

## **AC 2009-1231: LESSONS LEARNED FROM THE RECENT ACCREDITATION CYCLE**

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# Lessons Learned from the Recent Accreditation Cycle

## Introduction

The Civil Engineering program at Villanova University was evaluated by the Engineering Accreditation Commission of ABET in Fall 2008. This was the second time this program was evaluated under the criteria adopted by ABET in 1999 and the first time this (or any other) program was evaluated under the new program-specific criteria developed by ASCE and adopted in 2008. This paper will describe the evolution of our assessment process and some of the key factors that led to our successful evaluation. In addition, changes to our curriculum and outcomes as a result of the new program criteria will be discussed.

## Background on Villanova University and the Civil and Environmental Engineering Department

Villanova University was founded in 1842 by the friars of the Order of St. Augustine. It is a comprehensive Roman Catholic institution that welcomes students of all faiths. The university, the college, and our department are well ranked by US News and World report. For example, last year, amongst master's level universities, Villanova was ranked #1 in the Northeast, the college of engineering was ranked #10, and the Civil Engineering program was ranked #8<sup>1</sup>.

The university is located approximately 10 miles west of Philadelphia in what is often referred to as "The Main Line." The University offers a wide variety of degree programs through four colleges: the College of Liberal Arts and Sciences, the School of Business, the College of Engineering, and the College of Nursing. There are approximately 6,000 undergraduates at Villanova; nearly 900 of those major in engineering.

All engineering students take the same courses freshman year and they are required to select a major at the end of freshman year. We track students' progress through their enrollment in CEE 2602 Civil Engineering Measurements, which is a required course students take in the fall semester of sophomore year (Table 1). Some key figures to note from this table are:

- The number of students in our program has varied from 46 to 59 over the past five years.
- On average, 77% of our sophomores graduate with their BSCE within three years of enrolling in CEE 2602.
- On average, 82% of our sophomores graduate with a degree from Villanova within three years of enrolling in CEE 2602.

**Table 1. Cohort Study Summary**

Year in CEE 2602	Expected Graduation Year	No. Enrolled in CEE 2602	No. Entering Junior Level Classes	On time BSCE		On Time Other VU Degree		Still in CE Program*		Others**	
				No.	%	No.	%	No.	%	No.	%
2000	2003	59	57	45	79	2	4	5	8	5	9
2001	2004	46	42	33	79	3	7	3	7	3	7
2002	2005	47	43	28	65	2	5	4	9	9	21
2003	2006	54	51	42	82	1	2	4	8	4	8
2004	2007	48	47	37	79	4	9	2	4	4	8

\*This figure is the number of student still in the CE Program as of the expected graduation date. At the time of writing 17 eventually completed their degree requirements.

\*\*This figure includes students who transferred to other programs at Villanova, but did not earn a VU degree by the expected graduation date, students who transferred to other programs at Villanova and then left the University, and students who left Villanova directly from the CE Program.

**Mission Statements of the College and Department**

The Civil and Environmental Engineering Department mission statement is:

Our mission is to provide our students with a high quality, contemporary, broad-based civil engineering education within a Judaeo-Christian, humanistic context preparing our students for professional practice, graduate study, and life-long learning.

The College of Engineering’s mission statement is:

Villanova University’s College of Engineering is committed to an educational program that emphasizes technical excellence and a liberal education within the framework of the University’s Augustinian and Catholic traditions. As a community of scholars, we seek to educate students to pursue both knowledge and wisdom, and to aspire to ethical and moral leadership within their chosen careers, their community, and the world.

We value a spirit of community among all members of the college that respects academic freedom and inquiry, the discovery and cultivation of new knowledge, and continued innovation in all that we do.

The mission statement of the University is reflected in these mission statements. In addition, these mission statements guided the development of our objectives, which are presented later in this paper.

**Faculty**

A full-time teaching load in the College of Engineering at Villanova is 12 contact hours per semester. If a faculty member is an active scholar, this load is reduced to 9 contact hours per semester. Further reductions are given to center directors, department chairs, and recent hires. In addition, faculty are permitted to “buy-out” one course (3 contact hours) per semester with grant money if they so desire. Lastly, the Department Chair may grant a course reduction at their discretion.

