with supporting program outcomes are presented for comment and suggestions. Based on the Board's response, revised PEOs are then disseminated for further consideration. Another layer of review is added when comments are solicited from recent civil engineering alumni. Faculty reviews any potential additional revisions, puts the PEOs into final form and publishes them electronically.

Prior to adoption of the BOK2, the last time the PEOs were revised was in 2004, just before the last accreditation cycle. Although the focus of the BOK2 is on program outcomes, the faculty

determined that all aspects of the curriculum would be affected. Indeed, one of the heads of the Hydra certainly represented the potential changes to the existing PEOs, set forth below:

The objectives are to offer a program:

- *designed to provide students with a strong understanding of the fundamental principles of engineering;*
- *where students have the ability to identify the problem, formulate and analyze engineering alternatives, and solve the problem individually as well as in a team environment;*
- *that prepares students to apply contemporary computer based skills for the solution of civil engineering problems;*
- *that prepares students to effectively communicate in a professional engineering environment; and*
- *that stresses all aspects of professionalism including the need for professional development through life-long learning and the benefits of becoming a licensed engineer.*

After several rounds of discussions and proposed revisions, the faculty generated draft PEOs and submitted them for Board consideration. The final version of the most recent PEOs set forth below are the result of the complete review process:

The objectives of the Department of Civil Engineering are to offer a program that:

- *provides a strong foundation in mathematics, natural sciences, humanities and social sciences as a basis for developing into a well-rounded engineer;*
- *provides an essential understanding of the fundamental principles of engineering;*
- *develops the ability to identify and analyze problems with realistic constraints, devise and critique engineering alternatives, and formulate solutions both individually, as well as in a team environment;*
- *allows for the application contemporary skills for the solution of civil engineering problems, as well as the application and integration of the project management process;*
- *develops effective communicators in engineering and business environments and encourages positive contributions to all levels of public policy decision-making; and*
- *stresses professionalism, leadership and committing to professional development through life-long learning and licensure; and encourages community and professional service, and the need to act ethically in all matters.*

Virtually all the revisions to the PEOs have their genesis in the BOK2. Indeed, several outcomes are specifically cited, while action verbs—a primary element of Bloom's Taxonomy—are utilized to describe the learning path to the outcome. For example, the first bullet was updated to directly list the foundational outcomes covered in BOK2. The third bullet connotes the abilities needed to apply critical thinking, while employing the classic Bloom's action verbs: identifying, analyzing and proposing solutions to real-life engineering problems.

The fifth bullet initially addresses communication, an important component of the program outcomes. Public policy, which is a new outcome, is then denoted. The last bullet is somewhat of a catch-all, specifically mentioning three BOK2 outcomes, while hinting at a fourth: attitudes.

C. Review Process for Program Outcomes

Clearly, the adopting the BOK2 would trigger the need for an extensive review of the curriculum. Be that as it may, it was difficult to create and initiate a plan to battle the hydra. The Outcome Review Flowchart in Figure 1 was not generated prior to commencing the process. Rather, it evolved as the process evolved. Indeed, the simple boxes and straight lines suggests an easy path to implementation; in reality, the original review was relatively chaotic.

An example of this evolution was the fact that the process unexpectedly became iterative. Often faculty assume that a particular subject was finalized, Additional questions would arise, however, requiring faculty to revisit the subject and rehash old ground. The Hydra never gave up easily.

As depicted in Figure 1, the initial tasks for outcome review required the entire faculty to participate in the establishing of the appropriate achievement level for each outcome. Next, each outcome was mapped to one or more required courses. The decision diamond signifies the discussion and decision iteration for determining whether the current curriculum sufficiently addressed all the outcomes. To aid in this task, the faculty developed the Program Outcomes Coverage Matrix. The required courses component of the matrix is attached as Appendix B.

