

## **AC 2008-2403: PREPARING EFFECTIVELY FOR ABET ACCREDITATION: WHAT DOES IT ALL MEAN?**

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# Preparing Effectively for ABET Accreditation: What Does It All Mean?

## **Abstract**

The simple word, ABET, invokes different emotions from people, which can range from pleasant to complete frustration. In most cases, people seem to favor the latter emotion. People many times get so caught up in the minute details that they lose sight of the fact the main purpose of ABET is to assure quality within your program. While many programs have sailed successfully through previous ABET visits, they find the newer process of outcomes-based accreditation somewhat overwhelming and are unsure of how to proceed. Many programs have finally accepted some comfort with terms, such as objectives and outcomes, but find this newer terminology, including continuous improvement and performance criteria or measures, somewhat terrifying.

The purpose of this paper is to assist both established and newer programs with navigating successfully through the ABET requirements. The authors are both from an established ABET department but have incorporated newer methods and procedures to streamline the accreditation process. Suggestions will be provided on how to convert a 'death by data' department into an efficient ABET program. The authors will discuss the role that specific course information plays in the process and the importance of properly defining learning outcomes. Many departments find they have a list of learning outcomes, but most people do not know what is actually meant by the particular outcome. This paper will detail potential struggles found in incorporating new methods and will provide strategies utilized to effectively overcome these. In addition, before and after showcases will be shown, so that the reader can observe the effectiveness and clarity of the newer methods. These showcases include data collection methods, assessment methods, and definitions of the process. Both experienced and new personnel working with ABET programs will discover practical, effective methods in this paper.

## **Background**

Founded in 1932 under the name Engineers' Council for Professional Development, ABET (formerly Accreditation Board for Engineering and Technology) accredits post-secondary degree-granting programs. Many people interpret this to mean that ABET accredits departments, colleges, or even courses. In reality, ABET accredits programs, and your accreditation work should reflect the program as a whole.

Some programs treat the six-year time lag between visits with the following timeline:

- Year 1 – Celebrate success of previous ABET visit.
- Years 2-4 – Feel that ABET is a long time away.
- Year 5 – Begin to worry about ABET visit the following year, and survey every class imaginable to be ready for year 6 with the ABET visit.

This process invalidates the entire intent of ABET, which is to ensure continuous improvement within the program. The purpose of ABET is not to compare programs across the nation. It is

take a closer look at your own program and see if you are providing and preparing students with the best program you can.

The undergraduate program in the Department of Aerospace Engineering at Texas A&M University has been accredited by ABET since 1942. The department has seen many changes with regard to ABET through the years. The terminology of continuous improvement and outcomes based assessment became linked to ABET accreditation in the most recently adopted Engineering Criteria 2000 (EC2000). The difference with EC2000 is its focus on the continuous improvement and what students learn through the program.<sup>1</sup> This criterion has brought about terminology that programs are not accustomed to utilizing in their day to day business. These terms included *objectives* and *outcomes*. In addition, *continuous improvement* has become so important to ABET that a separate criterion has been devoted to it in the latest update from ABET.<sup>2</sup>

### **Defining Objectives and Outcomes**

Program objectives are long-range goals of what a program envisions their graduates will achieve. ABET regards objectives as being obtained by graduates a few years after graduation. Program objectives will usually focus on successful careers or being skilled practitioners. They are much longer range attributes a graduate accomplishes. One pitfall programs can face is that their objectives can many times be too closely related to what is expected of students at the time of graduation. Objectives should describe what is attained the first several years after graduation.

On the other hand, program outcomes are specific measurable qualities students must know or be able to do by the time of graduation. While they are normally measured as a student progresses through the program, the program must show they have been achieved by the time the student graduates. Programs will often times confuse the terms of *program outcomes* and *course outcomes* or *objectives*.

Courses within the program have defined course outcomes or objectives. While these need to be traced back to program outcomes, you must remember that ABET is about more than simply showing course outcomes are being met. You must complete the loop from measuring course details to program outcomes.