At the time of writing there are 14 full time faculty members. With one exception, all of the faculty hold a PhD in their field. Eight of the full-time faculty are tenured, three are non-tenured-tenure-track, and three are non-tenure track.

### **Our Departmental Philosophy Towards Educational Assessment**

Our department was evaluated under the outcomes based assessment criteria (EC 2000) for the first time in 2002. Our evaluation was successful, but like every other civil engineering program, we knew that our assessment processes needed significant refinement. Consequently, in 2003, we designated one faculty member as the assessment chair. While the entire department is engaged in the assessment process, this one person is in charge of the following tasks:

- coordinating with the professors that are teaching classes in which student work is to be assessed each semester
- organizing the alumni and senior exit surveys
- organizing and leading the yearly assessment meetings
- organizing and maintaining the files related to assessment
- keeping abreast of changes to the criteria, both ABET and Program Specific
- writing the self study

The most nebulous, but perhaps the most important, responsibility of the assessment chair is to cultivate a belief that nothing we do is more important than maintaining accreditation. Faculty that think that their individual work load takes precedence over the assessment process need to be gently, but firmly, reminded that that work will be irrelevant if the degree program is not accredited.

Lastly, the assessment chair needs to keep the faculty focused on assessment and continuous improvement of the program. This truly is a continuous cycle. Although that may seem draining, the benefit to keeping assessment and continuous improvement on the front burner is tremendous. The major benefit is a reduction in panic, stress, and work the year of your visitation if your process is well documented and utilized.

### **ASCE Program Criteria**

Changes to the Program Criteria had been a topic of discussion for several years at Civil Engineering Division sessions before the new Program Criteria were officially adopted<sup>2, 3, 4</sup>. To facilitate cross referencing, the new (2008-2009) ASCE Program Criteria<sup>5</sup> are numbered below:

1. (a) can apply knowledge of mathematics through differential equations, (b) calculus-based physics, (c) chemistry, (d) and at least one additional area of science consistent with the educational objectives
2. can apply knowledge of four technical areas appropriate to civil engineering
3. can conduct civil engineering experiments to analyze and interpret the resulting data
4. can design a system, component, or process in more than one civil engineering context
5. can explain basic concepts in management, business, public policy, and leadership
6. can explain the importance of professional licensure.

## **Our Objectives and Outcomes**

The Program Educational Objectives were developed by the faculty in our department in consultation with our department's constituencies in 2002. They have undergone insignificant changes since then. Our objectives are as follows:

Upon graduation from the Civil Engineering program at Villanova University, graduates are prepared to:

1. Use their broad-based civil engineering backgrounds to perform as entry-level engineers in general civil engineering or in environmental, geotechnical, structural, transportation, or water resources engineering.
2. Enter graduate schools in the disciplines listed above or closely related disciplines, as well as other areas such as business and law.
3. Continue the process of life-long learning as required for long-term personal and professional growth.
4. Recognize their professional and ethical responsibilities to society as members of the engineering professional community.
5. Use communication, computer, and teamwork skills to help themselves and their employers succeed.
6. Relate their personal and professional lives to the Judaeo-Christian, humanistic tradition.

The program outcomes were revised in 2007 to be compliant with the new ASCE Program Criteria for the 2008-2009 accreditation cycle<sup>5</sup> (Table 2). These revised outcomes were developed by an Ad-hoc Outcomes and Objectives committee established in 2007 at the suggestion of the Advisory Committee. The new outcomes were shown to the Advisory Committee in July 2007 and the group felt that they were well-stated and measurable. The revised outcomes were discussed and approved by the faculty in August 2007.

The relationship between the ASCE Program Criteria, ABET Criterion 3<sup>5</sup>, and our outcomes is shown in Table 3.

## **Changes to Curriculum**

Our curriculum was not significantly altered by the new Program Criteria. An existing course, CEE 4601 CEE Professional Practice was modified to include instruction on and assessment of "can explain basic concepts in management, business, public policy, and leadership." This course was the subject of a paper presented at a previous ASEE conference<sup>6</sup>.