The next step in the process was for individual faculty members, in their capacity as course coordinators, to evaluate and, if necessary, revise course objectives. To determine whether the appropriate outcome achievement levels for each course were attained, student learning was assessed. If the appropriate levels were not achieved, potential revisions to the courses were discussed and implemented. Even if the appropriate levels were attained, courses were still subject to a periodic curriculum evaluation and possible revision.

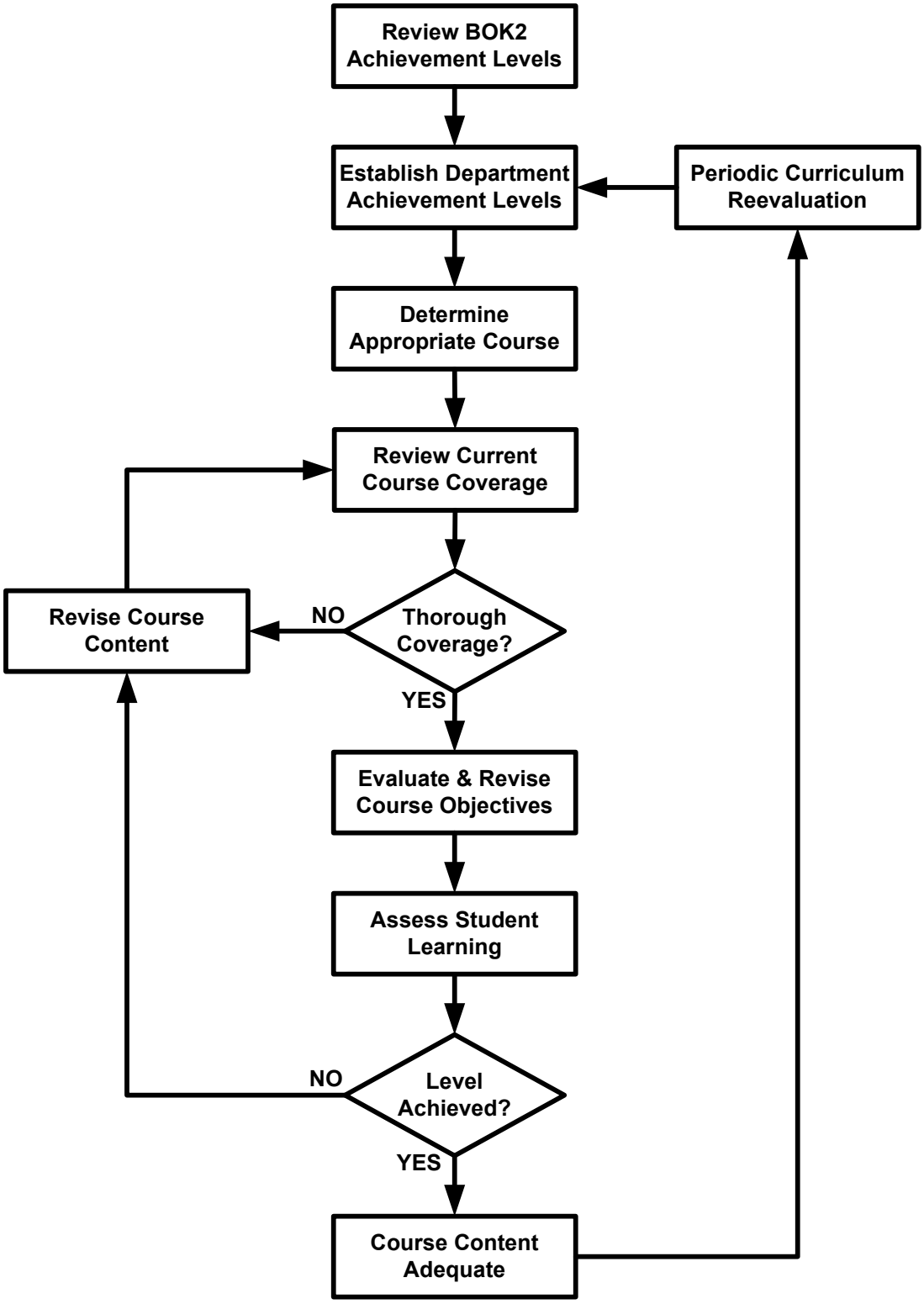

Figure 1 Outcome Review Process Flowchart

III. Challenges: The Hydra Rears its Ugly—and Numerous—Heads

For a business in any industry, a major change in a particular process often creates a monster that is difficult to tame, much less defeat. A university program is no different than a business when it comes to the painfulness associated with change. However, because adoption of the BOK2, to one degree or another, affected all areas of the civil engineering curriculum, slaying the monster became especially problematic. The BOK2 monster morphed into the dreaded Hydra—the mythical beast that attacks with multiple, ferocious heads—raising issues and creating challenges affecting all areas of the civil engineering curriculum.

A. Educating Faculty

When the Department decided to adopt the BOK2 Outcomes, we discovered that several faculty members had never been exposed to the BOK1 much less BOK2. Therefore, the concept of a professional body of knowledge was unknown to them. Consequently, a significant amount of time was dedicated to general discussions with respect to the intent of the BOK2.

Eventually the faculty developed an understanding of BOK2 sufficient to agree to embark on full implementation. Admittedly, a deeper appreciation for the concept of a body of knowledge did not develop until the outcome review process was well underway. It was then that faculty members began to understand the depth and importance of the BOK2.

While dissecting the meaning of the outcomes in BOK2, the Hydra again appeared. Several faculty members were only vaguely aware of Bloom's Taxonomy, which serves as the underpinning for the descriptions of the outcomes. Remedial discussions were held on Bloom's, and how the levels of cognitive achievement fit into the BOK2 equation. While the faculty developed an understanding of Bloom's, intense discussions still occur with respect to competing interpretations of various terms.

