AC 2009-2105: LET'S GET DOWN TO BUSINESS: PREPARATION FOR ABET UNDER THE NEW CE PROGRAM CRITERIA

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Abstract

For engineering programs undergoing ABET accreditation visits during the 2008-2009 accreditation cycle, there are now nine criteria against which the program is evaluated. There have been several organizational changes within the criteria with the most significant being the addition of Criterion 4 to collectively address continuous improvement in the program; Criterion 8, the Program Criteria, has become Criterion 9. For civil engineering programs, Criterion 9 was revised to be less restrictive in some areas, but now contains a few new twists that program directors must address to include coverage of at least on additional area of science, and the requirement for students to explain basic concepts in management, business, public policy, and leadership. This paper provides lessons learned from the preparation for an ABET visit that occurred during the Fall of 2008 under the newly revised ABET and CE Program Criteria.

Introduction

Preparation for an ABET accreditation visit can be a complex, difficult, and time-consuming project. If approached properly and proactively, however, many of the tasks associated with preparation can be simplified to a point where the impact on the faculty is not onerous. There are many keys to success, but the one that outweighs all is to establish effective systems and maintain them on a continuous basis. It is wishful thinking to assume that systems implemented shortly before an ABET visit will be seen as anything other than that—systems implemented a short time before an ABET visit. ABET evaluators are looking for evidence of established and functioning systems that assess all aspects of the program with the goal of continuous improvement in mind. And, there must be evidence that the systems in place will continue to function after the ABET team departs your campus on Tuesday afternoon following the final out brief. The bottom line is that preparation for an ABET evaluation should be a well-coordinated process that begins well in advance of the visit and has all the key players striving to achieve a rating of "Next General Review." We consider the following as the most important aspects of successful preparation.

Establishment of Program Educational Objectives and Program Outcomes

The establishment, periodic review, and assessment of program educational objectives and program outcomes are fundamental for a properly functioning and coherent civil engineering program. Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. Program outcomes are narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they advance through the program.[1] The ABET program evaluator (PEV) will expect to see that your program educational objectives are consistent with the mission of your institution and that they support your program's constituencies. The PEV will also expect your program outcomes to foster the attainment of your program educational objectives and will expect your

program outcomes to include the requirements specified in the ABET Criterion 3a-k. The PEV will be especially interested in your method for periodically assessing and evaluating the degree to which your program educational objectives and outcomes are achieved. Listed below are the USMA Civil Engineering program educational objectives and program outcomes. They were established in the form below in 2006 in anticipation of the new CE Program Criteria.

The USMA Civil Engineering program educational outcomes prepare graduates to:

1. As Army leaders, solve complex, multi-disciplinary problems effectively, to include:
   - recognizing and fully defining the physical, technological, social, political, and economic aspects of a complex problem;
   - using a methodical process to solve the problem;
   - demonstrating creativity in the formulation of alternative solutions;
   - using appropriate techniques and tools to enhance the problem-solving process;
   - working effectively on teams; and
   - developing high-quality solutions that consider the technological, social, political, economic, and ethical dimensions of the problem.
2. Provide appropriate civil engineering expertise to the Army, when called upon to do so.
3. Communicate effectively.
4. Continue to grow intellectually and professionally—as Army officers and as engineers.

The USMA Civil Engineering program outcomes prepare students to do the following at the time of graduation:

1. Design civil engineering components and systems.
2. Demonstrate creativity, in the context of engineering problem-solving.
3. Solve problems in the structural, construction management, hydraulic, and geotechnical discipline areas of civil engineering.
4. Solve problems in mathematics through differential equations, calculus-based physics, and general chemistry.
5. Design and conduct experiments, and analyze and interpret data.
6. Function effectively on multidisciplinary teams.
7. Describe the roles and responsibilities of civil engineers and analyze the issues they face in professional practice.
8. Use modern engineering tools to solve problems.
9. Write effectively.
10. Speak effectively.
11. Incorporate knowledge of contemporary issues into the solution of engineering problems.
12. Draw upon a broad education necessary to anticipate the impact of engineering solutions in a global and societal context.

