

ABET EC2000: How Has It Changed? Has It Accomplished What Was Intended?

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Abstract – Now that EC2000 has been in place for several years, schools are more comfortable with the assessments and continuous improvement which the criteria require. However, each year, the Engineering Accreditation Commission of ABET has incorporated small changes into the criteria. These have ranged from minor wording changes to more major changes, such as the proposed addition of an additional criterion on Assessment and Evaluation to the current list [1]. More than the criteria themselves, the guidance provided by ABET to accreditation visitors has changed considerably over the period since EC2000 was first put into place. This paper uses the author's years of ABET accreditation experience and the ABET documentation to discuss the changes in EC2000 and give a clear picture of the criteria as stated, and as assessed, today. The paper also draws on the literature to discuss whether EC2000 has met its goals of ensuring "program improvement and quality assurance" in higher education" [2].

Keywords: ABET, EC2000, Accreditation, Assessment

HOW HAS IT CHANGED?

How have the criteria changed?

The original criteria known as ABET Engineering Criteria 2000 were published for comments two years before they became effective [3], and were phased in over three years 1998-1999 through 2000-2001, during which programs could choose accreditation under the old criteria or under EC2000. The criteria as originally published were substantially the same as they are today in intent, and since the current accreditation cycle is the last in which any program can undergo accreditation under EC2000 for the first time the readers of this paper are assumed to be at least somewhat familiar with the EC2000 criteria. A brief list of the changes between the EC criteria as originally published and the version used in the current accreditation cycle [1], is given below:

Criterion 1. Students--The requirements that programs "have and enforce policies for the acceptance of transfer students and for the validation of courses taken for credit elsewhere" and "have and enforce procedures to assure that all students meet all program requirements" have been moved from Criterion 3 in the earlier publication [3] to Criterion 1 in the current year's documents [1]. This is primarily an editorial change which provides a more logical grouping than the original, but does not have a significant effect on how the criteria are applied.

Criterion 2. Program Educational Objectives--The primary change in this criterion is the definition of "objectives," making it plain that objectives are "the career and professional accomplishments that the program is preparing graduates to achieve;" [1] i.e., that these are items which a program expects its graduates to accomplish at some point in the future, usually defined to be some number of years after graduation.

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Criterion 3. Program Outcomes and Assessment--Several significant changes have been made in Criterion 3. One major change in this criterion is the definition of "outcomes" as "statements that describe what students are expected to know and be able to do by the time of graduation," [1] making the difference in time scale between outcomes and objectives clear. Another change is that the specific types of evidence listed as acceptable for assessment in the original version of the criteria, such as nationally-normed subject content examinations, placement data for graduates, design portfolios, etc., [3], were removed from the current version of EC2000. In a relaxing of constraints on the capstone experience described in Criterion 4, the list of constraints which have been included in the past in the capstone description (manufacturing, sustainability,...) have been moved from the description of the capstone project specifically in the original criteria [3] to engineering design in general (Criterion 3.c in [1]) and have also been relaxed from "most of the following considerations..." [3] to "realistic constraints such as..."[1]--also much more flexible language. Criterion 3.h. has been revised to include economics and environment in the context in which engineering solutions must be understood [1]. The final major change in the wording of Criterion 3 is to make clear that if any additional outcomes are added to the ubiquitous ABET a-k, the program's success in meeting these additional outcomes must also be demonstrated [1].

Criterion 4. Professional Component--This section, which includes requirements on engineering sciences and design, now offers the following definitions of these terms: [1]

The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs.

The constraints on the capstone experience have also been relaxed, as mentioned previously, with the description now reading simply "a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints," allowing much more freedom to select constraints appropriate to a given project, rather than being tied to an ABET defined list [1].

Criterion 5. Faculty--While the ABET requirements on faculty *qualifications* remain unchanged, a significant addition to the requirements of this criterion is that the faculty of a program "must have and demonstrate sufficient *authority* to ensure the proper guidance of the program and to develop and implement processes for the evaluation, assessment, and continuing improvement of the program, its educational objectives and outcomes." [1]

Criterion 6. Facilities and Criterion 7. Institutional Support and Financial Resources are essentially unchanged.

The wording changes discussed above, some of which are significant and some of which are not, are information available to anyone who takes the time and trouble to compare the two sets of criteria. However, the way in which the criteria have been applied has also changed significantly over the same time period, and in ways which can not necessarily be determined by those who have not been a continuous part of the review process. The discussion in the next section is based primarily on the author's personal experience as an ABET accreditation visitor continuously over the time period from her first EC2000 visit in 1999 to her latest one in the current evaluation cycle.