Because the civil engineering program caters to both day and night students, it is usually necessary to employ several industry practitioners as adjunct professors. The Department hosted evening meetings with the adjuncts to, among other things, update them on ABET accreditation preparations and to acquaint them with the BOK2. The attendees were bombarded with terms that, while they were well known in academia, they were relatively unfamiliar in industry. Terms such as assessment, program outcomes, ABET criteria and BOK2 required defining and discussion.

Even though some adjuncts had served as instructors in the Department for several years, and were knowledgeable about concepts such as course objectives, there was still confusion. There was little understanding as to the connection between course objectives and program outcomes. Moreover, the adjuncts were conflating ABET requirements with BOK2 Outcomes. It became evident that the Department assessment coordinator should meet with each adjunct individually to discuss the BOK2, with special emphasis on explaining the new program outcomes, how they

should translate into course objectives, and at what level of achievement their students should have upon course completion.

B. Setting Levels of Achievement

The BOK2 sets forth a recommended achievement level for each outcome at the baccalaureate stage. It is apparent a significant amount of thought by the BOK Committee went into the level determination. Regardless, the levels for most outcomes were subjected to spirited debate by faculty members.

The most contentious and prolonged debates revolved around the subtle differences between various action verbs in Bloom's Taxonomy. For example, is there any substantive difference between *solving* a problem and *analyzing* and *solving* a problem? One professor might see no appreciable difference—after all, doesn't an engineer need to analyze a problem before solving it? Are they not part and parcel to each other? Another professor might respond that there is a substantial difference; real analysis is definitely at a higher level.

The language in the BOK2 is non-prescriptive; that is, it is sufficiently non-specific such that each civil engineering program may determine for itself how to satisfy each outcome. As such, it is left to the faculty to determine the appropriate level of achievement for each outcome. The first question by faculty would always be whether the current civil engineering curriculum would support higher levels than those recommended in BOK2.

