Can ABET Assessment Really Be This Simple?

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Based on her extensive experience as an ABET program evaluator, as a training facilitator for program evaluators, and as a former commissioner on the Engineering Accreditation Commission (EAC), the author developed an efficient and sustainable ABET assessment program based on only three courses. This paper describes the assessment processes, along with the two-year cycle of the assessment schedule, and gives examples of assessment artifacts and rubrics. The paper also describes some common assessment errors and misconceptions, and recommendations on how to avoid them.

Keywords: ABET assessment, sustainable assessment

INTRODUCTION

With the hard roll-out of ABET's new outcomes 1-7 in the 2019-20 accreditation season, engineering programs across the country are re-examining and re-tooling their ABET assessment processes. Faced with the difficulty of acquiring student work artifacts from supporting departments and the problem of gaining buy-in for continuing assessment from over-burdened faculty, the author developed an efficient and sustainable assessment program based on only three courses. The program, based on the author's extensive experience as an ABET program evaluator, as a training facilitator for program evaluators, and as a former commissioner on the Engineering Accreditation Commission (EAC), formed the basis of the recent successful initial ABET accreditation visit to the new Computer Engineering program at the University of Tennessee at Chattanooga--that this positive evaluation took place in the first semester in which the new criteria were effective is regarded as particularly notable. While an earlier version of this work described this process as a partially implemented strategy (McCullough, 2018), the plan has now been completely detailed, implemented, and validated by the ABET visit which found no shortcomings. This paper describes the assessment processes, along with the two-year cycle of the assessment schedule, and gives examples of assessment artifacts and rubrics. The paper also describes some common assessment errors and misconceptions, and recommendations on how to avoid them. While each program should thoughtfully develop its own assessment plan based on its curriculum, its students, and the resources available, this paper can serve as an example for an effective assessment process for programs with few faculty and resources, faced with establishing an efficient assessment process that can be sustained in the long-term.

The concern about, and fascination with, ABET assessment for engineering programs is strong and sustained. A simple search of relevant databases for "ABET assessment" found hundreds of papers published every year, and 2,129 in the past five years. While it is obviously impossible to address all ABET-related papers, they fall into roughly five categories, each of which will be discussed briefly and a small, representative set of examples given for each:

- Assessment of Specific Courses or Outcomes,
- Assessment Under Special Circumstances,
- General Assessment Information or Tools,
- New ABET Criteria, and
- Efficient/Sustainable Assessment Processes.

Of the categories, the one with the most papers, and the most diversity of topics, is that of Assessment of Specific Courses or Outcomes, such as (Conry & Harrington, 2019), (Eschempati, 2019), (Egilmez, et al., 2019), (Lutz, et al., 2019), (McCullough & Wigal, 2019), (Stone & Chang, 2013), (Cheville & Thompson, 2014) and (Biney, 2007). The example papers considered in this category include such diverse topics as using a lower level Physics course in outcome assessment (Conry & Harrington, 2019), use of an on-line Ethics module (Egilmez, et al., 2019), metrics for "inclusive and socially just teaming practices (Lutz, et al., 2019),and an assessment of information literacy for ABET's outcome 7 (McCullough & Wigal, 2019). As many programs are now using a capstone design course or project as a major portion of their ABET assessment, there are numerous papers addressing different aspects of these, such as (Eschempati, 2019), which addresses the capstone from a mechanical engineering perspective; and (Stone & Chang, 2013), (Cheville & Thompson, 2014) and (Biney, 2007), which address evolution of the capstone projects and their uses in ABET assessment.

Assessment Under Special Circumstances is a smaller category, but addresses the particular problems encountered, and lessons learned, by special types of universities such as HBCUs (Connor, et al., 2017) and liberal arts universities (Martinez & Omari, 2019), and in programs doing assessment in multiple locations (Calderón, et al., 2016) or across multiple programs (Jemae-Okeke, et al., 2019). Also in this category are programs involving cooperative education (Plouff, 2013) and industrial internships (Biasca & Hill, 2011) in their assessment processes.