13. Are prepared and motivated to pursue continued intellectual and professional growth—as Army officers and engineers.
14. Explain the basic concepts of management.
15. Explain the basic concepts of business and public policy.
16. Are leaders of character.

It is important to note that the USMA program outcomes address the ABET Criterion 3a-k outcomes, but do not follow them in order. Many institutions choose to adopt the Criterion 3a-k outcomes as listed, but there is no requirement to do so.

High Quality Assessment Systems and Practices

The most time-sensitive aspect of preparation for an ABET evaluation is ensuring that high-quality assessment practices are established and functioning. It is the opinion of the authors that ABET Criterion 2, Program Educational Objectives, and Criterion 3, Program Outcomes, are the most important criteria of the nine ABET criteria. Criterion 2 and Criterion 3 require strong evidence that assessment systems are in place and can prove to evaluators that the program is adequately preparing its graduates. Program educational outcomes specify what graduates should be able to do at some point following graduation while Program Outcomes specify what students should be able to do at the time of graduation. The two requirements are very different; both require effective assessment practices to validate that the program is doing as it says. In the past, it was acceptable to depend on surveys—of students, recent graduates, more seasoned graduates, faculty members, practitioners, employers of graduates, etc. Surveys, while effective in many ways, are generally not considered adequate by themselves to demonstrate accomplishment of Criteria 2 and 3. The expectation, while not formally specified by ABET, is for programs to have in place established assessment practices using both indirect and direct measures of student performance. As Dr. Gloria Rogers, ABET's current Director of Assesment, writes, "A meaningful assessment program would use both direct and indirect assessments from a variety of sources (students, alumni, faculty, employers, etc.). This use of multiple assessment methods provides converging evidence of student learning. Indirect methods provide a valuable supplement to direct methods and are generally a part of a robust assessment program."[2] Much has been written on direct assessment encouraging its wide-spread adoption by many programs. In addition, there are many workshops available through ABET and other sources that provide models for high quality assessment practices.[3]

Direct measures of student performance include vehicles like embedded indicators, portfolios, and other methods that remove subjectivity from the assessment process. Direct measures may include such things as student grades on specific graded events where the graded event specifically maps to a program outcome. Overall course grades are not good indicators because they provide too broad a measure of student performance and do not pinpoint performance on a given program outcome. Another good direct measure is performance on specific subject areas of the Fundamentals of Engineering Exam—as long as the vast majority of program graduates sit for the exam. Unless the measure describes the performance of all students from a given group (or a statistically controlled sample of that group), it is not appropriate for consideration as a direct measure for assessment of program outcomes.

The establishment of a system of direct measures of student performance is not hard to implement, but requires discipline to maintain. The systems do not have to be and should not be complicated, because if they are, the faculty charged with collecting the data may not understand what they are collecting and how it contributes to the overall assessment process. The authors have found that the most effective systems are those that have faculty buy-in and that have low impact with regard to time and resources. An assessment system that starts at the individual course level and contributes to the larger program assessment process is one which has proven successful over time. If the primary goal of the assessment system is course and program improvement with the secondary goal being preparation for ABET, the system will be far more prone to succeed over time.

Proactive, Coordinated and Thorough Self Study Preparation

Preparation of the ABET self study is a large undertaking—one that should be started well in advance of the visit and shared among several faculty members. It is the authors' experience that successful self study preparation is something that should be overseen from an institutional level with milestones for self study preparation established early and maintained. Consistency between self study content across programs is very important from the perspective of the ABET evaluator team and demonstrates cooperation among the faculty.

