Ronald Welch, U.S. Military Academy
Colonel Ronald W. Welch is an Associate Professor at the United States Military Academy (USMA). He is a registered Professional Engineer in Virginia. COL Welch received a BS degree in Engineering Mechanics from USMA in 1982 and MS and Ph.D. degrees in Civil Engineering from the University of Illinois at Urbana-Champaign in 1990 and 1999, respectively.

Allen Estes, U.S. Military Academy
Colonel Allen C. Estes is a Professor and Civil Engineering Program Director at the United States Military Academy (USMA), West Point, NY. He is a registered Professional Engineer in Virginia. COL Estes received a B.S. degree from USMA in 1978, M.S. degrees in Structural Engineering and in Construction Management from Stanford University in 1987 and a Ph.D. degree in Civil Engineering from the University of Colorado at Boulder in 1997.

Fred Meyer, U.S. Military Academy
Lieutenant Colonel Fred Meyer is an Associate Professor at the United States Military Academy (USMA). He is a registered Professional Engineer in Virginia. LTC Meyer received a B.S. degree from USMA in 1984, M.S. and Ph.D. degrees in Civil Engineering from Georgia Tech University in 1993 and 2002, respectively.
Assessing Current Programs Against the New BOK

Abstract

Through the formal development of Policy 465, the American Society of Civil Engineers has defined the Body of Knowledge (BOK) that describes the knowledge, skills and attitudes necessary to become a licensed professional engineer.1,2 The BOK is presented in the form of 15 outcomes that prescribe the necessary breadth and depth of knowledge required for a practicing civil engineer. The levels of competence for these outcomes are defined as recognition, understanding, and ability. The attainment of the BOK is expected to occur through a broad undergraduate education, specialized education at the masters level, and practical experience during the pre-licensure and post-licensure periods.

As volunteer pilot programs that comprise the Curriculum Committee of the Committee on Academic Prerequisites for Professional Practice (CAP3) began to assess themselves against the new BOK using the definitions for recognition, understanding, and ability, they quickly determined that it was very difficult to accurately measure whether an outcome was met or not. While “recognition, ability and understanding” were chosen because they aligned with the terminology used in ABET3 outcomes, a more measurable definition for each level was needed. After much debate and research into alternative methods by the newly formed CAP3 Competency Committee, it was decided that Bloom’s Taxonomy4 for the cognitive domain is widely accepted and understood and provides the best avenue for assessing accomplishment of BOK outcomes. Ensuing discussions with the CAP3 Curriculum Committee concluded that a rubric of the six levels of Bloom’s taxonomy applied to the 15 outcomes was the best tool to qualitatively assess whether a course and/or program attained a certain level of achievement. Additional work in the Curriculum Committee established the level of Blooms that should be expected for each outcome at the undergraduate, masters, and practical experience periods of an engineer’s preparation to becoming a Professional Engineer.

The purpose of this paper is to present the methodology used by the West Point Civil Engineering program to assess its program against the BOK outcomes from the initial assessment using recognition, ability and understanding to the final assessment using the established rubric. The complete history of the numerous assessments provides insight into the process and rationale of the final methodology and levels of achievement. The assessment includes program strengths, areas for improvement, suggestions for a more detailed assessment and expected adjustments to the program and its outcomes to attain compliance with the BOK outcomes. The process may assist other programs using the new rubric to assess their own BOK compliance. This methodology provides another tool that can be used as part of the program self-assessment for future ABET visits.

I. Introduction

In a landmark effort to recognize that the civil engineering profession is growing increasingly complex while the number of credit hours in a typical undergraduate civil engineering curriculum is decreasing, ASCE adopted Policy 465 in October 1998 which stated that the
masters degree was the first professional degree for the practice of civil engineering. Recognizing that one of the characteristics of a profession is a body of knowledge (BOK), the ASCE Task Committee on Academic Prerequisites for Professional Practice (CAP) that was charged with implementing Policy 465 created a Body of Knowledge subcommittee. The Body of Knowledge (BOK) describes the knowledge, skills and attitudes necessary to become a licensed professional engineer. This BOK committee drafted the *Civil Engineering Body of Knowledge for the 21st Century*¹, which defines the BOK in terms of 15 outcomes and prescribes the degree of competency to be attained from formal education and experience prior to obtaining a professional license. The BOK committee was disbanded and the Curriculum Committee, Accreditation Committee, Fulfillment and Validation Committee, and Licensing Committee of CAP were formed to implement the BOK by developing curricula, establishing accreditation criteria, and coordinating with licensing jurisdictions. The work of these committees will proceed simultaneously and the implementation is expected to take two decades with intermediate milestones planned along the way.

The charge of the Curriculum Committee is to coordinate the development of new undergraduate and graduate curricula that are compatible with the BOK.² This includes finding existing curricula that already contain elements supportive of the BOK and share what is learned. The approach is to find a diverse range of universities that are willing to serve as design partners and develop model curricula that both incorporate the BOK and meet the needs of all universities whether they are public or private, large or small, research-focused or teaching-focused. To date, 18 universities ranging from Bucknell and Norwich to Penn State and the University of Nebraska have volunteered to participate. The committee formed in August 2003 and is scheduled to issue a final report that provides curriculum implementation strategies, suggests revisions to the BOK, and offers possible BOK-compliant curricula with commentaries sometime in 2006. The United States Military Academy (USMA) joined the partnership in October 2004.³

II. Body of Knowledge

The BOK is presented in the form of the 15 outcomes shown in Table 1 that prescribe the necessary breadth and depth of knowledge required for a practicing civil engineer. The BOK outcomes 1 – 11 are deliberately identical to ABET outcomes 3 a-k listed in the criteria for accrediting civil engineering programs.³ Outcome 12 focuses on specialization in a particular area of civil engineering. Outcomes 13 through 15 deal with leadership, business policy, and management which are not areas where engineering programs traditionally focus. As the policy comes to fruition, draft commentaries are being published that provide more specific guidance and elaborate on the intent of the BOK outcomes. The first edition of the BOK prescribes three levels of competency for these outcomes that are defined as recognition, understanding, and ability where:

- **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. For example, an engineer might recognize that a particular architectural plan poses significant construction difficulties without having the expertise to devise improved construction or design alternatives.
• **Understanding** implies a thorough mental grasp and comprehension of a concept or topic. Understanding typically requires more than abstract knowledge. For example, an engineer with an understanding of professional and ethical responsibility should be able to identify and to communicate ethical issues arising from a practical case study.

• **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. As an engineer develops, the engineer’s abilities also develop so that more challenging and difficult problems can be solved.

The reasoning behind the levels of competency is that attainment of the BOK is expected to occur through formal education and practical experience during the pre-licensure and post-licensure periods. Figure 1 shows where each level of BOK competency is expected to be attained. For the portion of the BOK that is expected to be achieved through formal education, the job of the Curriculum Committee is to define the expected relative contributions of the undergraduate and masters degree educations and to design curricula that support this.

III. The Initial Mapping Experience

The first task after joining the CAP Curriculum Committee was to map the USMA curriculum to the 15 BOK outcomes using the defined terms: O-No Competency, R-Recognition, U-Understanding, and A-Ability. The analysis was conducted independently by three senior faculty members who have taught most of the courses in the CE curriculum and who are very involved in curriculum development and course management within the civil engineering division. The activity was not new as some assessment of the contribution of courses in the curriculum to achieving outcomes 1 through 11 had already been done in preparation for accreditation visits. After generating independent assessments, the faculty team met, consolidated and compared their respective results, discussed the reasoning behind the ratings, and made changes when appropriate. Changes were typically made when one team member’s reasoning was particularly compelling or one rating included a key consideration ignored by the others. The results for outcomes 1 though 7 are shown in Table 2 where each faculty member’s rating of O, R, U, or A is listed in each box. Each box represents the contribution of a specific course or activity in the student’s four year West Point experience to a specific BOK outcome. Blank cells indicate that nobody felt that the specific course contributed to attainment of a particular outcome.