General assessment information or tools is a "catch-all" category. The papers highlighted here include topics of broader, or more general, interest, such as broad analysis of how 131 of the 252 ABET accredited Civil Engineering programs meet program-specific criteria (Hamilton, et al., 2019), pedagogical approaches, such as: "Developing Engineering Education Products via Project Ownership Oriented Learning" (DEEP POOL) (Traum, et al., 2019), and development of a curriculum plan based on a strong assessment plan (Gamadi, et al., 2018). Also of note in this category are a paper that addresses student perceptions and ABET outcomes in a capstone class (Jaeger-Helton, et al., 2019), and a paper intriguingly titled, "ABET Wont' Let Us Do That!" which addresses some misconceptions about ABET criteria (Heileman & Abdallah, 2019).

In the past three years, the new ABET criteria changes have been the topic of many papers, both in understanding the changes themselves, and dealing with them from a program perspective. When ABET's Engineering Area Delegation voted in October 2017 to replace the a-k outcomes which had been in place since the 1990s (ABET, 2017), the decision was also made to require that all programs be assessed according to the new outcomes for all visits in fall 2019 or later. This necessitates that all programs previously accredited by ABET must re-evaluate their assessment processes to bring them in line with the new criteria. Some are content to map the old a-k outcomes to the new 1-7, although not all elements in the new version have a direct mapping to the older criteria. Others are taking the opportunity to re-evaluate their assessment procedures for efficiency and sustainability, while determining how to include new elements of 1-7. The first papers addressing the new criteria began to appear in early 2016, before the changes had been approved, such as (Milligan, et al., 2016) written by some of the architects of the changes and (McCullough, 2016) written by the author from the perspective of a very experienced program evaluator. As the implementation of the changes grew closer, more papers began to appear discussing transitioning from the older versions of Criteria 3 and 5 and the new, such as (Turner, et al., 2018), (Bachnak, et al., 2019) and (Estes, et al., 2018).

Papers on efficient or sustainable assessment practices are a much smaller set, with general papers such as (Kelnhofer, et al., 2010) and (Sundararajan, 2014), considerations of faculty engagement (Burbano, et al., 2018), and papers addressing efficiency of assessment processes, such as "Assessing Both Institutional and ABET SLOs in One Platform," (Hayder, et al., 2017). Although it addressed ETAC rather than EAC criteria, also of interest is "Using Lean Principles to Improve an Engineering Technology Assessment Process." (Cook, et al., 2018) In spite of the multiplicity of papers regarding ABET assessment, few address ABET assessment using minimal resources or a minimum number of faculty, suitable for small programs trying to design a sustainable assessment program. A search for "easy ABET assessment" or "minimal ABET assessment" produced only two papers: "A Capstone Design Experience that Makes Easy the Assessment of Some of the Trickier ABET Student Outcomes to Measure" (Sones, 2015), which actually fits into the category on Assessment of Particular Courses or Outcomes, and the author's earlier paper (McCullough, 2018) on a plan to assess all outcomes using only three courses.

The University of Tennessee at Chattanooga had a newly developed Computer Engineering program, which had planned for an initial accreditation visit in fall 2019. As the program was housed in a department which was primarily Computer Science, with few dedicated faculty, and had many courses shared with Electrical Engineering, getting necessary student artifacts and building faculty buy-in were problematic. Based on the author's extensive experience as an ABET program evaluator for Electrical and Computer Engineering programs and as a former EAC commissioner, an assessment plan was developed to assess all of the new 1-7 outcomes using only three courses, a computer ethics course required of all majors, and the two semesters of the Computer Engineering capstone design course, all of which the author taught. While space considerations prevent the entire assessment plan being detailed here, the main points are discussed, with illustrations of competencies leading to the achievement of the outcomes with associated examples of rubrics (included in the Appendix), and a discussion of recommendations for programs in the process of re-evaluating their ABET assessment. However, the complete set of competencies and rubrics may be obtained by request to the author. However, before discussing the example assessment program, first one must look at what exactly ABET requires, and what it doesn't require.

