# AC 2012-3494: TEN YEARS OF ABET EC 2000: ONE PERSON'S REFLECTIONS

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# Ten Years of ABET EC 2000: One Person's Reflections


## Abstract

ABET accreditation criteria changed substantially at the turn of the century changing from a prescriptive, curricular-based standard to an outcomes-based approach for accreditation. The new system named Engineering Criteria (EC) 2000 required engineering programs to consult with their constituencies to establish program objectives and outcomes that define what their graduates will attain several years after graduation and at the time of graduation, respectively. The accreditation process involves assessing the degree to which graduates are attaining these outcomes and objectives and using the results to make changes and continuously improve the program. Most engineering programs have now been through two cycles of accreditation under the new system. There have been some growing pains, adjustments, and changes to the accreditation process since it was initially implemented.

This paper is in direct response to the session proposed by the CE Division of ASEE on the reflections of ABET over the past ten years from the perspective of program directors, program evaluators and members of the ASCE Committee on Curricula and Accreditation. This paper offers the perspectives and reflections from a full professor who has directed two different programs (Civil Engineering and Architectural Engineering) at two different locations through successful accreditation visits under this system. The author is also a seasoned program evaluator who has made ten ABET accreditation visits (one per year) to ten different CE and AE programs over the past decade.


## Introduction

ABET accreditation criteria changed substantially at the turn of the century changing from a prescriptive, curricular-based standard to an outcomes-based approach for accreditation. The new system EC2000 required engineering programs to consult with their constituencies to establish program objectives and outcomes that define what their graduates will attain several years after graduation and at the time of graduation, respectively. The accreditation process involves assessing the degree to which graduates are attaining these outcomes and objectives and using the results to make changes and continuously improve the program. Most engineering programs have now been through two cycles of accreditation under the new system. There have been some growing pains, adjustments, and changes to the accreditation process since it was initially implemented.

The accreditation criteria have not changed dramatically since the first version was published in 1998.[1,2] While the numbering system has changed slightly, the criteria have successively focused on students, program objectives and outcomes and their assessment results, curriculum, faculty, facilities, and resources. The outcomes, objectives and assessment processes have received the most scrutiny and been the greatest source of angst. Many of the changes have really been clarification of standards as different programs and ABET evaluators have struggled with how to interpret the criteria. ABET and the supporting professional societies have made great efforts to provide feedback and additional training to both programs and evaluators. Other

issues such as dual accreditation, harmonized criteria, accreditation of online programs and international programs, and the role of program criteria have been discussed and dealt with over the past decade. This paper offers the perspectives and reflections from a full professor who has directed two different programs (Civil Engineering and Architectural Engineering) at two different locations through successful accreditation visits under this system. The author is also a seasoned program evaluator who has made ten ABET accreditation visits (one per year) to ten different CE and AE programs over the past decade.

**Reflection #1**

EC2000 has appears to have abandoned some of the original core principles that made the outcomes based approach so attractive. A common criticism of the previous accreditation criteria[3] was that they were overly prescriptive and resulting in a "bean counting" documentation of the curriculum. Rather than focusing what courses the students would take, the EC2000 criteria focused on what the students were actually able to do. Program outcomes were defined as those things the students would be able to do at the time of graduation. To establish some minimum standards, the criterion 3 a-k outcomes were required of every program. In addition, programs were encouraged to create their own outcomes and define the unique nature of a particular program[4]. The cited advantage of EC2000 was that individual engineering programs, rather than ABET, would be able to define their own purpose and goals.

Over the decade this philosophical underpinning has been lost. Many programs attempted to embed the criterion 3 a-k outcomes into their own set of program outcomes or tailor the outcomes to reflect the particular emphasis or uniqueness of a program. This ended up requiring more work as programs now had to create tables showing a link between their outcomes and the 3 a-k outcomes. Some programs attempted to combine several of the 3 a-k outcomes into a single outcome. This often resulted in an accreditation shortcoming as the assessment process failed to demonstrate that all of the 3 a-k outcomes embedded in the larger outcome had been met. Those programs that created additional outcomes, as suggested, soon discovered the extra work involved in demonstrating the attainment of those additional outcomes. Failure to do this resulted in an accreditation shortcoming created by trying to exceed the prescribed minimum standard. There is a distinct disincentive to create new outcomes.