### **Developing Outcomes**

ABET has listed specific outcomes for each of the areas for applied science, computing, engineering, and technology. For engineering programs, these are referred to as criteria a-k and are listed as follows:<sup>2</sup>

- (a) *an ability to apply knowledge of mathematics, science, and engineering*
- (b) *an ability to design and conduct experiments, as well as to analyze and interpret data*
- (c) *an ability to design a system, component, or process to meet desired needs*
- (d) *an ability to function on multi-disciplinary teams*
- (e) *an ability to identify, formulate, and solve engineering problems*
- (f) *an understanding of professional and ethical responsibility*

- (g) an ability to communicate effectively
- (h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
- (i) a recognition of the need for, and an ability to engage in life-long learning
- (j) a knowledge of contemporary issues
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

While programs are able to select and personalize their own set of outcomes, they must be mapped back to the ABET outcomes. Initially, our department customized the eleven provided by ABET and formulated twenty-one program outcomes with several of the additions being related to AIAA (American Institute of Aeronautics and Astronautics) Program Criteria. In order to show the relationship between ABET’s a-k criteria and our program outcomes, we illustrated this in Table 1. In addition, it can be very helpful for a department to map all of the courses in the curriculum to their ABET program outcomes. A portion of this mapping completed in our department is shown in Table 2. Identifying the level on a scale of 1-5 that each course corresponds to the particular program outcome would be an additional, beneficial step in your process as it would assist you in focusing your energies for assessment.

ABET/AIAA Outcomes	Departmental Outcomes 1-21																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
3.a	X	X	X	X																	
3.b													X	X							
3.c										X											
3.d							X														
3.e									X												
3.f							X														
3.g					X	X															
3.h																X					
3.i															X						
3.j								X													
3.k											X										
PC.1																	X				
PC.2																		X			
PC.3																			X		
PC.4																				X	
PC.5																					X

Table 1. Mapping of Departmental Outcomes to ABET Outcomes.

Courses/Topics	ABET Criterion 3											ABET Program Criterion				
DEPT Courses	a	b	c	d	e	f	g	h	i	j	k	PC.1	PC.2	PC.3	PC.4	PC.5
201	X				X							X		X	X	
301	X	X			X		X				X	X				
302	X	X	X		X		X				X	X				
303	X	X	X	X	X	X	X				X	X				
Required Topics	a	b	c	d	e	f	g	h	i	j	k	PC.1	PC.2	PC.3	PC.4	PC.5
Tech Writing							X									
Design Elective	X	X	X	X	X		X				X					
Comp. Methods	X			X							X					
Tech Elective	X				X						X	X	X	X	X	X
ENGR Courses	a	b	c	d	e	f	g	h	i	j	k	PC.1	PC.2	PC.3	PC.4	PC.5
Math Courses	a	b	c	d	e	f	g	h	i	j	k	PC.1	PC.2	PC.3	PC.4	PC.5
Science Courses	a	b	c	d	e	f	g	h	i	j	k	PC.1	PC.2	PC.3	PC.4	PC.5
University Core	a	b	c	d	e	f	g	h	i	j	k	PC.1	PC.2	PC.3	PC.4	PC.5

Table 2. Portion of Mapping of Courses to ABET Outcomes.

### Improving the Process

Through the continuous improvement process implemented in the department, we formalized a departmental ABET committee and reviewed our accreditation procedures. We have found it helpful to utilize our Undergraduate Affairs Committee as our formal ABET committee. It includes representation from each of our three discipline areas in the department, our department head, and our undergraduate programs office. This provided balanced representation for the process with input gained from all areas. It also provided a formal review board for assessment purposes. The first task was to review current procedures in place, which included twenty-one program outcomes and assessment practices.