WHAT ABET REQUIRES

This paper concentrates on the assessment of the EAC outcomes. Thus the relevant criteria are Criterion 3, which details the outcomes themselves, and 4, which gives the requirements for continuous improvement. Criterion 3, Student Outcomes, states

> The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program.
>
> 1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
> 2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
> 3. an ability to communicate effectively with a range of audiences
> 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
> 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
> 6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
> 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. (ABET, 2018, pp. 5-6)

Criterion 4. Continuous Improvement, which governs assessment of the outcomes, requires

> The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the continuous improvement of the program. Other available information may also be used to assist in the continuous improvement of the program. (ABET, 2018, p. 6)

Also relevant is Criterion 5, Curriculum, which includes the following revised language regarding a "culminating design experience," commonly referred to as a "capstone:"
The curriculum must include…a culminating major engineering design experience that 1) incorporates appropriate engineering standards and multiple constraints, and 2) is based on the knowledge and skills acquired in earlier course work. (ABET, 2018, p. 6)

With the new version of the criteria, ABET has also added some definitions relevant to the interpretation of the outcomes and their assessment. One such is the definition of Complex Engineering Problems, which states:

> Complex Engineering Problems - Complex engineering problems include one or more of the following characteristics: involving wide-ranging or conflicting technical issues, having no obvious solution, addressing problems not encompassed by current standards and codes, involving diverse groups of stakeholders, including many component parts or sub-problems, involving multiple disciplines, or having significant consequences in a range of contexts. (ABET, 2018, p. 4)

In the past, some programs have defined "engineering problems" required by the previous versions of the criteria such as (ABET, 2016) in terms of mathematical problems or simple design problems, such as designing a sequence detector in a digital logic class. These clearly do not meet the new ABET definition. In order to include the complexity required by the new definition, programs may find the capstone design, required by Criterion 5, to be the most intuitive place in the curriculum to perform the assessment of Outcome 1. This may also be the case in Outcome 2, enhanced by the new definition of Engineering Design:

> Engineering Design – Engineering design is a process of devising a system, component, or process to meet desired needs and specifications within constraints. It is an iterative, creative, decision-making process in which the basic sciences, mathematics, and engineering sciences are applied to convert resources into solutions. Engineering design involves identifying opportunities, developing requirements, performing analysis and synthesis, generating multiple solutions, evaluating solutions against requirements, considering risks, and making tradeoffs, for the purpose of obtaining a high-quality solution under the given circumstances. (ABET, 2018, p. 4)
>
> It is clear that only a very significant design project will meet this definition, and the additional requirements of Outcome 2, such as "consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors." (ABET, 2018, p. 5)

WHAT ABET DOES NOT REQUIRE

In a recent conversation with a professor from another university, the professor expressed his confidence that his program's ABET visit would be successful, because, "They're not coming until next year, and we've already started this year." He also said that what he disliked about the ABET assessment process was that "it's so hard to prove that you introduce the material in one course, deepen understanding in a second course, and then assess it in a third course. Developing all of the required rubrics is also really time consuming." Notice the multiple misconceptions: first, starting ABET assessment the year before the ABET team is expected to visit means that the program is several years behind on the ideal of ABET continuous improvement. Next, although the multiple levels of coverage and understanding would be advisable in accordance with Bloom's taxonomy (Bloom, 1956), they are not required by the EAC criteria. Rubrics, however advisable they can be considered to be for consistency of assessment, are also not mandatory. How do such misconceptions arise? That is open to speculation, but perhaps when one program reports what has been successful in ABET assessment, hearers assume that what was done successfully must be required. Some of the incorrect assumptions about required EAC elements that the author has observed in ABET visits as a program evaluator or team chair include:

- All courses must be assessed.
- Assessment must be done every year or every semester a course is taught.
- Everything must be assessed multiple times or multiple ways.
- All students must be assessed.
- All student work must be saved.
- All faculty must be involved.
- Bloom's taxonomy must be demonstrated.
- Detailed rubrics must be developed.
- Once a program has been demonstrated to meet ABET requirements, it is not necessary to continue assessment.
- ABET insists that programs be perfect in order to be accredited.

While some of these can be helpful, none are actually required by the EAC criteria, and new evaluators are sternly admonished during their ABET training that no such "shadow criteria" must be allowed to creep into the evaluation process. Thus, each program should very carefully study the ABET requirements before developing its assessment processes to make sure it is not expending extra effort in satisfying criteria that do not exist.

THE ASSESSMENT AS IMPLEMENTED

It is the observation of the author, based on over 20 years of doing ABET evaluation both as a program evaluator for electrical and computer engineering programs, and as an EAC evaluation team chair, that many programs make ABET assessment much more difficult than it needs to be. ABET does not mandate that every course be assessed, or that assessments be done every year, or that outcomes be assessed at multiple levels of learning taxonomies, but only requires that programs clearly demonstrate that by the time of graduation, students have successfully met all learning outcomes. While it is expected that some of the assessments will be objective rather than subjective, and it may be advisable to divide complex outcomes into smaller, more easily measurable, competencies, it is definitely not necessary to measure everything, all the time. This is particularly problematic for smaller programs, where overly extensive assessment processes can become burdensome for faculty and are not sustainable in the long term for that reason.