Although the information is only based on expert opinion, it represents a good start toward an initial assessment. Obviously the judgment regarding courses taught within the CE program is more reliable than that with respect to those courses taught outside the department. The average of the three faculty members’ final ratings comprised the score for the contribution of a specific course or activity to an individual BOK outcome. Weighted averages were useful in determining the degree to which the entire curriculum contributes to a specific outcome, relative to the others. In this analysis, the curriculum contributed most to Outcome 7 (Ability to communicate effectively), since virtually every course requires students to communicate thoughts or problem solutions orally or in writing. The overall attainment of an outcome competency after completing the entire curriculum became more of a judgment call. There may be ten courses that
contribute to attainment of recognition and understanding is finally achieved through a Capstone design course. A numerical manipulation of averages was not helpful in making this assessment.

After considerable discussion, the attainment of each BOK outcome was assessed from the combined contribution of courses and other activities in the student’s four-year experience. The results are shown in Figure 2 where the ratings reflect, for example, that the USMA CE majors upon graduation are fully able to attain recognition and understanding competency in the design of a system and are about 20% of the way to ability which entails being able to design an actual real world system applying sound engineering judgment. This final 20% is largely attributable to the Capstone Design course which incorporates a real structure and a genuinely open-ended design problem. Prior to that, all of the student designs, even in steel and concrete classes, were straight forward and had most of the ambiguity removed.

This same analysis was performed for the other BOK outcomes. The USMA CE majors graduate with full competence in many of the engineering software packages that they have used in the classroom. Their ability to use spreadsheets, MathCAD, drawing programs, Microsoft Project, watershed modeling software, structural analysis software, and the internet rivals the competence of most currently licensed engineers. In fact, many engineers in a design shop rely on the newer graduates to show them how to use the newest software. The USMA graduate exceeds what is expected from the undergraduate experience in the BOK in the areas of communication and leadership, largely due to the additional opportunities they have to practice both in realistic settings.

The areas where USMA students fall short according to the initial assessment are in Outcomes 2 (Experiments, Analyze and Interpret), 5 (Solve Engineering Problems), 12 (Specialized Area), and 9 (Lifelong Learning). The BOK expects that the undergraduate education will provide attainment of ability for outcomes 2 and 5. Most of the experiments that USMA students conduct are in a controlled laboratory environment and are canned exercises. The instructor and the students already have a good idea of what the results are supposed to be. Most student experiments lack the complexity and uncertainty found in a real world engineering situation. Similarly, many student engineering problems contain assumptions and simplifications that do not model real world complexity. The solution is not necessarily a change in the West Point curriculum, but perhaps a change in the expectation of what an undergraduate education is realistically supposed to achieve. Despite the attempted depth in the Structures sub-discipline of civil engineering, there is not sufficient coverage to attain the ability competency in a specialized area. That will need to be left to a graduate program. While the USMA CE program prepares students for life-long learning, full understanding will not occur until either graduate school or work experience when they will truly appreciate how much they still do not know.

VI. Suggested Changes Based on Committee Efforts

The Curriculum Committee met in early December 2004 to compare results among the curriculum design partners, discuss issues, and monitor progress towards a final report. The most difficult aspect of the mapping exercise was a problem encountered by other universities participating in this same project. The terms recognition, understanding and ability mean different things to different people, despite the attempts at a formalized definition. The
Curriculum Committee members struggled with this during telephone conference calls and during the face-to-face meeting in December in Reston.

Because educators are familiar with Bloom’s taxonomy as an acceptable way to communicate increased complexity and attainment in cognitive thought, it was suggested that Bloom’s prescribed levels (knowledge, comprehension, application, analysis, synthesis and evaluation) be incorporated into the definitions of recognition, understanding and ability. The Curriculum Committee decided to suggest to CAP the use of a mixture of terms from both Bloom’s taxonomy and a revised Bloom’s taxonomy to establish the three levels of BOK competency. The competency levels R (recognition), U (understanding), and A (ability) were replaced initially by competency levels 1, 2, and 3, respectively as defined below.

- **Level 1** – Retrieve relevant knowledge from long term memory and understand the meaning of oral, written, graphic, and other instructions. Abilities demonstrated at this level typically include, but are not limited to, recognizing, recalling, interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining. Attitudes especially supportive of this competence level are curiosity, respect, thoroughness. Level 1 represents familiarity with concepts.

- **Level 2** – Apply a procedure appropriate to a given situation, break material into constituent parts, and understand how the parts relate to one another and to an overall purpose, structure, facility, or system. Abilities demonstrated at this level include, but are not limited to, executing, computing*, simulating*, discovering*, evaluating*, implementing, differentiation, organizing, and attributing. Attitudes especially supportive of this competence level are confidence, persistence, and thoughtfulness. Level 2 means application of concepts.

- **Level 3** – Exercise judgments based on criteria and standards and synthesize elements to create a site/situation specific or novel, coherent structure, facility, system or products. Abilities demonstrated at this level include, but are not limited to, checking, evaluating*, critiquing, designing*, generating, combining*, rearranging*, revising*, planning, recommending*, producing, operating*, and maintaining. Attitudes especially supportive of this competence level are commitment, fairness, integrity, intuition, judgment, self-esteem, sensitivity, and tolerance. Level 3 is performing with competence.

Bloom’s taxonomy defines actions for the cognitive domain and not all of the outcomes neatly fall into the cognitive domain. The verbs with an asterisk were added as they commonly occur in engineering practice. Because so many faculty members rely on Bloom’s taxonomy for the creation of course objectives and lesson objectives for the curriculum that will ultimately lead to BOK competency, using Bloom’s classification to define the levels of competency is a logical approach. It was generally understood that competency level 1 approximated Bloom’s cognitive domain of knowledge – list, recite and comprehension – explain, paraphrase; competency level 2 approximated Bloom’s cognitive domain of application – calculate, determine, solve, apply and analysis – compare, contrast, categorize, classify, derive, model; and competency level 3 approximated Bloom’s cognitive domain of synthesis – create, construct, design, improve, produce, propose and evaluation – judge, critique, justify, verify, assess, recommend. It was
hoped that these definitions would provide additional clarity. These revised definitions resulted in only minor changes to the mapping of the USMA curriculum shown in Table 2 since the authors had already considered action verbs and activities related to R, U, and A (as it turned out R ~ Level 1, U ~ Level 2, and A ~ Level 3) when completing the initial assessment in order to approximately define R, U, and A in a way that made assessment possible for them.

The Curriculum Committee addressed the level of knowledge, skills, and attitudes obtained through the bachelor’s program based on the revised definition of the three competency levels. The discussion included the degree to which additional experience prior to or after formal education would improve the desired knowledge, skills, and attitudes; what level of competency should be covered by the bachelor’s education as opposed to the masters degree; and what reasonably should be accomplished at the bachelors level. The changes to the expected competency resulting from this discourse are shown in Figure 3.

The competency required for Outcome 1, the Technical Core, was reduced to Level 2. Only a mathematician or scientist would really achieve Level 3 and experience will not normally improve the engineer’s capability here. Recent graduates, for example, are the most qualified to take the Fundamentals of Engineering exam because experienced engineers have forgotten much of the technical core. The attainment expected at the undergraduate level for Outcomes 2 (Experiments) and 5 (Solve Engineering Problems) was lowered to Level 2. The Committee acknowledged the lack of realism that occurs in the classroom and only experience with interpreting data and defining real engineering problems will allow attainment of Level 3 capability. The practitioners on the committee advocated for continued level 3 attainment at the undergraduate level for Outcome 11 (Engineering tools). Exposure to a variety of modern tools can only occur at the formal education level and that in practice, those experiences will be needed to guide an engineer to choose the best tool, teach themselves to use it, and select other tools when appropriate.