One of the methods utilized for assessing the outcomes was a survey in each of the undergraduate courses. The students were asked at the end of the semester to rate on a scale of 1-5 how applicable the course was to each of the twenty-one outcomes. In discussions with students we found high frustrations with the survey. Comments included students disliked seeing the same survey given in each of the classes whether the outcomes were relevant to the course or not. In addition, students felt unsure of what was meant by the particular outcome, which we felt would lead to inconsistencies in the data. For example, we asked students to rate “Knowledge of aerospace structures” on a scale of 1-5. Each student might have a very different interpretation of what type of knowledge we were looking for in this case. This caused the committee to further review the program outcomes. While we could map the courses related to each of the program criteria and then evaluate course objectives or outcomes for each one, it became a little difficult to exactly state what was meant by “Knowledge of aerospace structures” even within the committee. This led us to utilize Table 3 for each of our program outcomes. This table was provided from training received by Gloria Rogers. A few of the category locations and names were adjusted, but full credit for the idea goes to Gloria Rogers. Completing the worksheet table for each of the program outcomes has greatly assisted the committee in determining exactly what the department is looking for with regards to each of the program outcomes.

Program  
Outcome \_\_\_\_\_

Performance Criteria	Courses Involved	Courses to be Assessed	Assessment Method(s)	Time of Data Collection	Assessment Coordinator	Evaluation of Results

Table 3. Program Outcome Worksheet.

Faculty have been instrumental in assisting with completing these worksheets. Before the process could begin though, it was crucial that each of the columns be defined, so there was no ambiguity. Performance criteria are specific, measurable statements identifying the performance required to meet the outcome. Three to four statements under performance criteria should be sufficient. It is important that the statements contain an action verb and a subject focus of instruction.<sup>3</sup> For example, a performance criteria listed under “Knowledge of aerospace structures” could be “Analyzes structures using Finite Element Method”. This is a specific, and most importantly, measurable criteria where knowledge can be confirmed.

Matching performance criteria with courses involved and even courses assessed was good practice. While many courses might be associated with a performance criteria, all of the courses do not need to necessarily be assessed for ABET purposes. Keep in mind program outcomes need to be achieved by the time of graduation. Including a sophomore-level course in the assessment column might help internal departmental review of the process, but it does not solely meet ABET accreditation purposes. Information on assessment methods is important to include because it causes you to make sure the performance criteria you listed can in fact be measured. It is good to list a variety of assessment methods in your outcomes. The time of data collection, assessment coordinator, and evaluation of results person needs to be listed as well. A specific person and time frame should be planned. Having an annual review of data and documentation is part of the continuous improvement process ABET encourages.

Through this process, the department was able to streamline and have a better understanding of our program outcomes. This process resulted in the department going back to the original eleven ABET a-k criteria and the five AIAA Program Criteria. For example, the first four outcomes in the list of our original twenty-one outcomes were:

1. Ability to apply MATH (incl. Calculus and Differential Equations)
2. Ability to apply basic SCIENCE (chemistry, physics, etc.)
3. Knowledge of ENGINEERING principles and practice

4. Knowledge of computer skills (programming, FORTRAN, MathCAD, use of software, etc.)

Through the continuous improvement process, these quickly became the starting point for the performance criteria under ABET outcome a, *an ability to apply knowledge of mathematics, science, and engineering*. Another useful tool in helping to develop performance criteria for the different outcomes was the Engineering Education Assessment Methodologies and Curricula Innovation project, a National Science Foundation joint project.<sup>4</sup>

After going through this process, faculty within the department have a much better idea of what we are trying to achieve, and we feel we have taken the ambiguity out for the students as well when we assess the outcomes. It does take some undertaking and a little time. It may take several iterations to formulate a set of performance criteria for each outcome, but the energies spent will be well worth it as everyone will have a clear definition of the outcomes. It is helpful to have a smaller group develop the performance criteria and then obtain feedback from the faculty as a whole.

Continuous improvement is a key part of the accreditation process. To fully take advantage of the ABET procedure, results should be evaluated annually in a structured format. This process should include reviewing assessment results obtained, making appropriate modifications and/or additions based on these results, and updating your schedule of assessment activities. This assures your program is meeting a regular schedule for ABET requirements and is documenting the process each year. This annual piece provides evidence that the results of the assessment process are further developing and improving your program, which evaluators will be seeking when they evaluate your program. If you are only collecting data and not evaluating it annually, you are neglecting to provide crucial information, and you are not ensuring quality, continuous improvement within your program.