The assessment committee for the new Computer Engineering program at University of Tennessee at Chattanooga constructed an assessment process to evaluate all seven of the new ABET outcomes using only three courses: CPSC 3610, a computer ethics course, which all computer engineering students are required to take, and CPEN 3850 and 4850, the two semesters of the computer engineering capstone sequence, all taught by the author. This eliminated difficulties of obtaining artifacts and assured consistency of evaluation. In order to spread the assessment load across the entire time period, the assessment cycle was chosen as two years, with the competencies in 3610 being assessed in school years ending in odd numbers (e.g., 2016-17) and 3850 and 4850 being assessed in consecutive semesters in school years ending in even numbers. The choice of two years for the cycle allows the entire process to be repeated three times in a standard six-year accreditation cycle, although three years, with two years for assessment and one for evaluation, was also considered. It was judged that assessing 3850 and 4850 in consecutive semesters was necessary, as for several of the outcomes, a preliminary competency is measured in 3850, and the completion measured in 4850 (McCullough, 2018). For example, for outcome 2, the plan states:

- Competency: Students demonstrate the ability to identify appropriate realistic constraints, including consideration of health, safety, etc., to the engineering problem for the capstone design. Measure: Evaluated in final CPEN 3850 report
- Competency: Students demonstrate ability to generate effective solution(s) to the capstone design problem formulated in CPEN 3850, including identified constraints. Measure: Evaluated in final CPEN 4850 report (McCullough, 2018, p. 5)

Thus, in order to determine whether students can both identify and apply appropriate standards and constraints, and apply these in an engineering design, it was decided that it was necessary to evaluate students continuously working on a project; therefore, measuring in sequential semesters was specified. Other required ABET elements, such as a schedule for evaluation and improvement of Program Educational Objectives (PEOs), were tied in to the assessment schedule to assure that no required parts were omitted. For example, in each semester in which CPEN 4850 was assessed, the students in the class were surveyed regarding the current version of the PEOs, whether they are appropriate, and how (or if) they should be changed, thus capturing the views of the soon-to-be graduates of the program, who were one of the selected ABET constituencies of the program.

Some elements of the EAC criteria are not fully defined, but are left to the interpretation of the program. For example, what does it mean to "communicate effectively with a range of audiences?" (ABET, 2018, p. 5) In this program, it was defined to mean oral and written communication with both professors and other students. For outcome 6, the program interprets "engineering judgment" in the context of experimentation as the ability to determine whether the results make sense in the context of the experiment and what conclusions can be reasonably drawn from the data.

In order to measure "success" of students in meeting outcomes, each of the competencies making up assessment for an outcome was assessed on a three point scale—"below expectations," "meets expectations," and "exceeds expectations," where, "meets expectations" was regarded as the level which would be considered the minimum level of attainment for students to receive a level of C for the particular competency on the given assignment, or equivalently, the minimum level that the professor believes the student must have to be prepared to move on to later material. As most assignments, etc., used in the assessment contain multiple relevant elements rather than a single competency, they are assessed for the included competencies, independent of the overall grade on the item. The target for achievement in each case is that 80% of the students in the course will achieve a rating of "meets expectations" or better on each outcome. When multiple measures, or multiple sub-competencies, are used on a single outcome, the scores of each are averaged to achieve an overall score. Thus it is possible for students to demonstrate an acceptable level of performance on the overall outcome while failing to meet the level on one or more competencies. However, any sub-competency on which students fail to meet the desired level is flagged, and the instructor is requested to make changes to improve student performance on that element.

Although rubrics are not required by ABET, as the author wanted to ensure continuation of the process after she left the university, simple rubrics were produced as a way of documenting what had been done in the past. An example is shown in the Appendix. Most careful consideration was given to definition of the "meets expectations" level, as it is implied that students assessed at this level are, in the judgment of faculty, fully competent to perform the competency as necessary, and move on to work at the next level. For example, for a sub-competency of correct referencing for written communication, "exceeds expectations" requires all information to be properly referenced, in an accepted form, with no missing or misplaced information. "Meets expectations" allows some errors in the form of references, e.g., block quotes incorrectly using quotation marks rather than inset, but no unreferenced material. Any unreferenced material is "below expectations." (McCullough, 2018, p. 6)

Which outcomes were measured in which courses is shown in TABLE 1.