Each outcome was discussed thoroughly, and, with a few exceptions, most of the recommended levels of achievement were accepted by faculty. Outcome 7: Experiments was discussed at length and faculty decided that the curriculum went beyond *analysis* and into *synthesis*. Outcome 16: Communication was similarly dealt with. The BOK2 recommendation was a level 4, analysis: "Organize and deliver effective…communications." After much discussion, faculty determined that the curriculum reached level 5, synthesis: "Plan, compose and integrate… communication."

The faculty did determine that the current curriculum could not meet Outcome 19: Globalization, which requires students to solve engineering problems with a global context. None of the existing courses focused on global engineering problems as described in the BOK2. Faculty decided that level 2, comprehension, was sufficient, as opposed to level 3, application, given our program objectives.

C. Confirming Course Coverage of Outcomes

Significant and lengthy debates occurred over the issue of course coverage of outcomes. It took several meetings before the creation of the initial draft of the coverage matrix (see Appendix B). The changes ran the gamut from simple rewording of course objectives to promoting an elective course to a required course to ensure student attainment.

Early discussions did yield a couple of formal rules of engagement, both of which were driven by ABET accreditation considerations. For example, except for Outcome 14: Breadth in Civil

Engineering Areas and Outcome 15: Technical Specialization, the BOK2 does not require reaching the highest achievement level in more than one course. Be that as it may, the faculty determined it was prudent to introduce redundancy into the system by meeting the highest levels of each outcome in at least two courses. In the event the appropriate level of achievement was not attained for a particular outcome in one course, the student may have attained the required level in a second course.

Another rule required the achievement of all outcomes in required courses. Although it was commendable to attain high achievement levels in elective courses, to satisfy ABET requirements the Department needed to guarantee that all students would attain all outcomes. No such guaranteed could be given if the Department relied on electives for certain outcomes.

An important coverage issue revolved around a new outcome. By creating Outcome 13: Project Management, the BOK2 underscored the importance of construction engineering as a subdiscipline. The civil engineering curriculum, however, is essentially design-oriented; construction engineering courses are generally offered as electives. In order to attain the achievement level for Outcome 13, the *CE Management Practices* course was promoted from an elective to a required course. *CE Management Practices* also provided a platform for reaching the highest achievement levels in other outcomes, such as Outcome 14: Breadth, Outcome 16: Communication and Outcome 17: Public Policy.

D. Developing New/Additional Assessment Tools

The Department employs a robust multi-tool assessment program which includes direct assessment of student learning. Prior to adoption of the BOK2 Outcomes, a relatively straightforward process existed to document student learning. Student work was collected in senior level courses on a rotating basis, such that not every course was assessed every semester. A faculty subcommittee would assign a numeric score for each outcome, based on a five-point scale: a "1" indicated "no demonstration" and a "5" indicated "advanced demonstration."

Upon adoption of the BOK2, the process became much more difficult to implement, track and assess. The additional outcomes required the faculty to collect a larger volume of student work for evaluation. While the larger volume was anticipated, there were some unanticipated problems: Enter the Hydra.

Adopting the BOK2 dictated the sampling of a greater number of courses to verify student achievement (see Appendix B), necessitating the collection and evaluation of significantly more work. Furthermore, the scoring became problematic because the assigned numeric scores were confused with the Bloom's Taxonomy designations for the levels of achievement. Proving that the Hydra is alive and well, this situation is not yet resolved.

Finally, the Department recognized the need for improved tools to properly assess and score student work as it related to the BOK2 Outcomes. Examples include the revised writing and presentation rubrics employed in the senior capstone sequence. BOK2 language, including descriptions of the levels of achievement, were utilized in the development of the rubrics, which greatly assisted with communicating course expectations to students.

IV. Conclusion

Implementing the BOK2—a worthwhile task, no doubt—is nonetheless arduous and time-consuming. The goal of this paper was to forewarn of the danger of the Hydra; i.e., the numerous potential pitfalls civil engineering programs must consider when discussing whether to adopt the BOK2.