Before beginning the self study, check the ABET website for the ABET Self-Study Questionnaire which applies to the year during which your program will be visited.[4] The format specified in the questionnaire is the format one should follow when preparing the self study. Ideally speaking, the worksheet the PEV uses during the visit will follow the same format as the questionnaire making the review process much easier. It is vitally important to remember that if the evaluator has trouble following the self study or quickly finding information within it, it will likely mean more work for the program director prior to the visit. As the program director or somebody charged with self study preparation, you must do everything possible to ensure the self study is a coherent and easy-to-read document.

In assembling the self study, there are several items that serve as building blocks that are important to have available early in the process. A quick review of the self-study questionnaire reveals the requirement to complete numerous tables. Criterion 1 (Students), Criterion 5 (Curriculum), and Criterion 6 (Faculty) all require extensive tabular data. In addition, the appendix items which include course syllabi, faculty resumes, and the listing of laboratory equipment were useful references to have when preparing the criterion chapters and cross checking for completeness of the tables in Criterion 5 and Criterion 6. The authors recommend assigning specific faculty or staff members to the collection of this information to ensure consistency of format. With this background information available, it is much easier to provide responses to the questionnaire in preparing the self study.

Based on the new ABET self study format which now provides for nine chapters corresponding to the nine program criteria, it may be tempting to assign criterion responsibility to specific faculty members. In the end, however, it will be necessary for one person to take a holistic look at the document to ensure consistency. It is the experience of the authors that trying to lace the chapters together in the final review can prove to be a very time consuming task. It is our

recommendation that one faculty member should have overall responsibility for preparing the self study and other faculty members should be charged with providing solid support throughout the process.

Review of the self study for consistency not only within the program, but across the institution is a vital final step. The more sets of eyes that see the self study, the better. If possible, one faculty member should review all program self studies across the institution to ensure consistency of format, content and message. The ABET evaluator team will quickly discern inconsistencies across the institution if they exist.

Fulfillment of the Civil Engineering Program Criteria

In November 2007, the new CE Program Criteria were published and are listed under Criterion 9 in the new ABET self study format.[1] The new CE Program Criteria were revised to be less restrictive in some areas, but now contain additional requirements that program directors must address, to include coverage of at least on additional area of science and the requirement for students to explain basic concepts in management, business, public policy, and leadership.

The curricular portion of the new CE Program Criteria has been broken into six major components below. A short commentary on each component is provided to identify the sometimes subtle changes in the new criteria and to discuss how the requirement was addressed in our self study.

> ***Apply knowledge of math through differential equations, calculus-based physics, chemistry and at least one additional area of science consistent with the program educational objectives.***

The big change in this component is the requirement to apply knowledge of one additional area of science consistent with the program educational objectives. As the ASCE Commentary on the ABET Criteria indicates, The requirement for "one additional area of science" reflects ASCE's intent that civil engineering graduates develop greater breadth in the basic sciences beyond the technical core subjects of physics and chemistry.[5] The statement "consistent with the program educational objectives" allows tremendous latitude on the part of the program director to identify an additional area of science. In the case of USMA, our graduates are commissioned as officers in the US Army. During their term of service, our graduates are invariably faced with situations in which they must provide expertise in areas of geoscience to include digital terrain analysis, image interpretation and spectral analysis, remote sensing, global positioning systems, geographic information systems, and culture systems.

> ***Apply knowledge of four technical areas appropriate to civil engineering.***

The change in this component is the replacement of the previous requirement to "demonstrate proficiency" with the new requirement to "apply knowledge." The ability to apply knowledge is a less demanding standard than the requirement to demonstrate proficiency and thus is a more reasonable expectation with regard to undergraduate student abilities at the time of graduation.

Conduct civil engineering experiments and analyze and interpret the resulting data.

This requirement is also somewhat less stringent than the former requirement to "critically analyze and interpret data in more than one recognized civil engineering area."[1] This requirement was a significant point of interest during our most recent evaluation. There was a significant burden of proof to demonstrate that students were achieving this particular component of the criteria.

Design a system, component, or process in more than one civil engineering context.