## **Stakeholders**

As part of an academic institution, a department will have many stakeholders, or constituents. A state funded institution could even include residents of their state as stakeholders. Our department lists its stakeholders for our undergraduate students as follows:

- Current and prospective undergraduate students
- Faculty of the department
- Former students
- Employers of graduates of the undergraduate aerospace engineering program
- Aerospace companies, government agencies, public and private research agencies
- Parents and other relatives of students
- Departmental industry advisory board

At first glance, you might feel the need to involve each of your stakeholders equally in your assessment process. It is helpful to chart how each of your stakeholders affects your program. For example, current students and employers will have a direct interest in the quality of your program and need to provide vital input. Parents, on the other hand, are interested in the results but have no direct input into the program. One of the things we found as we examined our

stakeholders was that we had overlooked faculty of the department previously as an employer of our graduates. Many of our undergraduate students continue onto to graduate school in our department. While we had considered faculty as providing input on the undergraduate education through undergraduate courses, we had not considered their input into our long-range objectives. This provided a nice piece to close the loop. In addition, it is important to incorporate your stakeholders to their full potential. While reviewing our ABET objectives and outcomes had been commonly part of our advisory board meeting, we found it helpful to have a separate agenda item relating to ABET. This provided us time to have a discussion with them about our activities and thoughts as opposed to reference to ABET being one of many slides in a departmental presentation.

### **Assessment and Continuous Improvement**

Programs must assess student performance as part of their accreditation process. The assessment process includes collecting and analyzing the data to support a conclusion. It is essential to demonstrate objectives and outcomes for the program are being measured and accomplished. Programs often struggle with deciding what data to collect and ensuring the data is measurable.

In addition, your assessment process needs to show how results are applied to further improve your program. Documentation is vital, and it is important to keep current on the documentation. You will easily forget day-to-day activities regarding accreditation. Examine the suitability of including items you may be doing, such as content revisions, curriculum modifications, and updating labs. Accreditation involves improvement of a program, and your documentation should reflect this.<sup>5</sup>

Assessment methods are divided into two main types, direct and indirect methods. Direct assessment methods provide for the direct examination of student knowledge or skills and are much more difficult to achieve. Direct methods include observing students and examining their work. Indirect methods are much easier to achieve as they involve self-reporting of the extent or value of the learning experience. While indirect methods are valuable, they rely mostly on opinion or self-reporting.<sup>6</sup> The most effective assessment process involves using both direct and indirect methods and should include a variety of methods. There is not just one perfect method for assessing your program.

For most programs, assessing the long-range objectives is somewhat straight-forward. Former students and supervisors of these former students serve as the best resource for determining how successful students are once they are in the workforce. Input from your advisory board is also vital, especially if they hire graduates from your department. The most common assessment tool for objectives is a survey. While the response rate can sometimes be low when using surveys, it is important to keep them as short and to the point as possible. Surveys are not the time to ask every question you have ever wanted answered, but they can be useful tools to keep in contact with graduates and employers of your graduates for development and relationship purposes.

Assessing program outcomes, as you can imagine, invokes the greatest amount of time and resources. While ABET does not define outcomes for particular courses, the knowledge students gain in the classroom directly affects the outcomes of the program. Some programs feel ‘death



by data' is best and that all courses need to be evaluated regarding all outcomes every time the course is taught. While some programs have been very successful in the past relying on course grades and student self-assessment as achieving outcomes, some reviewers and even people providing training do not feel this is adequate. Course grades in many cases are problematic due to numerous program outcomes being associated with a particular course. It would be nearly impossible to single out the impact on one particular outcome from a course grade. Although they might not work the best for every program, our department utilizes surveys and direct interviews and/or input assessment methods the most. Embedded indicators provide excellent direct evidence, and we are beginning to use them more in our courses.