TABLE 1
OUTCOMES AND CLASSES ASSESSED

	1	2	3	4	5	6	7
CPSC 3610			x	x			x
CPEN 3850	x	x			x	x	x
CPEN 4850	x	x		x	x	x	

(McCullough, 2018, p. 6)

The only outcome measured in a single course is 3, ability to communicate effectively. This choice was made because most of the work in the capstone sequence was done as a team, and the program chose to evaluate communication on an individual basis. This, however, is not required by ABET, and the entire program could have been assessed using only the two-course capstone sequence.

At the end of each semester in which a course is assessed, the instructor produced a set of electronic files including copies of all student artifacts used in the assessment, course information such as syllabus and course grades, and the instructor's assessment of the competencies being measured in that course, including a discussion of any in which targets are not met. An example of the reports produced, which also include a file listing of relevant artifacts and course information, is given in the appendix. These files were stored on CDs, and were evaluated by the computer engineering assessment committee at the beginning of the following semester. Any recommendations for improvement, either from the course instructor or from the committee, were documented in the meeting minutes, which were stored with the other ABET assessment files.

This process was developed and some assessment begun four years before the expected ABET visit, and fully implemented in the two years before the visit: CPEN 3850 in fall semester 2017, and CPEN 4850 in Spring 2018, CPSC 3610 was assessed in fall semester 2018, completing the first cycle. As continuous improvement is the hallmark of ABET assessment, the results of the assessment of 3850/4850 were evaluated in Fall 2018, and it was noted that one outcome target was not met. Recommendations were made for possible improvement, and these were implemented during the Fall 2018/2019 class offering.

At the completion of the cycle, the assessment plan itself was evaluated, and changes made as necessary to ensure that the assessment would continue as an effective evaluation tool. For example, the original target of the assessment, that 100% of the students who made a C or better in the class would meet or exceed expectations, was changed to bring it in line with the Computer Accreditation Commission assessment of the Computer Science program in the department, as the CPSC 3610 course was used for assessment in both Computer Engineering and Computer Science programs.

At the completion of the cycle, the assessments for the courses were combined, and an assessment provided for each outcome as a whole.

DIFFICULTIES ENCOUNTERED

Ironically, the only difficulty associated with the successful implementation of this method was the perception by the engineering college administration that the plan was too simple and easy to be acceptable to ABET: in the semester prior to the ABET visit, the author was repeatedly and strongly urged to do more—more assessment of more courses with more artifacts, more complicated rubrics and more byzantine analysis. She was eventually allowed to proceed as planned only if willing to "take responsibility" for the results.

RECOMMENDATIONS

The following items are advice for programs developing assessment programs, based on the author's many years of ABET experience, and are not directly required by ABET. When developing a new assessment plan:

- Before you begin, study the current version of the criteria carefully, as incremental changes do occur.
- Decide how your program will define ambiguous requirements, such as "engineering judgment."
- Divide compound outcomes into easily measurable pieces or competencies.
- Gather relevant faculty and discuss how the competencies can best be mapped to the curriculum as a whole, placing each in the course(s) in which it most logically fits and is most easily measurable.
- Consider whether all students, or some subset, will be assessed, and what artifacts should be collected.
- Decide how you will assess artifacts and what you will use as your criteria for success.
- Consider what time scale would be most sustainable for the program.

When executing your plan:

- Make it part of your culture to collect artifacts regularly. It is better to have more than you need than to try to reproduce artifacts after the fact. Work can be easily scanned before being returned, making the process transparent to students.
- Meet regularly to discuss the relevant outcomes, assessments and results, and identify ways that they can be improved, throughout the entire six-year cycle, rather than trying to do it all in the year before the ABET visit.
- Rather than trying to have meetings at the end of a semester, when faculty are busy and anxious to get away, schedule them at the beginning of the following semester, when all faculty should be on campus.
- Schedule assessment in such a way that faculty workload is minimized. For example, if multiple outcomes are being assessed in a single course, assessing by outcome number could mean that a course is assessed more often than if the schedule is arranged by course number, thus multiplying the work for the faculty member teaching the course.
- Assessment is not sufficient to meet ABET requirements, so make it clear that you have "closed the loop" on the assessment: evaluating outcomes, making course or curriculum changes based on the evaluation, and evaluating again.
- Document everything and store documentation on a shared drive to which all relevant faculty have access, so it is possible for everyone involved to know the status of the assessment efforts and their results at all times.