There was wide agreement that Level 3 competency in Outcome 12 (Specialization) will have to be attained at the masters degree level. While Levels 1 and 2 competency are started at the undergraduate level, the Committee concluded that it would be difficult to share this responsibility, especially when a student completes specialization at the graduate level in a civil-engineering sub-discipline that may not be covered at all at his or her undergraduate institution. It was understood that most schools would be accomplishing Level 1 and some Level 2 in the sub-disciplines covered in the bachelors program, but the responsibility for proof of specialization would lie with the masters program that can validate transfer credits for fundamentals.

Outcomes 3, 4, 7, and 9 competency levels did not change where experience is required to move the engineer from Level 2 to Level 3. There was much discussion on the capability of the bachelors program to attain Level 2 for Outcome 9 (Life-Long Learning). The self motivation to attain additional formal education and the requirement for self-learning on the job will occur after the undergraduate experience. While the decision was close, the Committee concluded that the bachelors programs need to do more to promote an attitude of life-long learning and Level 1 competency was too easy to accomplish.
Undergraduate competency requirement for Outcomes 6 (Professional/Ethical) and 8 (Impact of Engineering) were actually raised from Level 1 to Level 2 for similar reasons that Outcome 9 (Lifelong Learning) stayed at level 2 in the preceding paragraph. It was time to hold the bachelor’s programs responsible for the knowledge, skills, and attitudes that lead to understanding professional and ethical standards and the impact of engineering on society. Competency requirements for Outcomes 10 (Contemporary Issues), 13 (Management), 14 (Business and Public Policy), and 15 (Leadership) remained at Level 1 for the bachelors program and Level 2 for experience prior to licensure. Only a large amount of post licensure experience would allow an engineer to attain Level 3 competence.

Given the new competency level definitions and revised requirements for the bachelor program, the three faculty member team re-mapped the courses against the 15 BOK Outcomes. The results of a revised USMA assessment are shown in Figure 4. Even though Outcome 12 (Specialization) is the sole responsibility of the master’s level, the USMA CE program does contribute to some level of competency in specialization, so it should be documented. Furthermore, the explicit decision to avoid splitting outcome responsibility between the bachelor and masters programs could be reversed in the future. The USMA competency attained in Outcome 1 (Technical Core) was reduced in light of the Curriculum Committee discussion. As shown in Figure 4, the revised initial assessment of the USMA program indicates a shortfall of the knowledge, skills, and attitudes for Outcome 9 (Life-Long Learning) and Outcome 14, (Business and Public Policy). The assessment for business and public policy was downgraded. The initial rating was based on averaging the assessment of business knowledge (sub-Level 1) and public policy awareness (almost Level 2). A new interpretation indicates that Level 1 ability is needed in both areas. Future USMA curriculum revisions will require more emphasis on business practices and issues.

After the Curriculum committee recommended the use of 3 levels mentioned above, CAP\(^3\) established the Competency Committee to study and recommend the best method of assessing the outcomes. After much debate and research into alternative methods by the Competency Committee, it was decided that the Curriculum Committee suggestion to use Bloom’s Taxonomy for the cognitive domain\(^4\) which is widely accepted and understood, provides the best avenue for assessing accomplishment of BOK outcomes. In fact, the interpretation of ABET Engineering Criteria may be rewritten using action verbs to define the level of expected activity; thereby, simplifying the interpretation greatly. During ensuing discussions between the Curriculum Committee and the Competency Committee (CAP\(^3\)) at the 2005 ASEE National Convention in Portland, it was decided that a rubric of the six levels of Bloom’s taxonomy versus the 15 outcomes (Table 3) was the best tool to qualitatively assess whether a course and/or program met a certain level of achievement. Additional work within the Curriculum Committee established the cognitive domain level of Bloom’s shown in the rubric that should be expected for each outcome at the undergraduate, masters, and practical experience periods of an engineer’s preparation to becoming a Professional Engineer. The faculty at West Point once again re-mapped their program using the new rubric and compared their results with the expected levels of achievement (Figure 5). The changes in definitions of achievement naturally drove the changes in achieved level seen in Figures 2, 4, and 5. Additionally, the numerous mappings and discussions have improved the understanding of the faculty as to what is actually accomplished and what is currently lacking in the program.
By this time, several other schools had assessed their program using the same successive series of rubrics established by the Curriculum Committee, and finally using the Competency Committee rubric shown in Table 3. The ensuing discussion in the Curriculum Committee noted that faculty who did not know the program beyond a few courses or were not comfortable using Bloom’s taxonomy to establish course and lesson objectives hindered the effort and prevented consensus among the team. What emerged was the USMA methodology for successful program assessment against the BOK, which allows a program to determine its strengths and areas that need improvement. Quite naturally, this methodology appears to be another tool that a program can use as part of its annual program assessment in preparation for future ABET evaluations. The ultimate goal is to determine where logical adjustments can be made to the program and resources applied to ensure all program outcomes are met.

V.  Current USMA Methodology for Curriculum Evaluation

The ratings shown in Table 4 were determined initially on the basis of departmental expert opinion. Members of the department who have taught many of the courses in the CE program and who are very familiar with the entire curriculum (to include individual focused discussion/study of courses outside of the department) evaluated the contribution of every course with respect to each BOK outcome using the six levels of Bloom’s taxonomy and their accompanying description as provided in Table 3. Bloom’s levels of cognitive skills provide a start point for discussion and help determine the actual activity level accomplished in each course. The quantity and quality of course activities helped establish the final Bloom’s level accomplished by each course. The overall assessment should include activities outside of the classroom that every student might be required to complete such as Summer Co-Ops, intramurals, military science courses, ASCE student chapter activities, F.E. review sessions, etc. You can see that those activities are summarized at the end of each year of courses (Table 4) if applicable only to that year or at the end if it pertains to all four years of the program.

After completing the ratings independently, the assessors (in this case three faculty members) met and discussed any Bloom’s level rating for a course versus a BOK outcome where individual ratings varied by more than one level. The overall ratings for each course against each BOK outcome were initially determined by simply averaging the Bloom level offered by each faculty member to set the conditions for discussion. The final rating for each outcome was agreed upon through active discussions on the content and activities present in each course or activity outside of the classroom. In many cases, faculty members changed their ratings based on the discussion, which either provided additional facts not previously considered or provided a different way to interpret the criteria.

The Bloom’s rating for each outcome is initially summarized at the bottom of Table 4 by the number of courses/activities outside of the classroom that reach each level of Bloom. These numbers are combined with the strength of coverage of the levels by a single course or a number of courses in determining the actual level of Bloom for each program outcome. Some members of the Curriculum Committee (CAP) advocated placing a dot for each course that has some coverage for a given outcome. Using that approach, there is no systematic means to determine and justify actual level of activity for the overall program. Some educators contend that with one
course getting to level 5 (synthesis), the program is at Bloom’s level 5. However, if the coverage of activities at level 5 is limited and there are numerous activities in a number of courses at level 4, then it is reasonable for the program to only take credit for getting to level 4 (analysis). Assessment based on the actual activity accomplished in each course enables a program to realistically determine where they need to increase the activity level to attain a certain Bloom’s level and where they might be able to reduce some of the activities to make room for other required activities (based on Bloom’s verbs).

While this assessment method offers a reasonable initial result, a higher quality analysis can be attained by mapping individual course objectives to BOK outcomes and examining student work. Over time, it should be possible to develop more quantitative methods that reduce some of the subjectivity and bias inherent in expert opinion methods. Additionally, with additional training and practice on the use of Bloom’s taxonomy, faculty that are not necessarily familiar with every aspect of every course can still provide reasonable input into the Bloom’s level attained and what activities support that level for the courses they teach. Then the program chair with a few senior faculty who are very familiar with the entire curriculum can use their experience to determine the overall assessment of the program for each outcome.

For example, each of the courses in the Civil Engineering program at the USMA has published course objectives (Table 5). Each lesson has published lesson objectives that feed into the course objectives (normally handed out at the beginning of the semester as part of the course syllabus, but occasionally handed out lesson by lesson or block by block when changes are needed in a course). Review of the lesson board notes (Figure 6, showing lesson objectives in the first block) establish what material was expected to be placed where on the chalkboard, but more importantly, serve as a permanent record of what was actually covered and completed in class; thereby, providing documentation for those not as familiar with the course as to the level of accomplishment of lesson and course objectives. By adding student homework, designs, and exams, a fairly accurate picture of the level of Bloom attained can be determined.