As demonstrated by the flowchart in Figure 1 and the accompanying discussion, full implementation required the faculty to participate in an iterative process. Although at first blush it appeared that implementation would be relatively simple, numerous issues soon arose that lengthened and complicated the process.

Probably the main reason the Department was able to keep the Hydra at bay was that each faculty member bought into the implementation. Without this total commitment to continuous improvement, the process would have been even more painful, possibly interfering with teaching operations, as well as jeopardizing the effort to achieve full accreditation.

That is not to say that all tasks are 100% complete. Examples of unresolved issues include the need to further consider how best to address Outcome 12: Risk and Uncertainty in design courses, and whether the achievement level chosen for Outcome 15: Technical Specialization is appropriate for an undergraduate program. The ongoing iterative process of assessment and evaluation, dictated by continuous improvement, will undoubtedly reveal the need for additional adjustments to the curriculum.

The BOK2 addresses different aspects of its relevance to various civil engineering stakeholders, including faculty:

> "[A]ssists civil engineering and other faculty in designing curricula, creating and improving courses, and teaching and counseling students."

While the above is most certainly true, the Hydra nevertheless lurks in the tall grass.

V. Acknowledgement

The authors gratefully acknowledge the assistance of Richard O. Anderson, P.E. in the adoption and implementation of the BOK2. Without Mr. Anderson's encouragement and guidance the Hydra may very well have prevailed.

Appendix A
Department of Civil Engineering
Program Outcomes

Outcome Number and Title	To graduate with a B.S. Degree in Civil Engineering from Lawrence Technological University and enter the practice of civil engineering, the student must demonstrate competence in each of 24 Program Outcomes.
Foundational Outcomes	
1 Mathematics	***Solve*** problems in mathematics through differential equations and ***apply*** this knowledge to the solution of engineering problems.
2 Natural Sciences	***Solve*** problems in calculus-based physics, chemistry and geology, and ***apply*** this knowledge to the solution of engineering problems.
3 Humanities	***Demonstrate*** the importance of the humanities in the professional practice of engineering.
4 Social Sciences	***Demonstrate*** the incorporation of social sciences knowledge into the professional practice of engineering.
Technical Outcomes	
5 Materials Science	**Use** knowledge of materials science to ***solve*** problems appropriate to civil engineering.
6 Mechanics	**Analyze** and solve problems in solid and fluid mechanics.
7 Experiments	***Specify*** and ***design*** an experiment to meet a specified need; conduct the experiment and analyze, interpret and ***explain*** the resulting data.
8 Problem Recognition and Solving	***Develop*** problem statements and solve both well-defined and open-ended civil engineering problems by ***selecting*** and applying appropriate techniques and tools.
9 Design	***Design*** a system or process to meet desired needs within such realistic constraints as economic, environmental, social, political, ethical, health and safety, constructability and sustainability.
10 Sustainability	***Apply*** the principles of sustainability to the design of traditional and emergent engineering systems and ***explain*** how civil engineers should strive to comply with the principles of sustainable development in the performance of their professional duties.
11 Contemporary Issues and Historical Perspectives	***Explain*** the impact of historical and contemporary issues on the identification and formulation of solutions to engineering problems, and ***explain*** the impact of engineering solutions on the economy, environment, political landscape and society.
12 Risk and Uncertainty	***Apply*** the principles of probability and statistics and solve problems containing uncertainty.
13 Project Management	***Analyze*** a proposed project and ***formulate*** documents for incorporation into the project management plan.