As a minimum, programs were encouraged to include the requirements from the ABET program criteria in a program outcome to ensure those requirements were not forgotten. Even this proved problematic as the requirements stipulated in the Program Criteria are limited to the areas of curricular topics and faculty qualifications[5]. Outcomes require that the students demonstrate attainment of a particular skill or attribute which is a higher standard. By not including the program criteria in the program outcomes, a program merely needs to demonstrate that the curricular content is sufficient for students to attain an outcome.

The cumulative effect has been that programs are now encouraged to adopt only the 3 a-k outcomes in their exact form rather than create new work and risk loss of accreditation by failing to demonstrate an additional outcome. The result is a substantial philosophical shift from the original intent and one of the core tenets that made EC2000 so attractive. ABET, rather than the engineering programs, is defining what all programs should achieve.

**Reflection #2**

Criterion 5: Curriculum[5] (formerly Criterion 4: Professional Component)[3] specifies curriculum requirements in subject areas appropriate to engineering but does not prescribe specific courses. It requires a year of math and basic sciences and one and one-half years of engineering topics. It also requires a general education component that complements the technical content of the curriculum. The general education component is so vague as to be meaningless and rarely causes accreditation issues. The one-year of math and basic sciences requirement can be difficult for some programs, especially with the budgetary pressure from many universities to force engineering programs to meet a 128 or even 120 semester hour maximum. The definition of one year is the lesser of 32 semester hours (or equivalent) or one-fourth of the total credits required for graduation.

Under this provision, a 120 semester hour program requires 30 hours of math and basic science while a 128 semester hour program requires 32 hours of math and basic science. Engineers either need a specific amount of math and basic science or they don't. The amount needed should not depend on the size of the program. This definition has other problems. Suppose a 120 unit program is allowed to add another four unit course to the program in order to enhance the program, meet a program outcome or accomodate an industry need. That program now has a requirement for an additional unit of math and basic science. The dual definition of a year is flawed and results in a dual standard for the amount of math and basic science that is required for accreditation. A better solution would be to define a year as 30 semester hours for everybody, impose the same requirements on all programs, and allow more flexibility for programs to define their own curriculum.

**Reflection #3**

The bar has been raised on the assessment standard for attainment of student outcomes – those things students know and can do at the time of graduation. This area has probably received more attention at workshops, conference presentations, and formalized training than any other element of the accreditation process. Programs are gradually becoming better about using direct measures of student performance to assess outcomes. Schools have been very creative in using the FE exam results, practitioner feedback, embedded indicators, student surveys, advisory board consultations, and student portfolios to assess attainment of student outcomes.[6,7,8] Many programs now use outcome notebooks to display student work and demonstrate the attainment of student outcomes. The Fundamentals of Engineering (FE) examination provides great unbiased, nationally-normed data for programs to use. The danger is over-reliance on the FE data and applying it to outcomes where there is no logical connection. Similarly, programs need to track how many of their students take the exam to ensure that it is a reliable indicator.

Initially many programs relied exclusively on indirect measures such as student surveys to demonstrate attainment of outcomes. If students thought they could design a structure, then they must be able to. Some direct measures of student performance are more compelling. It was established early in the process that course grades were not a satisfactory direct measure because they encompass too many variables.[9] The acceptable standard of assessment has been a moving

target and the specificity of guidance has ebbed and flowed. At one point, ABET issued very detailed guidance through a white paper[10] that appeared on the website in 2004 and was removed within a year or two. That paper set a high standard but answered questions regarding direct measures, whether every student must meet every outcome, and the ability to use sampling techniques to determine this. The year to year guidance has been less specific and left more of the judgment to the evaluator and team chief. The best source of specific guidance now is the training modules for the program evaluators on the ABET website. The current guidance specifically requires more than surveys and course grades to justify attainment of an outcome.[11]