Each USMA CE course conducts an annual course assessment with the program director where documents are presented that show how lesson objectives map to course objectives. Additionally, course directors directly assess how well their course contributes to accomplishment of program outcomes based on course objectives, in and out of class activities, and student performance on those activities (Table 6).

When estimating attainment levels, it is preferable to err on the low side. The purpose of the exercise is to determine what program improvement is required and where to place limited resources to ensure compliance. Examining the course objectives and student activities with respect to program outcomes supports accreditation assessment, documents strong and weak areas, and forms a basis for making program improvements.

V. a. Program Strengths

The USMA program was assessed at level 5 (synthesis) for student communication skills (Outcome 7) (Bottom, Table 4 and Figure 5). Every student takes three semesters of English (ENxxx) and writes major papers in their classes on history (HIxxx), international relations
The students are assessed at level 4 (analysis) for outcome 6, the professional and ethical component. Because the civil engineering majors are being prepared for two well established professions, soldier and engineer, they receive considerable instruction and discussion on what constitutes a profession. CE400 is dedicated to the professional practice of civil engineering. In their summer military training and entire four year academic life, the students are immersed in the corporate culture of the military profession and its values have been ingrained upon graduation. The students have a well respected and rigidly enforced honor code that is accompanied by over 20 hours of honor instruction. The students also receive significant values education training in a program administered by the commandant of cadets.

The program was assessed at the synthesis level in leadership (Outcome 15), largely because of leadership activities outside of the classroom. While there is a required course (PL300) that focuses specifically on leadership, the best leadership experiences come from summer military training where students are given specific leadership roles in the military exercises, Cadet Troop Leader Training (CTLT) where students spend three weeks as a lieutenant in a real Army unit (the USMA equivalent of a Co-Op experience), and the summer training programs where the upperclassmen form the cadre that teach and lead the under classes. The day to day activities during the academic year are administered through a student chain of command where every student will hold several leadership positions throughout their four year education. A number of other courses such as Military Science and Military History have a distinct leadership focus.
V. b. Program Areas for Improvement

The program needs improvement in Outcome 14 as it pertains to business policy. There is only minor coverage in the Economics course. The best coverage for this outcome occurs in the construction management course (CE460) which includes procurement of work, engineering economics, cash flow, contractual relationships, and cost estimating. Overall, the students barely meet the minimum requirements of comprehension (Level 2) considering both business and public policy. The reason for this is the heavy focus on public policy in American political systems (SS202) and international relations (SS307). The fact that the students must organize a unit and manage the activities to include drill, field training, intramurals, etc., they receive a large amount of personal experience in public administration with coverage of related topics in a required course (PL300) that focuses specifically on leadership. If only looking at business policy, the weakest link, the program barely reaches the knowledge level (level 1).

The students do not truly reach level 5 (synthesis) for outcome 2, conducting and designing experiments and analyzing and interpreting data. The students spend considerable time in the laboratory conducting experiments in chemistry, physics, materials, soils, concrete, fluids, and hydrology. Most of the experiments are well established and the instructor knows in advance what the answers should be. Students have multiple opportunities to analyze and interpret data. There are only three documented times in the curriculum where the students design an experiment. However, the students are not able to take a nebulous, open-ended real world situation and design the experiments that would provide the necessary data to solve the problem.

V. c. The Next Steps

While the Curriculum Committee activity progresses, the Accreditation Committee is writing and revising the commentary for these outcomes. This commentary provides guidance to civil engineering program ABET evaluators. As the specific details of the commentary changes, the degree to which a program attains the BOK outcomes may change as well. The current draft commentary is ambitious in what undergraduate civil engineering programs are expected to achieve. The requirements include for example, “an understanding in most of the following: biology, geology/geomorphology, engineering economics, mechanics, material properties, systems, geospatial representation, and information technology.” There is an increased emphasis on ethics, leadership, social awareness, political understanding, public policy, and business practice. The outcome that requires an understanding of asset management suggests the use of tools and techniques that include “design innovations, new construction technologies, materials improvements, geo-mapping, database management, value assessment, performance models, web-based communication, and cost accounting.” As program assessments become more detailed, the commentary will need to be examined carefully. In the USMA assessments, the faculty team made general judgments, but did not have to define exactly where the requisite biology, geomorphology, database management, etc. is being taught. Furthermore, as the committee work progresses and feedback from the engineering and academic communities is received, some of these requirements may be determined to be unreasonable and might be dropped. This development over time will provide a clearer picture as to what has to change in the USMA curriculum.
The West Point CE assessment system is well developed and sustainable for courses taught in the Civil Engineering department. As with most schools, the process is much weaker for courses taught outside the department. As many of the new BOK outcomes require skills, knowledge and attitudes that will come from courses taught by other departments, this process needs to be improved. Furthermore, the contribution of other mandatory activities that are part of the West Point experience such as the military training, honor classes, student club activities, etc. need to be assessed in the same way as courses and the data formally collected to validate the development of knowledge, skills, and attitudes necessary for successful performance as a licensed professional engineer. Since many of the identified shortfalls will need to be corrected with changes and revisions involving the core curriculum, the civil engineering leaders need to educate and communicate with the USMA level leadership so they are not surprised by requested changes and can become part of the solution.

Much of the assessment data that gets collected is based on surveys and opinion. Such data is an administrative burden to collect. Presently the Academy goal teams are working on using embedded indicators to assist in assessment. This involves capturing data that is already inherently present in the CE program, rather than developing new data strictly for assessment purposes. This can be done for example on a Capstone design project where a specific portion of the final score on the project is allocated to identifying the social, political, and economic issues associated with the design. That portion of the final score becomes a quantitative indicator of student performance with respect to that outcome. This process becomes easier as outcomes are mapped through course objectives and even to specific lesson objectives that ultimately get directly tested on an exam, problem set, laboratory experiment, or design problem. Meyer et.al.8, 9 illustrates an initial attempt at using embedded indicators for outcome assessment. There are many more opportunities to apply the same approach to other situations.

As the program compares its ratings and methodology with those of other schools, the ratings may change as they see how other schools with similar curricula view the same criteria. The next step includes incorporating the new BOK outcomes into the CE program outcomes and implementing a formalized assessment strategy in the same manner that already exists for current ABET criteria. Course assessment procedures need to be modified to capture the relevant data in terms of Bloom’s taxonomy and start to inform the institution of any curricular changes that might be needed to attain BOK compliance – such as in the area of business practice. The current assessment program does a good job of capturing data that come from courses within the control of the CE program. Since many of the new outcomes are achieved outside of the CE department, the program needs to implement better assessment vehicles for what occurs outside the department. The next step is to document the activities (homework, designs, experiments, etc.) that students actually do in these 44 courses and assess whether it is sufficient to attain a specified level of competency.

VI. Conclusions

The full implementation of ASCE Policy 465 that makes the masters degree the first degree of civil engineering is a monumental effort that will take two decades to implement. The process is well underway as an initial body of knowledge necessary for professional licensure has been defined in the form of 15 outcomes. The level of competency in these outcomes that is to be
attained through undergraduate education, masters level education, pre-license experience, and post-license experience is being defined. The committee work involving draft commentaries, sample curricula using different types of universities, accreditation board coordination, and state licensure communication indicates that this effort will be successful.

Assessment of a program against the BOK is not an easy task, especially if data is needed to support the ratings. The authors plodded through numerous program mappings/assessments using a variety of standards and definitions to get to the current method presented. Much of the success is based on familiarity with the overall program and the fact they each have taught numerous courses within the program. Additionally, the established annual course and program assessments rely on input from individual instructors who are teaching each course. The prescribed format for course assessments and the emphasis on lesson and course objectives makes their input more reliable and easier to provide. Bloom’s taxonomy is covered in the required summer instructor training programs and the ExCEEd Teaching Workshop.  