This requirement was largely unchanged from the previous criteria. Use of high-quality embedded indicators across the program in different civil engineering disciplines demonstrated appropriate levels of student achievement. Demonstration of design content in the vast majority of civil engineering courses as part of Criterion 5 (Curriculum) also contributed to our compliance with this criterion.

Explain basic concepts in management, business, public policy, and leadership.

This requirement, largely based on the ASCE Body of Knowledge, presents new areas to be covered in civil engineering curricula. The requirements of this component are not included in the ABET Criterion 3a-k, thus programs using the ABET Criterion 3a-k as their program outcomes will be overlooking this requirement. An adjustment of the USMA civil engineering program outcomes in 2006 in anticipation of the new civil engineering program criteria proved very beneficial. In order to include meaningful coverage of this component, it was necessary to bring guest speakers with the requisite knowledge and experience into our CE Professional Practices course. To demonstrate accomplishment of program outcomes related to this component, it was necessary to adjust end-of-program surveys for students and to have embedded indicators in place to provide both indirect and direct measures of student achievement.

Explain the importance of professional licensure.

This requirement carries from the previous CE program criteria. The use of embedded indicators and other measures demonstrated student achievement of this requirement.

The faculty portion of the new CE Program Criteria is identical to the previous version and is broken into two components below. A short commentary on each component is provided to discuss the process used to address the requirement.

The program must demonstrate that faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience.

We addressed this requirement by breaking our curriculum into two distinct groups—courses that are primarily design in content and courses that are *not* primarily design in content. Within the first category (primarily design in content), we listed the course, instructors, their

professional registration status, and then comments on their specific qualifications. In the case where an instructor was teaching a "design" course without being a registered professional engineer, we provided a short paragraph explaining why the instructor was qualified to teach the course based on experience and education. Within the second category (not primarily design in content), we listed the course, instructors, professional registration status, and then comments on the course to justify why possession of a PE license was not necessary. We referred to Bloom's Taxonomy and identified that the course typically did not exceed the "analysis" level.

The program must demonstrate that it is not critically dependent on one individual.

Proof that the program does not depend critically on one individual was demonstrated under Criterion 6, Faculty. We showed that at least two faculty members were competent in each of our four technical areas. In addition, we demonstrated our process to maintain a "bench" of qualified instructors based on our high annual turnover of rotating military faculty members.

It is important to note that PEVs cannot expect immediate compliance with the newly implemented civil engineering program criteria. It is important to demonstrate that your program has a process in place to adjust to the new requirements. Once the requirements have been in place for a longer period of time, PEVs will expect a higher standard of achievement.

Efficient Collection and Presentation of Examples of Student Work

As specified in the *ABET Policies and Procedures Manual*, representative examples of good, average and poor student work are required for all courses contributing to the major.[6] The task of collecting these representative examples is daunting, to say the least, and requires all faculty members to identify the examples, make the copies, then ensure the sample student work makes it to the right binder. As part of preparing for our ABET visit, we collected copies of all student work electronically using a high-speed sheet scanner. Collecting the copies electronically saved our department significant resources.

About two months prior to the visit, we decided to make hard copies of student work related to embedded indicators and compiled the hard copies in notebooks by program outcome. The resource requirement for these copies was about 10% of the total amount of student work collected. This proved to be a great decision. When communication with our assigned PEV began, we informed him of our method of collection of student work, and he was quite pleased with the plan. For the visit, we presented the following resources to the PEV:

- CD-ROM with electronic copies of all student work (except final exams) from all CE program courses.
- CD-ROM with electronic copies of student work on final exams from all CE program courses. Final exams are re-used from year to year, thus it was necessary to keep this CD-ROM secured when not in use by the PEV.
- One notebook for each CE program outcome containing samples of student work from each embedded indicator mapping to that particular outcome.
- One notebook for each course containing annual course assessment documentation since the previous ABET evaluation.

In the final analysis, the PEV looked only at the hard-copy documentation of embedded indicators by program outcome. Based on the limited time available for documentation review, he did not look at either of the CD-ROMs and looked only briefly at the course assessment documentation.

