EC2000: What to Expect/ What is Expected?

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All U.S. engineering programs, except those with outstanding conventional criteria issues (show cause or interim evaluations) should now be on board with Engineering Criteria 2000. As of Fall, 2001, these are now the standard for accreditation, yet institutions are still at varying levels of preparedness and willingness to be evaluated under these criteria.

This paper summarizes the observations I have made on the EC2000 transition process both from the program's and ABET's perspectives. Information from EC2000 visits, ABET reports, workshops, and discussions in the Engineering Accreditation Commission (EAC) of ABET have contributed to these observations. The focus of this paper is mainly on Criterion 3 issues, with some commentary on Criterion 2 and Criterion 4. These three criteria are the focus of most discussion in journal articles, workshops, conferences, team visits, and ABET training. The other five criteria are more familiar and are more routinely part of current practice in engineering programs.

The purpose of this paper is to make observations and sensitize readers to commonly observed problems in the implementation of EC2000 within engineering programs and within ABET. The purpose is not to offer solutions to all the problems, but specific suggestions are provided in some instances.

Definitions

Criterion 2 addresses the program educational objectives, and Criterion 3 describes student outcomes and their assessment. Although ABET has not provided its constituencies with definitions for the important terms in these criteria (and with some major negative consequences—more on this later), the general understanding of the meaning of these terms used at assessment workshops, within ABET and on its evaluation teams is as follows.

Program educational objectives are broad statements that describe the expected accomplishments of graduates during the first few years after graduation[1], while program outcomes are statements that describe what students are expected to know and are able to do by the time of graduation, the achievement of which indicates that the student is equipped to achieve the program educational objectives[1]. The objectives guide the program in a broad sense, and outcomes relate more directly to specifics about student learning in the program. These definitions will be used in this paper.

Observations on Institutions and Programs

As the typical visit cycle begins, the first major piece of evidence for accreditation offered by a program is its self-study. Over the past three years it has been observed that the preparation of program self-studies has been spotty and inconsistent[2]. Some self-studies provide useful evaluative materials for the program evaluators (PEVs) and answer directly to the criteria and the

self-study guidelines suggested by ABET. Other institutions do not follow the guidelines, but attempt to "write" themselves into compliance with the criteria, seemingly ignoring such Criterion 3 phrases as "*must demonstrate*," "*documented results*," "*evidence must be given*," and "*are being measured*."

In this context, Criterion 3-centered issues that are typically identified as shortcomings include the following:

- No measurement of outcomes at all—only opinions and self-assessment results;
- Assessment results presented for the PEV to evaluate and analyze;
- An assessment plan in place with little or no implementation;
- Only raw assessment data with no additional analysis or application (loop is not closed);
- Assessment data that are not representative or do not provide information than can be used for improvement (e.g., surveys with a small number of respondents).

Since the completion of the first rounds of transitional EC2000 visits, accreditation teams have taken a more rigorous approach to their analyses of compliance with criteria. Most notably, evaluation and assessment processes for both Criteria 2 and 3 must be functioning. Descriptions of *plans* for implementation are not acceptable evidence of full compliance.

Many programs make the case that they have practiced some level of program improvement well before the advent of EC2000; however, in many cases the improvement efforts have not been systematic, well documented or geared toward the specific requirements of EC2000. Most pre-EC2000 improvement efforts have been directed at course improvement, student satisfaction, and curriculum logistics. They are not sufficient evidence to prove the case for compliance with EC2000, which ask for specific documentation and evidence of improvement *relative to the objectives and outcomes, not simply generic improvement*.

Due in part to ABET's reluctance to be prescriptive, specific definitions of the important terms in the criteria--objectives and outcomes—have not been provided to date in any official documents. As is evident in some self-studies, in published literature, and even among accreditation team members, this may have caused considerable confusion about the intended meaning of these terms. ABET chose not to provide definitions in order to allow programs to use their own terminologies to represent the implied meanings for "objective" and for "outcome." For example, a program may wish to use the term "goal" instead of "objective" or "target" instead of "outcome." I believe that the intent was not for programs to write their own *definitions*, which, in effect, would rewrite the relevant criterion itself and cause difficulties in consistent evaluation of engineering programs.

With regard to Criterion 4, the major shortcomings center on lack of inclusion of *most* of the realistic design constraints listed in the text of the criterion. Simply including a few of these in student design projects has not been viewed as effective compliance.