The authors envision using the BOK outcome assessment described herein as part of the annual program assessment. The results provide data and support for additional resources and new courses that will achieve compliance with the new BOK.

Acknowledgments

Any opinions expressed here are those of the authors and not necessarily those of any supporting agencies.

Bibliography

5. ASCE, “Model Civil Engineering Curricula Supporting the Body of Knowledge for Professional Practice” Draft Report (6 January 2006), Curriculum Committee, Committee of the Committee on Academic Prerequisites for Professional Practice, American Society of Civil Engineers, Reston, Virginia.
<table>
<thead>
<tr>
<th>#</th>
<th>Body of Knowledge Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ability to apply knowledge of mathematics, science, and engineering</td>
</tr>
<tr>
<td>2</td>
<td>Ability to design and conduct experiments, as well as analyze and interpret data</td>
</tr>
<tr>
<td>3</td>
<td>Ability to design a system, component or process to meet desired needs</td>
</tr>
<tr>
<td>4</td>
<td>Ability to function on multi-disciplinary teams</td>
</tr>
<tr>
<td>5</td>
<td>Ability to identify, formulate, and solve engineering problems</td>
</tr>
<tr>
<td>6</td>
<td>Understanding of professional and ethical responsibility</td>
</tr>
<tr>
<td>7</td>
<td>Ability to communicate effectively</td>
</tr>
<tr>
<td>8</td>
<td>The broad education necessary to understand the impact of engineering solutions in a global and societal context</td>
</tr>
<tr>
<td>9</td>
<td>Recognition of the need for, and an ability to engage in, life-long learning</td>
</tr>
<tr>
<td>10</td>
<td>Knowledge of contemporary issues</td>
</tr>
<tr>
<td>11</td>
<td>Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
</tr>
<tr>
<td>12</td>
<td>Ability to apply knowledge in a specialized area related to civil engineering</td>
</tr>
<tr>
<td>13</td>
<td>Understanding of the elements of project management, construction, and asset management</td>
</tr>
<tr>
<td>14</td>
<td>Understanding of business and public policy and administration fundamentals</td>
</tr>
<tr>
<td>15</td>
<td>Understanding of the role of the leader and leadership principles and attitudes</td>
</tr>
</tbody>
</table>

Table 1. The 15 outcomes articulated in ASCE’s *Civil Engineering Body of Knowledge* ¹
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN101</td>
<td>Composition</td>
<td>3</td>
</tr>
<tr>
<td>MA103</td>
<td>Discrete Dynamical Systems/Intro to Calculus</td>
<td>4</td>
</tr>
<tr>
<td>CH101</td>
<td>General Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>IT105</td>
<td>Intro to Computing and Information Technology</td>
<td>3</td>
</tr>
<tr>
<td>HE1037</td>
<td>History of the U.S./World</td>
<td>3</td>
</tr>
<tr>
<td>EN102</td>
<td>Literature</td>
<td>3</td>
</tr>
<tr>
<td>MA104</td>
<td>Calculus I</td>
<td>4.5</td>
</tr>
<tr>
<td>CH102</td>
<td>General Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>PL100</td>
<td>General Psychology</td>
<td>3</td>
</tr>
<tr>
<td>HE1046</td>
<td>History of the U.S./World</td>
<td>3</td>
</tr>
<tr>
<td>FY201</td>
<td>Philosophy</td>
<td>3</td>
</tr>
<tr>
<td>MAC205</td>
<td>Calculus II</td>
<td>4.5</td>
</tr>
<tr>
<td>PH201</td>
<td>Physics I</td>
<td>3.5</td>
</tr>
<tr>
<td>LX201</td>
<td>Foreign Language</td>
<td>3.5</td>
</tr>
<tr>
<td>SS201</td>
<td>Economics-Principles/Problems</td>
<td>3.5</td>
</tr>
<tr>
<td>EV203</td>
<td>Physical Geography</td>
<td>3</td>
</tr>
<tr>
<td>MA206</td>
<td>Probability and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>PH202</td>
<td>Physics II</td>
<td>3.5</td>
</tr>
<tr>
<td>LX202</td>
<td>Foreign Language</td>
<td>3.5</td>
</tr>
<tr>
<td>SS202</td>
<td>American Politics</td>
<td>3.5</td>
</tr>
<tr>
<td>CE300</td>
<td>Fundamentals of Engineering Mechanics and Design</td>
<td>3</td>
</tr>
<tr>
<td>MA364</td>
<td>Mechanics of Materials</td>
<td>3.5</td>
</tr>
<tr>
<td>MA364</td>
<td>Engineering Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>ME311</td>
<td>Thermo-Fluids Systems I</td>
<td>3.5</td>
</tr>
<tr>
<td>CE390</td>
<td>Civil Engineering Site Design</td>
<td>3.5</td>
</tr>
<tr>
<td>PL300</td>
<td>Military Leadership</td>
<td>3</td>
</tr>
<tr>
<td>HI301</td>
<td>History of the Military Art</td>
<td>3</td>
</tr>
<tr>
<td>CE403</td>
<td>Structural Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CE391</td>
<td>Soil Mechanics and Foundation Engineering</td>
<td>3.5</td>
</tr>
<tr>
<td>CE386</td>
<td>Hydrology and Hydraulic Design</td>
<td>3.5</td>
</tr>
<tr>
<td>SS307</td>
<td>International Relations</td>
<td>3.5</td>
</tr>
<tr>
<td>EN302</td>
<td>Advanced Composition</td>
<td>3</td>
</tr>
<tr>
<td>HI302</td>
<td>History of the Military Art</td>
<td>3</td>
</tr>
<tr>
<td>CE404</td>
<td>Design of Steel Structures</td>
<td>3</td>
</tr>
<tr>
<td>CE483</td>
<td>Design of Reinforced Concrete Structures</td>
<td>3.5</td>
</tr>
<tr>
<td>CEXXXX</td>
<td>Field Elective (Advanced Structural Analysis)</td>
<td>3</td>
</tr>
<tr>
<td>LX403</td>
<td>Constitutional/Military Law</td>
<td>3.5</td>
</tr>
<tr>
<td>ME306</td>
<td>Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>CE492</td>
<td>Design Structural Systems</td>
<td>3</td>
</tr>
<tr>
<td>CEXXX</td>
<td>Engineering Elective (Vibrations/Independent Study)</td>
<td>3</td>
</tr>
<tr>
<td>CE460</td>
<td>Construction Management</td>
<td>3</td>
</tr>
<tr>
<td>EE301</td>
<td>Fundamentals of Electrical Engineering</td>
<td>3.5</td>
</tr>
<tr>
<td>CE405</td>
<td>Civil Engineering Professional Practice</td>
<td>1</td>
</tr>
<tr>
<td>VETclasses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beast Barracks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buckner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cadre Detail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Education courses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Initial USMA Assessment of BOK Competency Levels Attained in the Courses and Activities in the West Point Civil Engineering Curriculum. The Results are the Independent Assessments of Three Senior Faculty Members where the Ratings are: O- None; R-Recognition, U-Understanding, A-Ability
<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>Level 1: KNOWLEDGE</th>
<th>Level 2: COMPREHENSION</th>
<th>Level 3: APPLICATION</th>
<th>Level 4: ANALYSIS</th>
<th>Level 5: SYNTHESIS</th>
<th>Level 6: EVALUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math and science</td>
<td>Graduates can define key factual information related to mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science.</td>
<td>Graduates can explain key concepts and problem-solving processes in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science.</td>
<td>Graduates can solve problems in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science.</td>
<td>Graduates can analyze a complex problem to determine the relevant mathematical and scientific principles; and then apply that knowledge to solve the problem.</td>
<td>Graduates can create new mathematical or scientific knowledge.</td>
<td>Graduates can evaluate the validity of newly created mathematical or scientific knowledge.</td>
</tr>
<tr>
<td>Experiments</td>
<td>Graduates can identify the procedures and equipment necessary to conduct civil engineering experiments.</td>
<td>Graduates can explain the purpose, procedures, equipment, and practical applications of civil engineering experiments.</td>
<td>Graduates can conduct civil engineering experiments according to established procedures, and report the results.</td>
<td>Graduates can design civil engineering experiments according to established procedures, and analyze and interpret the results.</td>
<td>Graduates can design a civil engineering experiment to meet a need; conduct the experiment, and analyze and interpret the resulting data.</td>
<td>Graduates can evaluate the effectiveness of a designed experiment in meeting an ill-defined real world need.</td>
</tr>
<tr>
<td>Design a system</td>
<td>Graduates can define engineering design; list the major steps in the engineering design process; and list constraints that affect the process and products of engineering design.</td>
<td>Graduates can describe the engineering design process; explain how real-world constraints affect the process and products of engineering design.</td>
<td>Graduates can design a simple component (e.g., a structural member) to meet a well-defined set of requirements and constraints.</td>
<td>Graduates can design a system or process (e.g., a truss or water treatment process) to meet a well-defined set of requirements and constraints.</td>
<td>Graduates can design a complex system or process to meet desired needs, within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.</td>
<td>Graduates can evaluate the design of a complex system, component, or process to ensure that it meets a client’s needs and accounts for all relevant constraints.</td>
</tr>
<tr>
<td>Multi-disciplinary</td>
<td>Graduates can list the key characteristics of an effective multi-disciplinary team.</td>
<td>Graduates can explain the factors affecting the ability of a multi-disciplinary team to function effectively.</td>
<td>Graduates can function effectively as a member of a multi-disciplinary team.</td>
<td>Graduates can organize an existing multi-disciplinary team to accomplish a complex task.</td>
<td>Graduates can organize a multi-disciplinary team to accomplish a complex task.</td>
<td>Graduates can evaluate the composition, organization, and performance of a multi-disciplinary team in accomplishing a complex task.</td>
</tr>
<tr>
<td>OUTCOME</td>
<td>Level 1: KNOWLEDGE</td>
<td>Level 2: COMPREHENSION</td>
<td>Level 3: APPLICATION</td>
<td>Level 4: ANALYSIS</td>
<td>Level 5: SYNTHESIS</td>
<td>Level 6: EVALUATION</td>
</tr>
<tr>
<td>---------</td>
<td>------------------</td>
<td>------------------------</td>
<td>---------------------</td>
<td>------------------</td>
<td>------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>5</td>
<td>Engineering problem-solving</td>
<td>Graduates can list key factual information related to four technical areas appropriate to civil engineering.</td>
<td>Graduates can explain key concepts and problem-solving processes in four technical areas appropriate to civil engineering.</td>
<td>Graduates can solve well-defined engineering problems in four technical areas appropriate to civil engineering.</td>
<td>Graduates can identify, formulate, and solve an ill-defined engineering problem in four technical areas appropriate to civil engineering.</td>
<td>Graduates can identify, formulate, and solve an engineering problem involving integration of several different technical areas appropriate to civil engineering; and evaluate the effectiveness of the solution.</td>
</tr>
<tr>
<td>6</td>
<td>Professional and ethical responsibility</td>
<td>Graduates can list the professional and ethical responsibilities of a civil engineer.</td>
<td>Graduates can explain the professional and ethical responsibilities of a civil engineer.</td>
<td>Graduates can apply standards of professional and ethical responsibility in a relatively clear-cut situation, to determine an appropriate course of action.</td>
<td>Graduates can analyze a complex situation involving multiple conflicting professional and ethical interests, to determine an appropriate course of action.</td>
<td>Graduates can synthesize their studies and experiences to foster their own long-term professional and ethical development.</td>
</tr>
<tr>
<td>7</td>
<td>Communicate</td>
<td>Graduates can list the characteristics of effective verbal, written, and graphical communications.</td>
<td>Graduates can describe the characteristics of effective verbal, written, and graphical communications.</td>
<td>Graduates can correctly apply the rules of grammar and composition in verbal and written communications; and apply appropriate graphical standards in preparing engineering drawings.</td>
<td>Graduates can organize and deliver effective verbal, written, and graphical communications.</td>
<td>Graduates can plan, compose, and integrate the verbal, written, and graphical communication of a complex project to technical and non-technical audiences.</td>
</tr>
<tr>
<td>8</td>
<td>Impact of engineering solutions</td>
<td>Drawing upon a broad education, graduates can identify global, economic, environmental, and societal impacts of engineering solutions.</td>
<td>Drawing upon a broad education, graduates can explain the global, economic, environmental, and societal impacts of engineering solutions.</td>
<td>Drawing upon a broad education, graduates can determine the global, economic, environmental, and societal impacts of a specific, relatively constrained engineering solution.</td>
<td>Drawing upon a broad education, graduates can analyze a complex engineering solution to determine its global, economic, environmental, and societal impacts.</td>
<td>Drawing upon a broad education and their experience, graduates can develop and evaluate the effectiveness of a complex engineering solution that appropriately accounts for the global, economic, environmental, and societal impacts of that solution.</td>
</tr>
</tbody>
</table>