Evidence that the standard has been elevated can be found in the accreditation results over the past 11 years. Table 1 shows that the percentage of Next General Review (NGR), Interim Reports (IR), Interim Visits (IV), Show Cause (SC) and Not to Accredit (NA) ratings for programs in the Engineering Accreditation Commission (EAC) has remained fairly constant over this period. The NGR rating is the six year accreditation that every program wishes to attain and has remained in the 65% - 75% range despite programs getting better and more sophisticated in their processes. These statistics reflect the results after the due process phase is complete. The NGR percentage is much lower prior to this taking place and the NGR rate for the EAC is higher than those of the other three commissions (Applied Science Accreditation Commission, Computing Accreditation Commission, and Technology Accreditation Commission).[12]

| Year | NGR | IR | IV | SC | NA |
|---|---|---|---|---|---|
| 2000 | 66% | 22% | 11% | 1% | 1% |
| 2001 | 72% | 13% | 14% | 1% | 1% |
| 2002 | 68% | 21% | 11% | 1% | 0% |
| 2003 | 77% | 17% | 5% | 1% | 0% |
| 2004 | 71% | 20% | 7% | 1% | 1% |
| 2005 | 72% | 22% | 5% | 1% | 0.40% |
| 2006 | 65% | 26% | 9% | 0% | 0% |
| 2007 | 65% | 30% | 5% | 0% | 0% |
| 2008 | 67% | 32% | 1% | 0% | 0% |
| 2009 | 76% | 23% | 1% | 0% | 0% |
| 2010 | 76% | 22% | 0% | 0% | 1% |

Table 1. Engineering Accreditation Commission Accreditation Actions From Year 2000-2010[12]

These results can lead to one of two conclusions depending on one's perspective of failure. A program director might quite reasonably conclude that any result other than NGR is considered failure. From that perspective a third of the programs evaluated are failing even after a decade of lessons learned. The results are more grim prior to the due process resolutions. On the other hand, if failure is defined as loss of accreditation, the percentage of NA ratings is miniscule and tells a quite different story.

**Reflection #4**

Conversely, program educational objectives (PEO) have created challenges throughout this process and have recently started to get out of hand. The PEOs covered in Criterion 2 are

defined as broad statements that describe what graduates are expected to attain within a few years of graduation. The early accreditation criteria did not provide this definition of a PEO and many programs created objectives that stated what the program would accomplish rather than what the graduates would accomplish. The formal definition helped resolve that issue.

The criterion requires that the program constituencies are consulted in the creation of the PEOs. The programs needed to define their constituencies which might included faculty, students, graduate schools, industry partners, the profession as represented by professional societies, parents, alumni, the university, and even the society that is served. Some programs received criticism and even shortcomings if they neglected to include students on the list.

The standard for demonstrating attainment of PEOs was deliberately less than that expected for outcomes. Because the students being assessed have left campus, it is harder to get student feedback and almost impossible to get direct measures of performance. Surveys of graduates and employers are the primary means of assessment and many programs struggled with acceptable sample sizes, response rates and keeping track of their graduates. Some programs made the mistake of using current student surveys, FE exam data, or current academic performance to assess PEOs which serves to blur the distinction between outcomes and objectives.

A challenge for many in the wording and assessment of the PEO's is to create a difference between outcomes which are attained at the time of graduation and objectives which are attained several years after graduation. This can be difficult for outcomes such as 3g: the ability to communicate effectively and 3i: to engage in life-long learning. Making a distinction between those desired skills at graduation and several years after graduation requires significant thought. The wording of acceptable PEOs has become so finely parsed and evaluator dependent that is has become impossible to develop PEOs that are universally accepted. The 2011 Civil Engineering Department Head conference hosted an ABET workshop as part of the program. The workshop developers sought to provide good examples of properly worded PEO's[13]. There was no consensus from the audience that any of those presented were acceptable. A degree of reasonableness and flexibility needs to return to this particular area.

**Reflection #5**

There are other accreditation areas where there has been little scrutiny and the bar has not been raised. The areas of faculty, equipment and resources have evolved very little over the past ten years, have been the source of fewer shortcomings, and have received little scrutiny….but that could change at any time. Criterion 6 for faculty states, for example, that the overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching effectiveness and experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and licensure as Professional Engineers. What constitutes an acceptable level in any of those areas is left almost exclusively to the judgment of the evaluator and team chief and there has been nowhere near the level of discussion on these items as there has been on outcome and objective assessment. Even the ABET evaluator training provides little guidance in this area.