Looking for the Easy Way Out—Self-Assessment

Many engineering programs perceive that effective implementation of EC2000, Criterion 3 in particular, will take a major input of human and financial resources. It is clear that the start-up of the processes needed for criteria-compliant assessment of outcomes requires a high initial input of resources.[3] For the long term, however, the desire to find assessment methods that are easy to administer, inexpensive, provide "measurable" data, and take little or no faculty time has driven many programs to the use of surveys.[4] Program evaluators and ABET administrators have observed an over-dependence on surveys for the assessment of student outcomes. This may be due to the unfortunate placement of the list of example assessment methods in the text of Criterion 3, allowing some programs to make the argument that if they use an assessment tool from the list, then they must have satisfied the criterion.

Whether commercially available surveys or home-grown survey instruments are used, their typical purpose with respect to Criterion 3 is to obtain a *self-assessment* from students on their abilities in the ABET-designated outcomes. Students are asked to evaluate themselves on outcomes of which they do not even understand the meaning. E.g., a survey question might read as follows:

> *"On a scale from 1 (low) to 5 (high), rate your abilities in and understanding of life-long learning skills."*

What might we read into the answer? How much trouble do we as faculty have in understanding what life-long learning skills are; yet we ask our students to rate themselves. Do the students have a clear understanding of the expectations that faculty members have for student performance in each of the outcomes—i.e., what is a "high" level of performance? How can we expect objective answers from students? At best, we can test their awareness of coverage of an outcome in a particular course, but beyond that, this type of subjective data can only play a role as *secondary* evidence of achievement of outcomes.

We cannot expect true assessment and measurement of student achievement in the program outcomes unless we, the faculty, *directly and objectively evaluate student work*. Unfortunately, this is not something most faculty members feel they have the time to do, and so subjective assessment methods have become popular. In a recent study of the initial effect of EC2000 implementation in mechanical engineering programs,[4] the five assessment methods mentioned most frequently included

1. Advisory board feedback
2. Graduate exit interview/survey
3. Alumni survey
4. FE exam
5. Employer survey

Only two of these methods (exit interview and FE exam) obtain information from students at all. The exit interview most likely obtains student *opinion* rather than assesses student knowledge or skills. The FE exam is not suited for all engineering disciplines or for the assessment of all ABET-designated outcomes. Alumni surveys can provide good evidence of the achievement of

graduates, as long as recent graduates are surveyed. Employer surveys have proven to be difficult to administer and provide limited or sparse useful data.

Advisory board feedback and alumni and employer surveys are potentially good tools for secondary evidence of the achievement of student outcomes. However, these tools are really better suited for the evaluation of achievement of program educational objectives, where constituencies must be involved in the process. Criterion 3 does not require involvement of outside constituencies per se (Criterion 3 does not contain the word "constituencies"), although most programs choose to do so. It is my strong believe that for effective assessment and improvement processes, evidence for demonstration of outcomes should come from student work, with input from outside constituencies limited to secondary evidence as discussed earlier.

Given the preceding discussion, it is curious that the survey of mechanical engineering programs[5] also indicated that the assessment method that truly does evaluate student work directly—the student portfolio—has been dropped by many programs. This has been the case in our program at Michigan State University as well. Depending on how the portfolios are used, they can become a labor-intensive management headache. So, if we really should directly assess student work as the primary means of evaluating achievement of outcomes, how can this be done without a tremendous drain on resources?

Using Existing Classroom Strategies

Designing an assessment process has been likened to an engineering design process. The good news is that we don't have to start from "scratch." If we RE-design our standard student evaluation methods and adapt them for outcomes assessment, we may save considerable time and effort in an effort to comply with ABET criteria. Opportunities to evaluate student learning already exist in our classrooms--student projects, quizzes, exams, competency tests, and other common evaluative instruments. These very same common evaluative tools can be used to demonstrate the knowledge or skills in the eleven ABET-designated outcomes.[6,7,8]

When programs plan for evaluation of the program outcomes in their students, most program faculty look to their curricula. Many programs have mapped their program outcomes into the curriculum by identifying courses that help students to achieve the outcomes, and most faculty already have good ideas of how to guide student learning toward these outcomes. The most difficult psychological hurdle is performing the assessment.

Fortunately, the idea of embedded assessment has been implemented at many institutions; it will not be covered explicitly in this paper. Embedded assessment involves the use of existing classroom practices that has been modified for assessment purposes.[6,7,8] An added advantage to this approach is that case study institutions report embedded assessment within capstone or other courses as the best means for getting students to take assessment activities seriously.[9]

Assessment and grading are not equivalent.[9] Some institutions claim that their student outcomes are already measured through grades. In these cases, the typical approach has been to assign a weighting factor or percentage to each outcome covered within a particular course, and to then assign the weighted average of the student's grade in that course as a measure of the specific outcome. The problem is that the result provides no information for effective improvement

strategies. E.g., if a student earns a 2.5 in a course that spends 30% of the effort covering problem solving skills, what useful information does the weighted average of the 2.5 grade provide? There is no information with which to dissect out the student performance on any specific outcome or to know exactly where specifically the student's lack of learning occurred.