---

For example, at Level 3: APPLICATION, graduates are expected to solve well-defined engineering problems in four technical areas appropriate to civil engineering.
<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>Level 1: KNOWLEDGE</th>
<th>Level 2: COMPREHENSION</th>
<th>Level 3: APPLICATION</th>
<th>Level 4: ANALYSIS</th>
<th>Level 5: SYNTHESIS</th>
<th>Level 6: EVALUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifelong Learning</td>
<td>Graduates can define life-long learning.</td>
<td>Graduates can explain the need for life-long learning and describe the skills required of a life-long learner.</td>
<td>Graduates can demonstrate the ability to learn on their own, without the aid of formal instruction.</td>
<td>Graduates can analyze a complex problem to differentiate between aspects that are already known and aspects that must be learned in order to solve the problem.</td>
<td>Graduates can develop a plan to acquire the expertise necessary to solve a complex problem.</td>
<td>Graduates can self-assess their learning processes and can evaluate them in light of competing and complex real-world alternatives.</td>
</tr>
<tr>
<td>Contemporary issues</td>
<td>Graduates can list contemporary issues that affect engineering problems.</td>
<td>Graduates can explain how contemporary issues affect the identification, formulation, and solution of engineering problems.</td>
<td>Graduates can incorporate specific contemporary issues into the identification, formulation, and solution of a specific engineering problem.</td>
<td>Graduates can analyze the global, regional, and local situation to determine which contemporary issues will affect the identification, formulation, and solution of an engineering problem.</td>
<td>Graduates can synthesize the influences of all relevant contemporary issues into the identification, formulation, and solution of an engineering problem.</td>
<td>Graduates can evaluate the extent to which all relevant contemporary issues have been incorporated into the identification, formulation, and solution of an engineering problem.</td>
</tr>
<tr>
<td>Engineering tools</td>
<td>Graduates can identify the techniques, skills, and modern engineering tools that are necessary for engineering practice.</td>
<td>Graduates can explain how these techniques, skills, and modern engineering tools are used in engineering practice.</td>
<td>Graduates can apply relevant techniques, skills, and modern engineering tools to solve a simple problem.</td>
<td>Graduates can select and organize the relevant techniques, skills, and modern engineering tools to solve a complex problem.</td>
<td>Graduates can create new techniques and tools to solve a complex problem.</td>
<td>Graduates can evaluate the effectiveness of techniques and tools that have been developed to solve a complex problem.</td>
</tr>
<tr>
<td>Specialized area related to civil engineering</td>
<td>Graduates can define key factual information in a specialized area of civil engineering.</td>
<td>Graduates can explain key concepts and problem-solving processes in a specialized area of civil engineering.</td>
<td>Graduates can solve simple problems in a specialized area of civil engineering.</td>
<td>Graduates can analyze a complex system or process involving a specialized area of civil engineering.</td>
<td>Graduates can design a complex system or process or create new knowledge within a specialized area of civil engineering.</td>
<td>Graduates can evaluate the design of a complex system or process, or evaluate the validity of newly created knowledge within a specialized area of civil engineering.</td>
</tr>
<tr>
<td>OUTCOME</td>
<td>Level 1: KNOWLEDGE</td>
<td>Level 2: COMPREHENSION</td>
<td>Level 3: APPLICATION</td>
<td>Level 4: ANALYSIS</td>
<td>Level 5: SYNTHESIS</td>
<td>Level 6: EVALUATION</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------</td>
<td>------------------------</td>
<td>---------------------</td>
<td>------------------</td>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>13</td>
<td>Project management, construction, and asset management</td>
<td>Graduates can list key factual information related to management, such as project, construction, or asset management.</td>
<td>Graduates can explain key concepts and problem-solving processes used in management.</td>
<td>Graduates can solve simple management problems, such as those in project, construction, and/or asset management.</td>
<td>Graduates can analyze complex problems involving project, construction, and/or asset management.</td>
<td>Graduates can evaluate the effectiveness of management plans for a complex real-world engineering project.</td>
</tr>
<tr>
<td>14</td>
<td>Business, public policy, &amp; public administration</td>
<td>Graduates can list key factual information related to business, public policy, and public administration.</td>
<td>Graduates can explain key concepts and problem-solving processes used in business, public policy, and public administration.</td>
<td>Graduates can solve simple problems involving business, public policy, and public administration.</td>
<td>Graduates can analyze complex real-world problems involving business, public policy, and public administration.</td>
<td>Graduates can evaluate the effectiveness of a business plan, devise public policy recommendations, and create or adapt a system of public administration to meet a real-world need.</td>
</tr>
<tr>
<td>15</td>
<td>Leadership principles and attitudes</td>
<td>Graduates can define the role of the leader and list leadership principles and attitudes conducive to effective professional practice of civil engineering.</td>
<td>Graduates can explain the role of the leader, leadership principles, and attitudes conducive to effective professional practice of civil engineering.</td>
<td>Graduates can apply leadership principles to direct the efforts of a small, homogenous group to accomplish a simple task; and graduates demonstrate attitudes conducive to effective professional practice of civil engineering.</td>
<td>Graduates can organize the efforts of a large, diverse group to accomplish a complex task; and analyze a complex task to determine which attitudes are most conducive to its effective accomplishment.</td>
<td>Graduates can evaluate the leadership of an organization and the attitudes of its members.</td>
</tr>
</tbody>
</table>