14 Breadth in Civil Engineering Areas	***Analyze*** and solve well-defined engineering problems in at least four technical areas appropriate to civil engineering.
15 Technical Specialization	***Apply*** specialized tools or technologies to solve problems in traditional or emerging specialized technical areas of civil engineering.
Professional Outcomes	
16 Communication	***Plan, compose*** and ***integrate*** the verbal, written, virtual and graphical communication of a project to technical and non-technical audiences.
17 Public Policy	***Discuss*** and ***explain*** key concepts and processes involved in public policy.
18 Business and Public Administration	***Explain*** key concepts and processes used in business and public administration.
19 Globalization	***Explain*** global issues related to professional practice, infrastructure, environment and service populations as such issues arise across cultures and countries.
20 Leadership	***Explain*** leadership principles and attitudes and ***apply*** those principles and attitudes when making decisions and directing the efforts of a small group.
21 Teamwork	***Function*** effectively as a member of an intra-disciplinary team and ***evaluate*** the performance of the team and individual team members.
22 Attitudes	***Explain*** attitudes supportive of the professional practice of civil engineering.
23 Lifelong Learning	***Demonstrate*** the ability for self-directed learning and ***identify*** additional knowledge, skills and attitudes appropriate for continued professional practice.
24 Professional and Ethical Responsibility	***Explain*** the many aspects of professionalism and what it means to be a member of the civil engineering profession; ***analyze*** a situation involving multiple conflicting professional and ethical interests to determine an appropriate course of action.

Lawrence Tech University
Dept. of Civil Engineering

Appendix B
Program Outcomes Coverage Matrix

Required Courses

Foundational Outcomes					Technical Outcomes											Professional Outcomes								
Course	Math (1)	Natural Science (2)	Humanities (3)	Social Sciences (4)	Material Science (5)	Mechanics (6)	Experiments (7)	Problem Solving (8)	Design (9)	Sustainability (10)	Cont. Issues & Historical (11)	Risk & Uncertainty (12)	Project Management (13)	Breadth (14)	Technical Specialization (15)	Communication (16)	Public Policy (17)	Business & Public Admin. (18)	Globalization (19)	Leadership (20)	Teamwork (21)	Attitudes (22)	Lifelong Learning (23)	Prof. and Ethical Responsibility (24)
1012	3		2	2	2			3	3	2	2			2	2	4					3	2		3
1013	3						4	3			2			4		3					3			
1101								2							2									
1102	3							2				1												
1413		1			3	2	3	3	3		1	1		3	1	4					3			2
LDR2001																				3		3		
MCS3403												3												
3013	3	3			1	3		3	3					3		4								
3213					1	1			2				2	2		3	2	2						
3324	3	1					3	3	3		2			4		4	1							
3424	2	1			3	3	5	3	1			1		3	2	4					3			
3523	3					3		3						3										
3723	3	3				4		3	4					3										4
3823	3			3			3	3	2		3		2	4		4	2	2		2	2		3	4
4021				3	3	3		3	4	3		2	3	4	2	4	2	2		3	3	2	4	
4033				3	3	3		3	5	3		2	4	4	3	5	2	2		3	3	2	4	
4051			3							2	3					4	2		2	2		2	4	4
4243								4		2		2	4	4	3	5	2	2	2					
4544	3	3				4	5	4	4	3	3	3		4	3	4					3			
4743	3				2	3		3	4			1		4	1	5								4
4761	3					4	5		4			3		4		4					3			
Required Level of Achievement	**L3**	**L3**	**L3**	**L3**	**L3**	**L4**	**L5**	**L4**	**L5**	**L3**	**L3**	**L3**	**L4**	**L4**	**L3**	**L5**	**L2**	**L2**	**L2**	**L3**	**L3**	**L2**	**L4**	**L4**

[1] "Academic Prerequisites for Licensure and Professional Practice, Policy Statement 465", ASCE, http://www.asce.org/pressroom/news/policy_details.cfm?hdlid=15

[ii] "Civil Engineering Body of Knowledge for the 21st Century, Preparing the Civil Engineer for the Future, Second Edition", ASCE (2008).

[iii] ABET Criteria for Accrediting Engineering Programs, 2009-2010, http://www.abet.org/Linked%20Documents-UPDATE/Criteria%20and%20PP/E001%2009-10%20EAC%20Criteria%2012-01-08.pdf.