Similarly, the Criterion 7 on Facilities states, "Classrooms, offices, laboratories, and associated equipment must be adequate to support attainment of the student outcomes and to provide an atmosphere conducive to learning." There has been little discussion on what standards and measures are to be used. The area that has seen the most scrutiny from evaluators and been the source of most shortcomings in this area is laboratory safety which is surprisingly not mentioned in the current criteria[5]. While the pre-EC2000 criteria were highly prescriptive on requirements for support facilities such as libraries, the current criterion states only that, "the library services and the computing and information infrastructure must be adequate to support the scholarly and professional activities of the students and faculty." Evaluators visit these facilities as part of an accreditation visit, but an identified shortcoming rarely results. The ABET guidance provided to evaluators as part of their training is more helpful stating that facilities shortcomings should come from insufficient space, overcrowded laboratories and classrooms, unsafe conditions, essential equipment inoperable, lack of modern instrumentation and lack of software / hardware needed to support the curriculum.[11]

The assessment of Criterion 8 on institutional support can be most open-ended and difficult to judge. Shortcomings in this area can come from unstable leadership situations, frequent turnover of university administration, insufficient support staff, and inadequate operating budgets that can affect everything from acquisition and maintenance of laboratories and appropriate equipment to faculty salaries, professional development support, or hiring and retention of faculty and staff.[4] With such far reaching areas, the potential is great for inconsistency among different evaluators. Evaluators are often reluctant to deliver a shortcoming in this area unless personnel from the university cite it as a problem themselves. It is surprising that a number of engineering programs were not cited for shortcomings in this area despite the faculty being on furlough two days a month for the entire year due to budget inadequacies.

Some programs believe that an ABET Criterion 8 shortcoming may assist their efforts to obtain additional resources from their university. This is a dangerous strategy that should only be tried under specific circumstances.

**Reflection #6**

The biggest changes from year to year are subtle and appear in the self-study template rather than in the accreditation criteria. Criteria changes go through an extensive approval process, are posted for public comment, and are announced well in advance. Changes to the self-study template are less transparent, occur without notice, but certainly affect how an evaluator might interpret a situation. Programs need to watch for changes because they occur every year.

Some are not well advertised but can have a large effect on the documentation required for the self-study. The tables required for Criterion 1 and Appendix D have changed dramatically over the years and a program using a previous year's self-study template could easily miss them. Appendix D (previously Volume II) Institutional Self-Study was a voluminous effort usually assembled by the Dean's Office. The 2008-2009 accreditation year template required the Institutional Self Study to include sections on the institution; type of managerial control; institution history; student body composition; regional or institutional accreditation; personnel

and policies to include promotion, tenure, and salary process; administrative chain of responsibility to include names, titles, resumes, and an organization chart; credit unit Count; instructional modes; grade-point average requirements; supporting and non-supporting academic units; and faculty workload. The sections were supported by data tables for each program being evaluated that included program offerings, degrees awarded, support expenditures, personnel and student data, enrollment and degree data, and faculty salary data[14]. The 2011-2012 template caught many evaluators and team chairs by surprise as the Institution Self Study was reduced to two tables and a few sections that could be covered in just a few pages[15]. Even the ABET evaluator refresher training did not cover this change.

Criterion 1: Students has not changed in substance over the period that EC2000 has been in existence. The focus is on student admissions, acceptance of transfer credit, adequacy of academic counseling, evaluation of student performance, and enforcing graduation requirements. In 2006, the self-study template required five tables: History of admissions standards for freshmen in the past five years, Transfer students for the past five Fall terms, Enrollment trends for past five academic years, List of the 25 most recent program graduates, and Program enrollment and degree data[16]. The requirement for these tables disappeared several years later without notice or explanation and they are not currently required.

**Reflection #7**

The collection of transcripts is often not given much attention, but can be critically important to the evaluation. A program is required to send the evaluator six transcripts from the most recently graduated class beginning with a specified letter of the student's last name. Some programs will simply request the appropriate transcripts and mail them to the evaluator. Many evaluators use these transcripts to understand the nature of the curriculum, evaluate whether graduation requirements are met, assess whether pre-requisites are enforced, judge transfer credits and gain a first impression of the program. The exercise can be frustrating as the graduates are often following a curriculum from an earlier catalogue cycle than that reported in the self-study. The exercise can generate dozens of questions from the evaluator that the program must answer and leaves a bad first impression with the evaluator. A more proactive program will evaluate the transcripts themselves, explain catalogue variations, account for pre-requisite violations, identify and explain any discrepancies in advance, and present their program in a much better light to an evaluator.