How has the application changed?

In the years since the criteria were first applied, while the criteria themselves have changed somewhat, the ways in which the criteria have been applied have changed much more drastically. The good news is that the changes have been in the directions of more leniency and discretion for individual programs.

When the EC2000 criteria were first applied, some accreditation teams and team chairs took the criteria themselves very seriously, to the point that the criteria seemed to be viewed as being as important as the quality of the programs they were meant to measure. On the author's first EC2000 accreditation visit in 1999, the team chair recommended the

same accreditation action of an interim visit for one program which had successfully met all of the criteria and successfully demonstrated all outcomes, yet had its objectives and outcomes published only on the internet and not on paper, as for another program which had no capstone design project and categorically refused to implement one. Fortunately, in the EAC review process, wiser heads prevailed, but in the years following, the team training has increasingly emphasized that the goal of the accreditation process is to determine whether students are being successfully prepared for engineering practice rather than whether "i's are dotted and t's are crossed."

When the EC2000 criteria were first applied, if a program had Concerns (defined as "A criterion is currently satisfied; however, potential exists for this situation to change in the near future such that the criterion may not be satisfied. Positive action is required to ensure full compliance with the criteria." [4]) and was required to have an interim visit or prepare an interim report, all Concerns must be addressed. However, it is now ABET policy that while programs have the option to address Concerns in an interim visit or report, only Deficiencies and Weaknesses *must* be addressed by the program.

There was, in the past, some lack of consistency in how the criteria were applied, depending heavily on the team chair and the program accreditation visitors, with some giving a program the worst rating on a multi-part criterion such as Criterion 3, and others going with a preponderance of the evidence. ABET has made an effort to address this by requiring an on-site training review as part of each accreditation visit, and by stating plainly in this training, "The Key term ... [Deficiency, Weakness, or Concern] is the overall assessment for the criterion as a whole, not the worst finding among the sub-areas on the worksheet. Do not give a Deficiency to a program that lacks only a measurement for outcome 'e.'[5]" The on-site training now provided also very highly stresses consistency of the evaluations across programs, and that all accreditation recommendations are to be team recommendations rather than individual recommendations--this definitely represents a shift from previous practice, but one which makes the process more predictable for the programs being assessed.

Selecting outcomes for a particular program is another area where the assessment has changed considerably over the course of the last few years. Over the past several years, it was viewed by ABET accreditation visitors as an indication that the program had not sufficiently considered outcomes or sufficiently consulted the needs of its constituencies if the programs adopted ABET's a-k as outcomes directly, yet programs were required to demonstrate that a-k were being assessed and achieved. Thus schools were being expected to generate some mapping of a-k onto their own outcomes, assess and demonstrate success of their own outcomes, and then perform a reverse mapping demonstrating success of a-k. Some evaluators did consider it sufficient if a program put its own "unique emphasis" on the a-k criteria, but others expected a totally different set of outcomes for each program. This has relaxed considerably in recent years as well, and as long as the outcomes are periodically reviewed and meet the needs of constituents, use of a-k, in whole or in part, seems now to be regarded as acceptable. If, however, programs do define additional outcomes, Criterion 3 now makes it plain that these, as well as a-k, must be assessed and must be successfully demonstrated [1].

It is perhaps in the assessment of Criterion 3 and a-k that the application of the criteria has changed the most. Although it was never written or officially stated by ABET, evaluators have in the past expected "triangularization"--assessment of each outcome by three or more disparate methods. These increasing, though unofficial expectations, led one frustrated professor, when told he had only two forms of measurement for one outcome, to exclaim, "Well, we're *bi*-angulating!" While multiple types of assessment are still regarded as desirable, a single assessment, if convincing, now seems to be regarded as acceptable. What would be accepted as evidence that an outcome was met has also changed considerably. For the 2004-2005 and 2005-2006 accreditation cycles, ABET provided as part of its documentation to accreditation visitors a white paper on assessment of Criterion 3, giving examples of both acceptable and unacceptable types of evidence [6]. Included as unacceptable are

- "Student learning outcomes that have not been defined (e.g., What is "effective communication skills?" How will you know "effective communication skills when you see it?");
- "no direct measures of student learning";
- "overuse of surveys";

- " 'traditional' course evaluations and student 'satisfaction' surveys used as basis for improvements";
- "assessment ... done by external parties";
- "use of methods that do not align with program's own definition of its outcomes";
- "Course grades do not constitute measurement of outcomes;" [6]