A Robust External Advisory Board

The value-added by a robust external advisory board is significant. A properly formed board that contains members who represent the program's constituencies is clear demonstration of connection to those constituencies. As part of our self study, we included the minutes from two previous advisory board meetings to demonstrate how the board was being used to collect information to provide direction for the program and to assess students and faculty members on various questions. It is important to ensure that the advisory board reviews the program educational objectives and program outcomes as a part of their proceedings and that the results of the review are clearly articulated in the meeting minutes. Our PEV read every board comment carefully and asked many follow-up questions prior to the visit. In many cases, the questions he asked provided a venue to discuss other aspects of the program or the institution that might not have been addressed fully in the self study. Including board minutes can be problematic if the board does not understand its role; however, the importance of demonstrating a connection to constituencies cannot be understated.

Good Communication with the ABET Program Evaluator Prior to and During the Visit

Good communication prior to and during the visit is absolutely vital. As the program director, you should endeavor to answer all the PEV's questions before he or she arrives at your campus. The PEV will develop an opinion of the program director and the program long before arriving on campus. The evaluation schedule is very tight and affords evaluators very little, if any, discretionary time. By providing as many answers to the PEV's questions in advance as possible, you are effectively reducing stress on your evaluator during the on-site visit. The PEV who shows up at your campus with significant information requirements yet to fill will not likely begin the visit on a good note.

The initial request for transcripts is where you can make things easy on the PEV. By systematically going through each transcript and identifying unique aspects of each student's program, you can save your PEV countless hours. We completed a separate spreadsheet configured after Table 5-1 (refer to the ABET Self Study Questionnaire) to accompany each student's transcript. By modeling the spreadsheet after Table 5-1, we demonstrated how each student's program met our graduation requirements. Along with the spreadsheet, we attached any waivers issued for the student to explain course substitutions or the like. The PEV had no questions on the transcripts.

As the PEV sorts through the self study, he or she will develop a list of questions or requirements for additional information. The initial request for additional information from our PEV contained some 23 detailed questions that required a lengthy response. After the response to the initial 23 questions, the PEV did not pose any further questions and seemed very satisfied with the self study and responses we sent.

The Importance of Process

Through all aspects of preparation for our ABET evaluation, the importance of having a process in place seemed to be a common denominator. In a few cases, we were concerned about the ways in which actions were being handled. In the final analysis, we concluded that even if the PEV did not agree with our policy, if we had a well defined process in place, it would be difficult to criticize. We concluded that instances where a process was weak or did not exist would be grounds for the PEV to identify a concern, or worse a weakness or deficiency.

A prime example of a need for process relates to the new Criterion 4, Continuous Improvement. For a program to demonstrate continuous improvement, a process must be in place that requires ongoing assessment of courses and the overall program. The word "ongoing" is the key to success. A PEV will quickly determine whether improvements have been made to the program since the last visit. We have found that the best time to assess the program and make change is in the year following the ABET visit. Any changes implemented will be done with ample time for follow-on assessment prior to the next visit.

Identifying places in your program where processes are weak or non-existent is a great way to determine where to focus effort in improving the program or preparing for an ABET visit.

Conclusion

There is not one right answer to preparing for an ABET evaluation. There are, however, ways to make the process easier through proactive planning and ensuring that key processes are in place and functioning. The establishment of appropriate program educational objectives and program outcomes based on constituencies and a high quality assessment system that includes both direct and indirect measures of student work are the foundations of the program. If those elements are not properly thought out, the rest of the program can never be fully integrated. Faculty must understand the process and contribute to it as active members in order for the assessment system to function properly. And the systems in place must be easy to understand and not require an inordinate amount of effort to maintain. Again, the bottom line is that preparation for an ABET evaluation should be a well-coordinated process that begins well in advance of the visit and has all the key players striving to achieve a rating of "Next General Review."

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