While surveys are considered indirect measures, they are usually the most popular form of assessment for program outcomes as well as program objectives. Administered to students and faculty, surveys ask individuals to share their perceptions about the program or course attributes. As we mentioned earlier, having properly defined questions is a key to using a survey successfully. They can be developed and administered quickly, and results are easily accessible and relatively inexpensive. They can be as short and simple or as in depth as you would like. Changes can be implemented quickly as the result of information received from survey. In addition, you are able to acquire information from various stakeholder groups as surveys can be web-based or even mailed to groups other than your current students. A difficulty with survey tools is that wording must be clear enough to be equally understood by all parties, and improperly worded surveys can cause a bias with your results. By adding open-ended questions to the survey, this can sometimes diminish these problems.<sup>3</sup>

Interviews can be regarded as both indirect and direct methods of assessment, depending on the implementation. Interviews held between the department head and graduating seniors where the discussion focuses on their favorite class, favorite professor, etc. would be considered an indirect method since opinions or self-reporting is expressed. However, bringing industry members to observe student performance during a senior capstone course design review would be considered a direct method. We have found this particular use to be an excellent way to achieve non-bias input from one of our constituent groups who have a vested interest in seeing our students enter the workforce as prepared engineers. Industry members are able to evaluate our students on numerous areas, such as ability to communicate effectively, ability to design a system to meet desired needs, understanding of impact of engineering solutions, etc. While some may counter this type of input is simply a survey, it is truly a focused, direct, objective observation of student performance and is regarded as a direct assessment method.

Another mechanism for direct feedback of our program is through our industry review panel. The role of this panel is to: help the department determine how well it is achieving its program and curriculum goals and objectives; assess whether students are achieving the desired educational outcomes and to what extent the outcomes are being achieved; recommend changes in the curriculum, pedagogy, and procedures, to improve areas where outcomes are falling short; and recommend other changes, as appropriate, that may improve the educational process and overall quality of the graduating engineering student. Industry members interview graduating seniors and determine how well the department is meeting its desired outcomes. Once the interviews are complete, the interviewers generate a report and brief the department head. The report summarizes strengths and weaknesses of the academic preparation students receive and

the extent to which the outcomes are being achieved, on a scale of 1-5, along with any corrective actions needed to achieve the desired outcomes. By having this review panel occur during the same visit as our senior capstone course design review, we maximize our participation from industry personnel. Work experience opportunities for your students, such as co-op or summer internships also provide occasions to obtain direct feedback from supervisors on the educational preparation of our students.

Direct assessment of student performance in a course directly tied to a specific program outcome is referred to as an embedded indicator. This type of information reflects a direct assessment method and can provide quite useful information. To be clear, embedded indicators do not refer to course grades, and we will discuss those separately. Embedded indicators relate to student performance on a particular activity, such as an exam question, project, or report, and correlate to a particular outcome. Courses that are more relevant to a particular outcome, such as shown in Table 2, are better choices for utilizing embedded indicators. It is important for the score of the activity to directly correlate to a specific outcome. This may take a little time on the part of the faculty member to directly associate test questions or weekly activities to a particular outcome. In addition, the management and statistical summary of results can be overwhelming for faculty and/or staff members but can be automated with a spreadsheet program to provide ease in obtaining results over time once developed.<sup>7,8</sup> While embedded indicators can be found in any course, a senior capstone design course may be an ideal place to capture information on numerous program outcomes at the senior, near graduation, level.

As you develop your assessment process, remember there is not simply one magic assessment method for your program. All assessment methods contain some bias and have their limitations. A comprehensive assessment program contains both direct and indirect assessment methods using a multi-source approach with regards to your stakeholder groups to maximize validity and reduce bias of any one approach. By incorporating multiple methods for each outcome, you will be able to obtain converging evidence that supports achievement of knowledge is acquired. You should strive for at least two assessment methods for each outcome, and three methods would be preferable with one of them being a direct method. A solid direct method in combination with surveys or other indirect methods for support would be ideal.

## **Summary**

The ABET accreditation process can only be as helpful to your program as you make time for it. The process involves time and energy to be meaningful, but the more time you spend at the beginning developing and defining your procedure the more efficient and less time-consuming your process becomes. Only once you clearly define what you are looking for with regards to your outcomes and objectives can you properly assess them. Developing and following an annual plan for accreditation assists in reducing some of the time burden for this process. Utilizing multiple assessment methods with your stakeholder groups allows you to obtain converging evidence and maximizes the validity of your results in support of your program.

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