**Table 2. Program Outcomes and Suboutcomes**

<b>Graduates of the Department of Civil and Environmental Engineering will:</b>	
<b>Outcomes</b>	<b>Suboutcomes with ABET and ASCE designations</b>
1. explain and apply selected principles from basic and applied sciences to solve common engineering problems	a,1. an ability to apply knowledge of mathematics through differential equations a,1. an ability to apply science (chemistry and calculus-based physics) and engineering (fluid mechanics, mechanics of solids, environmental engineering science, and statics and dynamics) 1. an ability to apply knowledge in at least one additional area of science consistent with the educational objectives (geology)
2. explain and apply principles and practices from five civil engineering disciplines to solve common civil engineering problems, and, in addition, be able to analyze and design solutions for more complex problems in at least three civil engineering disciplines	c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability e. an ability to identify, formulate, and solve engineering problems 2. can apply knowledge of four (five) technical areas appropriate to civil engineering 4. can design a system, component or process in more than one civil engineering context
3. demonstrate relevant skills associated with contemporary civil engineering practice including written and oral communication, computer proficiency, appropriate engineering laboratory techniques, and teamwork	b,3. an ability to design and conduct experiments, as well as to analyze and interpret data d. an ability to function on multi-disciplinary teams g. an ability to communicate effectively k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice 5. can explain basic concepts of leadership
4. explain by way of several examples the societal context of civil engineering practice including the importance of civil engineering works to society and contemporary issues from at least three civil engineering disciplines	h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context j. a knowledge of contemporary issues
5. explain basic concepts in management, business, and public policy	5. explain basic concepts in management, business, and public policy
6. explain the professional and ethical responsibilities of engineering practice including the significance of licensure and the need for life-long learning	f. an understanding of professional and ethical responsibility i. a recognition of the need for, and an ability to engage in life-long learning 6. can explain the importance of professional licensure
7. demonstrate an interest in liberal arts and the Judaeo-Christian humanistic tradition	demonstrate an interest in the liberal arts demonstrate and interest in the Judaeo-Christian humanistic tradition

**Table 3. Map of Outcomes to ABET Criterion 3 and ASCE Program Criteria**

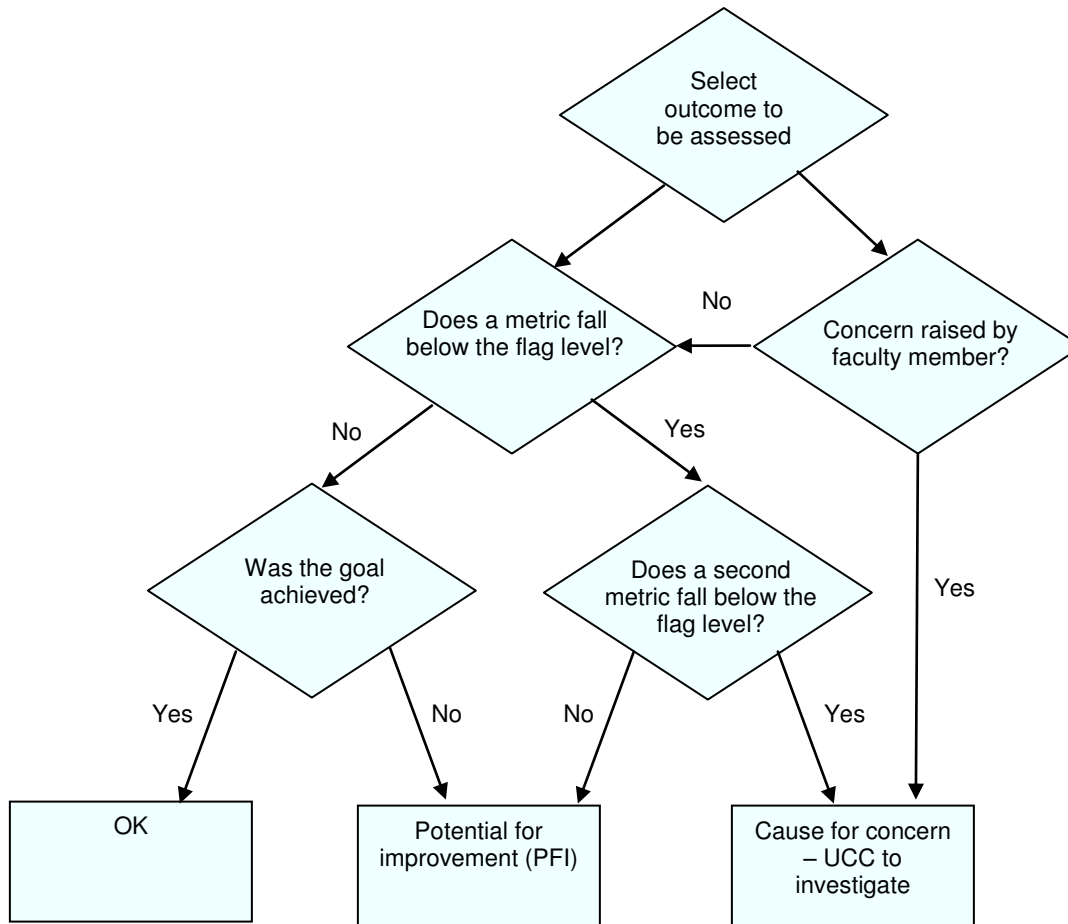
ABET	Outcomes						
	1	2	3	4	5	6	7
a	✓						
b			✓				
c		✓					
d			✓				
e		✓					
f						✓	
g			✓				
h				✓			
i						✓	
j				✓			
k			✓				
<b>ASCE</b>							
1	✓						
2		✓					
3			✓				
4		✓					
5			✓		✓		
6						✓	