CONCLUSIONS

While it may appear daunting, if planned in advance and done regularly, ABET assessment does not have to be difficult or burdensome for faculty. The assessment method described here has been fully implemented, covers all of the new ABET outcomes in multiple ways, and is very efficient in terms of faculty effort required. Each program should thoughtfully develop its own assessment plan based on its curriculum, its students, its faculty, and the resources available, but using the recommendations presented here can aid in streamlining the process and eliminating unnecessary effort. Also, the process presented here can serve as a blue-print for an ABET evaluation process for programs with few faculty, faced with establishing an effectual, efficient assessment process that can be sustained in the long-term.

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APPENDIX

Example Competencies and Rubrics

Outcome 1: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Competencies	**CPEN 3850 1** Students demonstrate the ability to identify appropriate mathematical, scientific and engineering principles related to the engineering problem for the capstone design. **Measure:** Evaluated in final CPEN 3850 report	**CPEN 3850 2** Students demonstrate ability to properly identify and formulate an engineering problem for the capstone design. **Measure:** Evaluated in final CPEN 3850 report
Below Expectations	Students have omitted significant elements of mathematical, scientific and engineering principles necessary to the capstone design problem. **OR** It is unclear how significant elements they apply to the problem. Students may have included irrelevant material.	The description of the capstone project is incomplete or demonstrates a lack of understanding of major issues. **OR** The formulation of the problem is significantly too broad or too narrow, which will hinder finding an appropriate solution.
Meets Expectations	Students have included most elements of mathematical, scientific and engineering principles relevant to the capstone design problem. While some are omitted, those are minor and will not affect the success of the project. **OR** The students have indicated how each of the elements is necessary to their project and how it will be applied to the design, but some explanations are unclear, or minor elements are omitted.	Description of the capstone project is vague at times. Students demonstrate that they understand the major issues, but may have missed some minor issues with the problem. **OR** The problem statement may be slightly too broad or too narrow, but captures the essential essence of the problem.

Exceeds Expectations	Students have included all elements of mathematical, scientific and engineering principles relevant to the capstone design problem. **AND** The students have clearly indicated how each of the elements is necessary to their project and how it will be applied to the design.	Students have clearly and concisely described their capstone design problem, demonstrating understanding of all of the issues involved. **AND** The formulation of the problem is broad enough to allow for creativity, but specific enough that it will lead to an appropriate solution.
Competencies	**CPEN 4850 1.** Students demonstrate ability to apply appropriate mathematical, scientific and engineering principles to the capstone design problem formulated in **CPEN 3850.** **Measure:** Evaluated in final CPEN 4850 report	**CPEN 4850 2.** Students demonstrate ability to generate effective solution(s) to the capstone design problem formulated in CPEN 3850 **Measure:** Evaluated in final CPEN 4850 report
Below Expectations	Students have failed to apply significant elements of mathematical, scientific and engineering principles necessary to the capstone design problem. **OR** Significant elements have been applied to the problem incorrectly.	The solutions to the capstone project do not effectively address all elements of the problem as formulated in CPEN 3850. **OR** Other potential solutions to the design problem are clearly superior to that presented.
Meets Expectations	Students have included most elements of mathematical, scientific and engineering principles relevant to the capstone design problem, but have omitted some minor elements that could aid/justify results. **OR** The students have applied each necessary element to their project but some explanations are unclear OR irrelevant material may have been included.	Students have generated solutions to their design project which address all major issues, but may leave some minor elements unsatisfied. **OR** The problem solution is effective but not very creative OR could be improved in an obvious way.
Exceeds Expectations	Students have appropriately applied all elements of mathematical, scientific and engineering principles relevant to the capstone design problem. **AND** The students have clearly indicated how each of the elements is necessary to their project and how it has been applied to the design.	Students have generated solutions to their capstone design problem which effectively address all of the issues involved. **AND** The solution demonstrates both creativity and clear understanding of the engineering principles.

Example Assessment Sheet for Course Outcome

ABET EAC Outcome 3

An ability to communicate effectively with a range of audiences.