**Reflection #8**

Early ABET documents introduced a two-loop evaluation process shown in Figure 1. The fast loop evaluation occurs frequently such as on annual basis and collects data in a systematic manner. These assessments become the basis for making smaller changes and for establishing trends over time. A slow loop evaluation occurs less frequently but covers broader issues and results in major decisions such as revising program outcomes and objectives. Major changes are disruptive and have a lag effect that argues for only making them every few years.[8] This figure and this concept has been removed from all ABET training products and literature although it can still be found on a number of university websites[17]. It was a valuable and sound concept that should be resurrected.

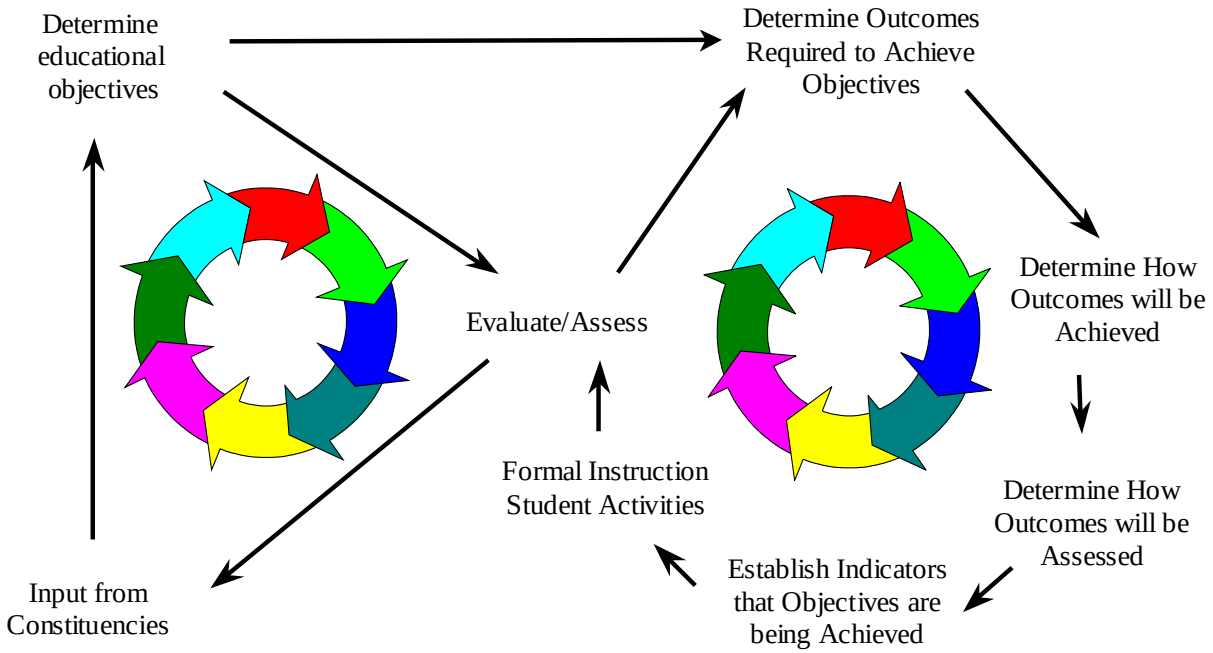


Figure 1: ABET Two-Loop Process that has been removed from ABET literature

**Reflection #9**

The program criteria are an important aspect of the accreditation process and can have a substantial effect on the nature of engineering programs on a national level. Section III (formerly Criterion 9 and previously Criterion 8) Program Criteria are developed by the supporting professional societies for the respective engineering discipline. The program criteria can add requirements for accreditation but cannot remove or contradict any of the requirements in the general criteria. For example, the American Society of Civil Engineers is the lead society for both Civil (CE) and Architectural Engineering (AE) programs in the U.S. A study of the seventeen Architectural Engineering programs in the country reveals that they differ vastly in terms of curricular emphasis, length of program, and where they are housed with a university. The program criteria for AE programs require proficiency in two of the three recognized disciplines of architectural engineering: structural engineering, construction, and electrical/mechanical systems. The flexibility in program criteria allows a wider range of diversity and permits one program to focus almost exclusively on structures and architecture and another to be weighted more heavily towards mechanical, electrical, plumbing (MEP) topics with every possible combination in between[18]. The CE program criteria require proficiency in at least four of the recognized areas of civil engineering (structures, construction, water resources, environmental, geotechnical, and transportation). As a result, it is harder for any program to specialize in one area and the 200+ CE programs are far more homogeneous than their AE counterparts, even though they share the same lead professional society[19].

The most critical role of a team chief on an accreditation visit is enforcing consistency across programs. Program evaluators from different disciplines, backgrounds and universities meet for a two and a half day visit at the campus being evaluated. They bring different perspectives and

sometimes different standards of compliance, although the increased requirement for ABET training has reduced that. The team chair must ensure that all programs are judged by the same standard. This is critical for the perception of fairness, especially since many programs at the same university share information, prepare using the same assessment methodology, and deliberately attempt to achieve standardization. Consistency is easier with respect to the general criteria where the written standard is the same for every program being evaluated. It becomes more problematic for the program criteria where every program's requirements are different and the team chair cannot be expected to be an expert in them all.