**Our Assessment Protocol**

The first detailed Assessment Protocol that utilized student work in a comprehensive way was developed in June 2003. This protocol has been revised four times since its development. Most of these revisions were based upon the results of assessments. A major revision occurred after the development of the current 2007 outcomes.

A variety of tools are used to assess whether our students are achieving the educational outcomes developed by our department. Because none of these tools are “perfect” we often use several tools to assess each outcome. However, we have made every effort to use the tools strategically to develop a plan that is effective and efficient. The assessment chair, as discussed previously, is responsible for delegating the tasks associated with these activities.

We utilize three different tools to assess the outcomes: a criterion-referenced exam (the Fundamentals of Engineering (FE) exam), student work, and surveys. Each outcome was broken into several sub-outcomes (Table 1) to facilitate assessment. We set goals and flags for each of the assessment tools we use (Figure 1). In general, the goal is what we try to achieve and a flag indicates a problem. In this figure UCC is the Undergraduate Curriculum Committee.



**Figure 1. Assessment Procedure**

Student work is a critical tool in assessing whether the program is achieving our outcomes. We use rubrics to aid in the process. Just like the rest of the assessment process, the rubrics have evolved over the past few years. Initially, our rubrics had four categories, but the faculty felt that there was too large of a jump between categories. The five-category rubric was adopted in 2007.

The categories are:

- Complete mastery of the concept with no errors
- Mastery of the concept with minor errors
- Satisfactory attainment of the concept with some errors
- Limited attainment of the concept – multiple errors
- Unsatisfactory attainment of the concept – many grave errors

The goal for student work is 80% performing at satisfactory or above and the flag for student work is 65% performing at satisfactory or above.

The goal and flag levels for the FE exam are determined by using the “scaled score”, which is the method recommended by NCEES<sup>7</sup>. Our goal for the FEE is +1 and the flag is -1.

$$\text{scaled score} = (\text{our score} - \text{national score}) / (\text{national standard deviation})$$

$$\text{error} = \pm 1 / \sqrt{\text{\# of test takers from VU}}$$



The CEE Senior Exit Survey is developed by the department. This survey is administered near the end of the spring semester. A discussion among the seniors and faculty is held afterwards. This discussion is a truncated version of a SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats - with no Threats). The goal and flag levels vary depending on the type of question asked. The evaluation tools we use to assess Outcome One is provided in Table 4 as an example.