From the same document,

...the assessment process should include direct and indirect measures and does not rely only on self-report surveys and evidence that the material is "covered" in the curriculum. Evidence that needs to be provided must be "convincing" evidence. Student self-assessment, opinion surveys, and course grades are not, by themselves or collectively, acceptable methods for documenting achievement of outcomes. [6]

Listed as being desirable in the white paper, are

- A "limited set of performance indicators that define each outcome to be assessed";
- Secondary evidence such as surveys being used only in conjunction with direct measurement methods;
- Data collection methods focused on the indicators;
- Map of outcomes to the curriculum;
- "Documentation of how the process is being sustained and what multiple assessment methods are being used to assess the various outcomes";
- "Summaries, evaluation of results, and action taken ... presented outcome by outcome." [6]

Although these items were not required, they, taken together with the items given as not being acceptable, did imply the sort of triangularization expected in previous years. However, the fact that this white paper was withdrawn by ABET and was not provided as part of the documentation for accreditation visits in the 2006-2007 cycle demonstrates the relaxing of assessment as practiced in earlier accreditation cycles.

There is one item which was included in this white paper that has not been withdrawn, and which is now included in the on-site training as part of every accreditation visit; this is the clear statement that each and every student must successfully achieve acceptable levels on all of outcomes a-k, as well as the professional component of the program (Criterion 4) and any additional outcomes defined by the program. However, it is up to each program to define what is an "acceptable" level based on the needs of its constituencies. [5]

What changes are planned?

One major change is being proposed for the next accreditation cycle, if approved by the EAC in the summer of 2007. This is the elevation of assessment to a separate criterion. The new criterion, which will become Criterion 4, is stated in the draft as

Criterion 4. Assessment and Evaluation

The program uses a documented process incorporating relevant data to regularly assess its program educational objectives and program outcomes, and to evaluate the extent to which they are being met. The results of the evaluations are used to effect continuous improvement of the program through a documented plan. [1]

While this is being viewed by the EAC as an editorial change rather than the addition of a new criterion, how it is assessed, and the relative weight placed on assessment as compared to accomplishment of outcomes, objectives, etc., by accreditation visitors is yet to be seen. Old criteria numbers 4-8 would be renumbered 5-9 under the proposed change, but would remain in the same order.

HAS EC2000 ACCOMPLISHED WHAT WAS INTENDED?

What was it supposed to do?

First we must ask what EC2000 was supposed to accomplish. According to [7], EC2000 began as a result of a call by industry for engineering graduates better prepared to function in modern industry in terms of ability to "team effectively," and understand concepts of "customer service, environmental sensitivity, social responsibility, and continuous quality improvement." In [2], the goals are expressed more succinctly as ensuring "program improvement and quality assurance" in higher education.

How has effectiveness been measured?

Now that EC2000 has been in place for some time, several workshops, studies, town meetings, and articles have addressed the effectiveness of the criteria in both formal and ad hoc ways.

In 2002 and 2003, ABET conducted a series of workshops and information gathering, including participants from programs which had had two accreditation cycles under EC2000, leaders from the 1994 Accreditation Reform Workshops that led to the development of the EC2000 criteria, ABET's Industry Advisory Council, and technical societies.[7] Some of the conclusions of this group are

- accreditation visits have been very subjective and visitor dependent and should be made more standardized and objective;
- more specific tools for assessment are needed; the current criteria involve too much paperwork; there is no clear faculty reward structure for the work associated with this process;
- "There is growing acceptance of the value of the systematic engagement of external constituencies in improving program quality;"
- "There is a growing awareness of the value of outcomes-based assessment processes for improving program quality."

Two of the benefits of the criteria are the on-going participation and the meaningful curriculum discussions which this generates. One rather surprising conclusion of this group is that "here is increased faculty attention to student learning as part of improving program quality" [7]--this is surprising in that without attention to student learning, an educational program has no meaning.