**Reflection #10**

The fierce debate about dual accreditation has so far proven to be much ado about nothing. Until March 2008, there was a prohibition against dual accreditation, which meant accreditation of both an undergraduate and graduate program of the same name[20]. Opponents of the dual accreditation were most concerned that once master's programs started attaining ABET accreditation, they would use it for competitive advantage and then every program would feel pressured to accredit their master's degree. Proponents viewed master's degree accreditation as a means to allow those undergraduates who had not graduated from an ABET accredited program (particularly international students) to get an accredited degree, be allowed to sit for the Fundamentals of Engineering exam and eventually attain licensure. The prohibition has been lifted for several years and few master's program have sought accreditation. Section II covers master's level accreditation and the primary criterion is the ability to apply master's level knowledge in a specialized area of engineering. The challenge for these programs is to demonstrate that those students without an ABET accredited undergraduate degree meet all of the ABET general criteria of an undergraduate program.

**Concluding Thoughts**

The EC2000 ABET accreditation process has experienced growing pains and has frustrated some programs that must expend considerable effort to develop processes for continuous improvement and assemble the documentation necessary to demonstrate attainment of outcomes. Nevertheless, the process has had a substantial effect on engineering education in the United States. Programs have been forced to think critically about what they want their graduates to attain and to communicate and seek input from the constituencies they support. It is rare to find a program without an Industry Advisory Board. The effect of ABET EC 2002 was detailed in a Penn State study in 2006[21]. There have been an ever increasing number of international programs seeking ABET accreditation. U.S. engineering accreditation has attained sufficient status that many in the rest of the world want the credential as well.

The accreditation process is fairer than many realize. Some programs worry that they may fall victim to a rogue evaluator who imposes his or her own agenda on a particular program. While that is always possible when human beings are part of an evaluation process, there are several levels of protection to prevent this from happening. The first level of protection is the team chief who is an experienced evaluator and whose primary job is to ensure consistent treatment between programs. There is a six to nine month due process period between the on campus evaluation and the final accreditation determination. During that period, programs can correct shortcomings

and question errors of fact; editors look for consistency among team chiefs; and accreditation decisions are made in an open, transparent forum. In addition, the program evaluators receive ratings both from ABET and their professional society. The program being evaluated is also asked to rate the evaluator. These ratings are used to determine if an evaluator is allowed to continue to serve. Evaluators are required to take both refresher training and pre-visit training to improve performance and consistency.

Any engineering program director should consider becoming an ABET evaluator as a means to stay current on ABET changes and to prepare one's own program for evaluation. It is a lot of work, but there is no better way to learn what other programs are doing.

ABET is us. The ABET staff is very small and most of the accreditation work is done by volunteer evaluators and team chiefs who are either practitioners or academic faculty in similar programs. We are in essence a self-regulating entity. And hopefully if we do a good job policing ourselves, nobody else will ever have to.

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