**Table 4. Evaluation Tools for Outcome One**

<b>Outcome</b>	<b>Student Work Goal <math>\geq</math> 80% Satisfactory Flag <math>\leq</math> 65% Satisfactory</b>	<b>FE Goal = +1 Flag = -1</b>	<b>CEE Senior Survey</b>
Explain and apply selected principles from basic and applied sciences to solve common engineering problems			Attitudinal question Goal = 4.0 Flag = 3.5
<b>Suboutcomes</b>			
an ability to apply knowledge of mathematics through differential equations	Fluid Mechanics homework assignment or test problem	Mathematics	
an ability to apply science (chemistry and calculus-based physics) and engineering	Water and Wastewater Treatment homework or test problem Structural Analysis homework or test problem	Chemistry, Statics, Dynamics, Circuits, Fluids, and Mechanics of Solids	
an ability to apply knowledge in at least one additional area of science (geology)	Geology for Engineers homework or test problem		

### **Faculty Responsibilities**

The student work from a given class is evaluated by the instructor teaching that class. At the beginning of the semester all professors required to evaluate student work for the assessment process are notified by the assessment chair. The professor then has the following responsibilities:

- Discuss the choice of assignment(s) with the assessment chair by the second week of the semester to ensure that the proper student work is being assessed. The instructor will be provided with the required rubric from the assessment chair.
- The rubric will be applied to all of the collected student work for the identified assignment.
- For archival purposes, the instructor places examples of each of the categories in the outcome binder. Note that an instructor may not have any examples for a given category if they did not rate any of the student work as being of that quality.
- Complete a summary sheet (a template is provided by the assessment chair) describing the assignments evaluated with the rubrics, summarizing the rubric results for each sub-outcome analyzed, and a composite rubric value (if applicable) for the entire course. This summary sheet will also contain a brief written section detailing suggested improvements

for the next time the class is offered. These suggestions should be based on both the results of the rubrics, as well as the observations of the professor and others (e.g. peer evaluators). An abbreviated summary sheet (a template is provided) that only describes suggested improvements will be required for classes in which student work is not evaluated as part of the assessment process.

In August, the department holds annual assessment meetings. The assessment data collected throughout the year from student work, exam results, and surveys are used in this process. Each year three out of the seven outcomes are assessed and all of the objectives are assessed every three years.

### **Closing the Loop**

ABET Criterion Four<sup>5</sup> requires you to document the improvements that you have made to the program as a result of the assessment process. This may be the criterion that programs struggle with the most. However, “closing the loop” is what makes the process worthwhile and valuable to the program. Morale and acceptance of the process is improved if the faculty feel that their efforts in assessment are actually used by the program.

### **Conclusions: The Lessons Learned**

There are many paths to a successful evaluation; consequently, this paper is not intended to serve as a set of rules, but rather as an example of what worked for us. These lessons learned can be grouped into several main categories, although there is overlap amongst the categories.

#### **Cultivate a culture of continuous quality improvement**

Our department has selected an assessment chair (who is not the chair of the department) to organize and delegate all tasks associated with assessment. However, this person is not just a “task master,” they also serve a philosophical purpose. In this role of “cheerleader,” they need to convince everyone (or at least nearly everyone) that nothing they do is more important than maintaining accreditation. The assessment chair needs to be patient with those that “don’t get it” by explaining the process, and the importance thereof, over and over again.

Nothing kills morale faster than feeling like the assessment process is a waste of time. Thus, if you actually use your results to improve your program you not only “close the loop” (which is required by ABET), you explicitly demonstrate the value of the process to the faculty.

#### **Keep the process manageable and organized**

Assessment and continuous quality improvement can be a messy process. However, you want to do everything in your power to stay organized for your own sanity and to make your evaluator have a pleasant experience reading your self study and visiting your program. To that end, you should create your own outcomes that encompass both the ABET a-k and the program specific criteria. (It is important to note that this also improves faculty acceptance of the process because they helped create it; thus this item could have easily been placed in the previous lesson learned.) Organize the collected student work by your outcomes to facilitate outside review.

To avoid fatigue with the process assess some portion, not all, of your outcomes and objectives every year. Assessing something every year also keeps the faculty engaged and maintains the concept that this is truly a continuous cycle. If you adopt this approach, the year of evaluation should not differ too much from any other year. However, I do recommend giving the author of the self study the time they need to create a quality report by providing summer support and/or a reduced teaching load.

Keep abreast of changes in the accreditation criteria

Attending ASEE civil engineering division sessions is especially useful. There is always at least one session, and often more, focused on assessment and accreditation. In addition, I found it extremely useful to attend the ABET summit two years before your visit. Lastly, check the ABET website to monitor any changes to the criteria.

## References

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