In an informal assessment article by Gloria Rogers of Rose-Hulman Institute of Technology, a report card is given, based on an assessment conference with 1200 participants. The report card, reproduced below [8], gives a really high mark only for alignment of curriculum with learning outcomes. The C in learning outcomes is related to the perceived failure of programs to identify unique outcomes for each program, as discussed earlier. The D+ in assessment is also tied to issues already previously discussed: use of surveys and lack of multiple objective methods of assessment for each outcome. The only failing grade in the list is related to a failure to identify a "limited number of performance indicators for each outcome"--i.e., specifics about what faculty need to see from students in order to truly demonstrate that the outcomes have been met. This paper states that programs have not made much progress in this area, but since the criteria do not specifically require articulation in this area, progress could be difficult to measure and assess. Note that all of the conclusions stated in the report card are based on subjective discussion rather than objective assessment. [8]

OUTCOMES ASSESSMENT REPORT CARD [8]	
SUBJECT	GRADE
Educational Objectives	B+
Learning Outcomes	C
Assessment	D+
Curriculum Alignment	A
Evaluation	B
Improvement	B
Performance Indicators	F

A major three-year longitudinal study funded by the National Science Foundation was recently completed to determine whether the graduates of programs accredited under EC2000 are better prepared for engineering practice than students were under the earlier ABET criteria. The researchers surveyed programs, faculty, deans, 1994 and 2004 program graduates (representing pre- and post-EC2000 graduates), and employers to assess the impact of EC2000. Faculty and program chairs report increased emphasis on the ABET a-k topics, and an increase in use of active learning methods. However, it is interesting to note that program chairs are much more likely than faculty to give ABET credit for these changes in emphasis. Both chairs and faculty report that the majority of faculty are actively involved in assessment and systematic efforts to improve their programs, and approximately 70% of the faculty regarded the level of effort they are required to provide is "about right." However, about half of the faculty and chairs do not see this additional effort reflected in their universities reward systems. The study also includes survey results for 1994 and 2004 graduates on how well prepared they felt when they graduated in each of the Criterion 3 a-k outcomes. The conclusion of this study is, "The weight of the accumulated evidence collected for *Engineering Change* indicates clearly that the implementation of the EC2000 accreditation criteria has had a positive, and sometimes substantial, impact on engineering programs, student experience, and student learning." [9] It is highly ironic that *all* of the conclusions in this study, regarded as currently the best measure of EC2000 success, are based solely on self reporting and surveys, which ABET has uniformly denounced as being insufficient evidence that objectives and outcomes are being met for engineering programs being evaluated!

There have certainly been unintended consequences of EC2000 as well. The new criteria have spawned a cottage industry of "accreditation experts" conducting workshops, performing mock evaluations for fees, etc. While some of these individuals are truly experts, and provide excellent service to universities, others have provided very bad, very costly advice, as one which the author visited, which had been advised by a consultant, paid \$15,000, to proceed with an accreditation visit even though they had not yet had a graduate from the program, and therefore could not even be considered for accreditation. It may also not be widely known that it is regarded by the EAC as a conflict of interest for active accreditation visitors to provide such services for a fee, though former evaluators are free to do so.

WHAT'S NEXT?

What is the future of ABET? ABET is currently looking at what can and needs to be done to improve and insure the future of the organization. Some challenges include

- the fact that as of 2001, ABET is no longer recognized by the US Department of Education,
- ABET is essentially a monopoly,
- neither industry nor academia are directly represented on ABET's Board of Directors,
- the fee structure may not continue to support the organization, and
- the lack of an international organization to respond to global market issues. [10]

ABET is also working on improving recruitment, training, and assessment of program evaluators, to improve both quality and consistency of the evaluation provided. [11] How well ABET defines its own objectives, how well it does its own assessment and evaluation, and how well it responds to the needs of its own constituents, will determine how well and in what form it continues into this century.

CONCLUSION

What's the conclusion? The criteria in EC2000 have changed somewhat, and the way in which they are applied has changed still more, but in the direction of more leniency and freedom for individual programs. As to whether EC2000 has accomplished what was intended, regardless of the conclusions of any number of studies, is actually something that must be determined by each program. The intent of the assessment requirement was that the faculty of the program would continually assess and improve their own program, yet some schools hire outside firms to essentially "do ABET" for them. Increasing weight on areas highlighted by EC2000 may or may not be perceived as positive by the students in a program; for example, the increased emphasis at the University of Tennessee at Chattanooga on

multi-disciplinary teamwork led one frustrated student to declare that we were "teaming them to death." Questions you should be asking in determining whether EC2000 has done what it was supposed to do in your program are

- Are faculty more aware of how well students are accomplishing what faculty intended for them?
- Are faculty making changes to be more responsive to what students need?
- Do faculty have the resources and the power necessary to make the changes the program needs?
- Is this program what students need now or what they needed ten years ago? How do we know?
- Are students well prepared for local industries or the graduate schools they are likely to attend?

If you can answer positively to questions such as these, then for your program, EC2000 has succeeded in doing what it was intended to do.

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