**LEGEND:**
- Should be attained through bachelor’s level education (B)
- Should be attained through master’s level education (M/30)
- Should be attained through experience (E)
- Attained through post-licensure experience, if at all.
Table 4. Mapping of Civil Engineering Curriculum to the ASCE Body of Knowledge Using Bloom’s Taxonomy (as formatted in the Curriculum Committee report)

Requirements for a Bachelor of Science in Civil Engineering (141.1 credits)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN 101</td>
<td>Composition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VA 103</td>
<td>Intro to Calculus</td>
<td>2 1 1 1 1 1 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 101</td>
<td>General Chemistry I</td>
<td>2 3 1 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT 105</td>
<td>Intro to Computing and Information Technology</td>
<td>1 1 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HI 103/7</td>
<td>History of the U.S./World</td>
<td>3 1 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN 102</td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MA 104</td>
<td>Calculus I</td>
<td>3 1 1 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 102</td>
<td>General Chemistry II</td>
<td>3 3 1 1 1 1 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PL 100</td>
<td>General Psychology</td>
<td>2 1 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HI 104/8</td>
<td>History of the U.S./World</td>
<td>3 1 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breast Barracks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PY 201</td>
<td>Philosophy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MA 205</td>
<td>Calculus II</td>
<td>3 1 1 1 1 1 1 1 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PH 201</td>
<td>Physics I</td>
<td>3 3 1 1 1 1 1 1 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LX 201</td>
<td>Foreign Language</td>
<td>2 1 1 1 1 1 1 1 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS 201</td>
<td>Economics-Principles/Problems</td>
<td>1 2 2 1 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EV 203</td>
<td>Physical Geography</td>
<td>3 1 2 2 2 2 2 2 2 2 2 2 2 2 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MA 206</td>
<td>Probability and Statistics</td>
<td>3 2 1 1 1 1 1 1 1 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PH 202</td>
<td>Physics II</td>
<td>3 3 1 1 1 1 1 1 1 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LX 202</td>
<td>Foreign Language</td>
<td>2 1 1 1 1 1 1 1 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS 202</td>
<td>American Politics</td>
<td>1 1 3 1 2 3 3 3 3 3 3 3 3 3 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 300</td>
<td>Fundamentals of Engineering Mechanics and Design</td>
<td>3 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camp Buckner</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Upper Division Courses (71.5 credits)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Third Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 364</td>
<td>Mechanics of Materials</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>MA 364</td>
<td>Engineering Mathematics</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 311</td>
<td>Thermo-Fluids Systems I</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 390</td>
<td>Civil Engineering Site Design</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PL 300</td>
<td>Military Leadership</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HI 301</td>
<td>History of the Military Art</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 403</td>
<td>Structural Analysis</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 371</td>
<td>Soil Mechanics and Foundation Engineering</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 380</td>
<td>Hydrology and Hydraulic Design</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS 307</td>
<td>International Relations</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN 302</td>
<td>Advanced Composition</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HI 302</td>
<td>History of the Military Art</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIAD</td>
<td></td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cadre Detail (Breast/Buckner)</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 404</td>
<td>Design of Steel Structures</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 483</td>
<td>Design of Reinforced Concrete Structures</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE XXX</td>
<td>Field Elective (Advanced Structural Analysis)</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE XXX</td>
<td>Field Elective (Wood and Masonry Design)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LW 403</td>
<td>Constitutional/Military Law</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 306</td>
<td>Dynamics</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 492</td>
<td>Design Structural Systems</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE XXX</td>
<td>Engineering Elective (Vibrations/Independent Study)</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 460</td>
<td>Construction Management</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 301</td>
<td>Fundamentals of Electrical Engineering</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 400</td>
<td>Civil Engineering Professional Practice</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Number</td>
<td>Course Description</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Mathematics Science &amp; Engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Experiments, Analyze, and Interpret</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Ability to Design a System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Multi-Disciplinary Teams</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Solve Engineering Problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Professional &amp; Ethical Responsibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Communicate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Impact of Engineering Solutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Lifelong Learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Knowledge of Contemporary Issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Modern Engineering Tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Knowledge in a Specialized Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Elements of Project Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Business and Public Policy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Leadership and Role of the Leader</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### All Years

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honor Instruction</td>
<td>4 2 2 2 2</td>
</tr>
<tr>
<td>VET classes</td>
<td>4 2 2 4 2</td>
</tr>
<tr>
<td>Physical Education courses</td>
<td>2</td>
</tr>
<tr>
<td>Military Science course</td>
<td>2 4 3 1 3 2 2</td>
</tr>
<tr>
<td>Intermurals/Corps Squad Athletics</td>
<td>3 1 2</td>
</tr>
<tr>
<td>Cadet Chain of Command Position</td>
<td>4 5 5 3 2 3 4</td>
</tr>
<tr>
<td>FE</td>
<td>2 2 1 3 1 1 2</td>
</tr>
</tbody>
</table>

#### Expected Level of Competency at BSCE Level

<table>
<thead>
<tr>
<th>Expected Level of Competency at BSCE Level</th>
<th>3</th>
<th>5</th>
<th>5</th>
<th>3</th>
<th>3</th>
<th>4</th>
<th>4</th>
<th>3</th>
<th>3</th>
<th>3</th>
<th>30</th>
<th>+</th>
<th>2</th>
<th>2</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>15</td>
<td>9</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
<td>3</td>
<td>13</td>
<td>11</td>
<td>8</td>
<td>19</td>
<td>18</td>
<td>9</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>7</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>2</td>
<td>18</td>
<td>11</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