NOTE: We define range of audiences as oral and written, professors and students.

CPSC 3610

Competency 1: Students demonstrate ability to give an oral presentation, which is well organized, with a clear purpose.

Measure: Evaluated in final presentation
Competency 2: Students demonstrate ability to write a paper, which is well organized, with a stated purpose and clear organization of ideas.
Measure: Evaluated in final paper
Competency 3: Students demonstrate ability to communicate with other students orally, and in the written portions of a presentation
Measure: Evaluated by class survey following student presentation

CPSC 3610 is the computer ethics class required of all computer engineering and computer science majors, though only BSCpE students are included here.
CPSC 3610 - Ethical and Social Issues in Computing

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(3) Credit Hours
This course examines the ethical and social issues arising from advances in computer technology and the responsibility that computer professionals and users have with regard to computer use by focusing on the intrinsic link between ethics and the law, how both try to define the validity of human actions, and on the moral and ethical dilemmas created by computer technology that challenge the traditional ethical and moral concepts. Prerequisites: ENGL 1020 and CPSC 1000 or CPSC 1100 with minimum grades of C or department head approval. Differential course fee will be assessed.
Target: 100% of the students who make a C in the course (the grade required to move forward in the major) will meet or exceed expectations.
Implementation Plan (timeline): Spring 2018 and Fall 2019
Key / Responsible Person: instructor of the class

Findings for EAC ABET Outcome 3, Competency 1:
Students demonstrate ability to give an oral presentation, which is well organized, with a clear purpose.
From the syllabus:
The presentation will be of the approved final paper topic and will be approximately 13 minutes long.
The presentation will include both technical and ethical aspects of the issue.
The topic must be presented to the class in some manner, and must include written documentation for grading.
The presentation is assessed by the professor on the following elements:

- Student presentation has a clear purpose and organization
- Presenter can be clearly understood and engages the audience
- Presenter projects a professional appearance and demeanor
- Overall, the presentation was effective in accomplishing the stated goal

Summary of Finding: Meets or Exceed Expectations = 100%
Exceeds Expectations =63,5 %
Meets Expectations = 37.5 %
Below Expectations = 0%

A detailed breakdown of student results on the sub-competencies is found in the *file detailed results for two bscpe students.xlsx*.

Findings for EAC ABET Outcome 3, Competency 2:
Students demonstrate ability to write a paper, which is well organized, with a stated purpose and clear organization of ideas.
From the syllabus:

The paper should be approximately 10 pages, single-spaced (references and title page do not count as part of the 10 pages), and have at least 5 references not including your text. These references are required to be credible, attributable, and non-ephemeral.
The paper should be a detailed discussion of a current computer-related ethical issue, including
- details of the issue, news stories or current events related to the issue,
- an examination of how this issue would be regarded by proponents of different ethical theories,
- a discussion of your ethical position on this issue, demonstrating informed judgment
- reasoned arguments defending your position relative to proponents of other ethical theories.

The paper is assessed by the professor on the following elements:
- Student paper uses correct grammar
- Student paper uses language which is detailed and accurate
- Student paper is well organized
- Student paper has a clear purpose
- Student paper correctly cites references

Summary of Finding: Meets or Exceed Expectations = 100%
Exceeds Expectations = 50 %
Meets Expectations = 50 %
Below Expectations = 0%

A detailed breakdown of student results on the sub-competencies is found in the file *detailed results for two bscpe students.xlsx.*

Findings for EAC ABET Outcome 3, Competency 3:
Students demonstrate ability to communicate with other students orally, and in the written portions of a presentation
This is assessed using a brief survey of students present in the presentation, on the basis of:
- Students felt that presentation was successful in communicating the ethical issue and that the oral part of the presentation was clear and understandable*
- Students felt that the written part of the presentation was clear and understandable*
  *Since this is based on student surveys, students are deemed to have met expectations if at least 80% of student respondents support this finding

Summary of Finding: Meets or Exceed Expectations = 100%
Exceeds Expectations = 0 %
Meets Expectations = 100 %
Below Expectations = 0%

Findings for EAC ABET Outcome 3:

Summary of Finding: Meets or Exceed Expectations = 100%

Exceeds Expectations = 37.5 %
Meets Expectations = 62.5 %
Below Expectations = 0%

Results: Target Achievement: Achieved
Recommendations: As the target was met, no recommendations are made at this time.