The difference between grading and assessment is effectively described by Nichols.[9] As demonstrated in Table 1, when faculty grade student work, they have in mind several criteria by which they evaluate student work. The student's grade on the problem represents the aggregate score across all of these criteria. This is represented by the vertical direction in the column for each student.

Let's suppose that we correlate each grading criterion with a student outcome. A particular quiz, assignment or exam may cover one, a few or several of the ABET-designated a-k outcomes. Assessment is evaluation of student performance on any one criterion (outcome) across all students, represented by the horizontal direction on the table for each criterion (outcome). Grading is an aggregate for all relevant criteria (outcomes) for one student; assessment is one criterion (outcome) across all students. Alternatively, one may view grading as a lumped parameter analysis and assessment as a distributed parameter analysis.[10]

Table 1. Grading versus Assessment.[9]

Outcome / Grading Scale 1-5	Student 1	Student 2	Student "n"	**Outcome Average**
Criterion (outcome) #1	3	4	1	**2.7**
Criterion #2	2	5	2	**3**
Criterion #3	4	5	3	**4**
Total	9		6	
Grade	**C**	**A**	**D**	

Trying To Do Too Much

In an attempt to cover all possible aspects of evaluation and assessment, many programs appear to have used the "shotgun" approach--to implement as many assessment methods as possible to try comply with ABET criteria. In some cases, as many as twenty different assessment methods have been noted! It is no wonder that faculty and administrators are discouraged by the amount of work that this requires.

It is apparent that in such cases, a more focused and deliberate approach would be just as effective and significantly more efficient if the particular contribution of each assessment method were mapped to its specific and targeted purpose in the assessment process. Proper assessment requires some redundancy (triangulation), but "more" is not "better" in terms of process sustainability.

Some programs attempt to assess all outcomes for all students on a regular basis. ABET does not explicitly require that all outcomes be assessed with equal frequency or even that all students

be assessed. Programs may prioritize the importance of their outcomes in the context of their contribution to the achievement of their program educational objectives. In this case, assessment of the crucial outcomes may be done more regularly—say, once per semester or once per year--and the less critical outcomes might be addressed less frequently.

Because of the time constraints on faculty and to ensure process sustainability, assessment could justly be done on the basis of a sampling of the student population. This approach is supported by Nichols,[9] who suggests that the aggregated accomplishments of the students in the program outcomes are the primary available reflection on our programs. He further states that ". . . not all students or graduates need take or respond to all means of assessment, since a representative sample is sufficient for evaluation of the program." The sampling approach appears to be indirectly supported by ABET policy as well[11] which clearly states that ABET accredits *programs*. This implies that its role does not include accreditation or evaluation of individual student performance, but rather the aggregate outcome.

Observations in ABET

The transition from Conventional Criteria to EC2000 has caused some difficulties within ABET. The issue with lack of definitions for key terms has been discussed. There have also been some challenges associated with implementation and maintenance of current documentation, a new web format, new training, and new background processes within ABET. To the credit of the staff at ABET headquarters, they have maintained an open-door policy with regards to questions and concerns coming from the institutions and their volunteers. Accreditation visits are conducted with the same openness. This has certainly alleviated some of the concerns.

The major issue recognized by ABET, its volunteers, and the institutions is one of consistency. Consistency issues arise in three areas as follows:

1. in program evaluation from one program to another within a single institution,
2. in comparing evaluations across institutions, and
3. in final recommended accreditation actions.

Several layers of checks and balances are in place throughout the visit cycle, and the general trajectory of improvement on this issue has been positive. Specific training to achieve consistency for team chairs and PEVs is now in place. ABET editors check for consistency in evaluations across institutions, and a consistency committee considers consistency in recommended actions at the time of the final action. However, a fourth area of consistency issues is really based in a program's understanding of the requirements of ABET criteria, as discussed earlier in this paper. It is hoped that this paper is helpful in this regard.

Conclusions

EC2000 was intended to foster inventiveness and individuality in engineering curricula, and to encourage faculty to think more creatively about effecting student learning. When driven by the needs of its constituencies, engineering programs should not all be clones of one another. Yet, it is apparent that the freedom to develop novel curricula has not yet been embraced by engineering programs. Program faculty still feel encumbered by the need to develop realistic and sustainable improvement processes that comply with ABET criteria.

As long as faculty members maintain an open mind about how assessment can be used to improve student learning, this "grand experiment" has a good chance of success to the ultimate benefit of our students.

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