#### Achieved Level of Competency at BSCE Level

<p>| Achieved Level of Competency at BSCE Level | 4 | 4 | 5 | 4 | 4 | 4 | 5 | 3 | 3 | 4 | 4 | 3 | 3 | 2 | 4 |</p>
<table>
<thead>
<tr>
<th>Table 5. CE492 Course Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D1.</strong> Develop feasible alternatives for a building and site such that all functional requirements are satisfied and the structural design is consistent with the architectural design.</td>
</tr>
<tr>
<td><strong>D2.</strong> Explain the integration between architectural/site civil, structural, geotechnical, hydrological, environmental, construction management and community based design requirements for a proposed facility.</td>
</tr>
<tr>
<td><strong>D3.</strong> Apply the nine-phase engineering design process model to a real world project.</td>
</tr>
<tr>
<td><strong>D4.</strong> Explain the relationship between the A-E design team and the customer/client.</td>
</tr>
<tr>
<td><strong>D5.</strong> Explain and produce the inputs and products associated with the 10%, 35%, 65%, and 100% submittals used to develop and refine a design.</td>
</tr>
<tr>
<td><strong>D6.</strong> Use a commercial computer-aided design (AutoCAD) program to produce, coordinate, and communicate a complete set of project plans.</td>
</tr>
<tr>
<td><strong>D7.</strong> Explain the advantages and disadvantages of composite floor system construction.</td>
</tr>
<tr>
<td><strong>D8.</strong> Analyze/design a composite floor system.</td>
</tr>
<tr>
<td><strong>D9.</strong> Check the adequacy of bolts in combined shear and tension.</td>
</tr>
<tr>
<td><strong>D10.</strong> Analyze a bolt group which is loaded in eccentric shear.</td>
</tr>
<tr>
<td><strong>D11.</strong> Analyze a simple bolted (shear) beam connection.</td>
</tr>
<tr>
<td><strong>D12.</strong> Analyze a simple diagonal bracing connection.</td>
</tr>
<tr>
<td><strong>D13.</strong> Analyze a moment resisting beam connection.</td>
</tr>
<tr>
<td><strong>D14.</strong> Analyze/design a column base plate.</td>
</tr>
<tr>
<td><strong>D15.</strong> Function as a member of a design team and adequately fulfill my assigned role (architect/site civil/construction management, structural, hydro/environmental, geotech).</td>
</tr>
</tbody>
</table>
### TABLE 6. HOW DOES THE CE492 CONTRIBUTE TO THE PROGRAM OUTCOMES?

<table>
<thead>
<tr>
<th>Activity</th>
<th>CD Assess</th>
<th>Explain CD's Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Apply the engineering thought process to design CE components and systems</td>
<td>EDP</td>
<td>5</td>
</tr>
<tr>
<td><strong>2.</strong> Creativity, in the context of engineering problem-solving.</td>
<td>PS2 and EDP</td>
<td>5</td>
</tr>
<tr>
<td><strong>3a.</strong> Proficiency in structural engineering</td>
<td>EDP, WPR, Problem Sets</td>
<td>5</td>
</tr>
<tr>
<td><strong>3b.</strong> Proficiency in environmental engineering</td>
<td>EDP</td>
<td>3</td>
</tr>
<tr>
<td><strong>3c.</strong> Proficiency in hydrology &amp; hydraulic engineering</td>
<td>EDP</td>
<td>4</td>
</tr>
<tr>
<td><strong>3d.</strong> Proficiency in geotechnical engineering.</td>
<td>EDP</td>
<td>4</td>
</tr>
<tr>
<td><strong>4a.</strong> Proficiency in mathematics</td>
<td>EDP, WPR, Problem Sets</td>
<td>4</td>
</tr>
<tr>
<td><strong>4b.</strong> Proficiency calculus-based physics</td>
<td>1</td>
<td>Not assessed</td>
</tr>
<tr>
<td><strong>4c.</strong> Proficiency general chemistry</td>
<td>1</td>
<td>Not assessed</td>
</tr>
<tr>
<td><strong>5.</strong> Design and conduct experiments, and analyze and interpret data.</td>
<td>EDP</td>
<td>2</td>
</tr>
<tr>
<td><strong>6.</strong> Function on multidisciplinary teams</td>
<td>EDP</td>
<td>5</td>
</tr>
<tr>
<td><strong>7.</strong> Roles and responsibilities of civil engineers and the issues / professional practice</td>
<td>EDP and PS2</td>
<td>5</td>
</tr>
<tr>
<td><strong>8.</strong> Use the modern engineering tools necessary for engineering practice</td>
<td>EDP, WPR, Problem Sets</td>
<td>5</td>
</tr>
<tr>
<td><strong>9.</strong> Write effectively</td>
<td>EDP</td>
<td>5</td>
</tr>
<tr>
<td><strong>10.</strong> Speak effectively</td>
<td>EDP</td>
<td>5</td>
</tr>
<tr>
<td><strong>11.</strong> Knowledge of contemporary issues</td>
<td>PS2 and Class discussions</td>
<td>3</td>
</tr>
<tr>
<td><strong>12.</strong> Broad education /understand the impact of engineering solutions in a global/societal context</td>
<td>In-class discussions, EDP</td>
<td>3</td>
</tr>
<tr>
<td><strong>13.</strong> The preparation for and willingness to pursue continued intellectual and professional growth</td>
<td>In-class discussions, EDP</td>
<td>4</td>
</tr>
<tr>
<td>Outcome</td>
<td>Recognition</td>
<td>Understanding</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>-------------</td>
<td>---------------</td>
</tr>
<tr>
<td>15 Leadership</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Business and Public Policy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Contemporary Issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Impact of Engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Professional / Ethical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Life-Long Learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Multi-Disciplinary Teams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Specialized Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Engineering Tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Engineering Problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Experiment, Analyze, Interpret</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Technical Core</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. The Expected Competency Levels for BOK Outcomes Attained Through Formal Education, Experience Prior to Obtaining Professional Registration, and Post-Licensure Experience.
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Recognition</th>
<th>Understanding</th>
<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Leadership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Business and Public Policy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Contemporary Issues</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Impact of Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Professional / Ethical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Life-Long Learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Multi-Disciplinary Teams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Specialized Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Engineering Tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Engineering Problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Experiment, Analyze, Interpret</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Technical Core</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Initial Assessment of Competency Attained in each of the BOK Outcomes Through Completion the Four Year West Point Curriculum

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Leadership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Business and Public Policy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Contemporary Issues</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Impact of Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Professional / Ethical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Life-Long Learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Multi-Disciplinary Teams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Specialized Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Engineering Tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Engineering Problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Experiment, Analyze, Interpret</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Technical Core</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: Proposed Curriculum Committee Revisions to the Competency Level Designations and the Respective Responsibilities of Formal Education and Experience in Attaining these Levels in the BOK Outcomes
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Leadership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Business and Public Policy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Contemporary Issues</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Impact of Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Professional / Ethical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Life-Long Learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Multi-Disciplinary Teams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Specialized Area</td>
<td></td>
<td></td>
<td>Masters Degree</td>
</tr>
<tr>
<td>11 Engineering Tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Engineering Problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Experiment, Analyze, Interpret</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Technical Core</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4. Revised Assessment of Competency Attained in USMA Curriculum as a Result of Curriculum Committee Discussions

<table>
<thead>
<tr>
<th>Outcome</th>
<th>1 Knowledge</th>
<th>2 Comprehend</th>
<th>3 Application</th>
<th>4 Analysis</th>
<th>5 Synthesis</th>
<th>6 Evaluate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Technical Core</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Experiment, Analyze, Interpret</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Multi-Disciplinary Teams</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Engineering Problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Professional / Ethical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Impact of Engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Life-Long Learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Contemporary Issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Engineering Tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Specialized Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Business and Public Policy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Leadership</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5. Current graphical assessment of the USMA program against the 15 outcomes.
Figure 6. Board Notes for ExCEEd Teaching Workshop Demonstration Class

Figure 7. Truss Analysis Presentations at USMA at the Turn of the Century