

Continuous Improvement Process Based on Outcome Based Education

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Abstract

This paper details a “Continuous Improvement Process” (CIP) that was developed and implemented by the Department of Electrical and Computer Engineering Technology (ECET) for the Technology Accreditation Commission / Accreditation Board for Engineering and Technology (TAC/ABET) visit. The continuous Improvement Program is based on “Outcome Based Education” (OBE) Philosophy. This Paper describes the assessment tools that were developed and used to provide a path to achieve CIP. This process was implemented four years ago and has shown a positive trend in student learning. This CIP is an ongoing one and the data collected since its inception will be shared at the conference.

The program assessment is an on going activity since 1975 when the department received its first accreditation from ECPD. It started as an internal evaluation process for the university to justify recourses allocation. While some form of continuous improvement existed "Between 1985-1996" it was not emphasized until TAC/ABET made it as a requirement for accreditation starting in year 2000^{1,2}.

The faculty embraced the philosophy of “Outcome Based Education” and developed a program assessment methodology in 2003. According to William (Spady, W., 1993)^{3,4} the OBE is based on: 1) All students can learn and succeed but may not on the same time are in the same way, 2) each success by a student breeds more success and 3) Academic institutions control the condition of learning.

Continuous Improvement Process (CIP).

The department’s assessment model was developed as follows (Farook et al. ASEE 2005)⁵.

1. Identify major constituencies
2. The constituencies define the programs educational objectives (PEO).
3. Incorporate the accreditation agency’s criteria (TAC/ABET).
4. Incorporate program specific outcomes as per IEEE (5).
5. Develop learning objectives based on items 3, 4 above.
6. Develop multiple evaluation tools to implement a continuous improvement process
7. Evaluate the CIP model on a continuous time basis and make the necessary changes to achieve improvement in the delivery of educational objectives.

I. Introduction

The Electrical Engineering Technology program of the ECET Department has an ongoing assessment and continuous improvement plan in place since 1995. What is unique with our program is that the department faculty has implemented the methodology of Outcome Based Education (OBE) first and then has implemented the Outcome Based Assessment (OBA). The plan has gone through an evolutionary path and was refined during this time frame. In its current form it is designed to encompass all aspects of Outcome Based Assessment conforming to TAC/ABET's model^[1, 2].

The current Program assessment Methodology that ensures the Program's Continuous Improvement is depicted in Figure 1. The process ties together the different Constituencies that define the department's Program Education Objectives (PEOs) along with the Program Outcomes (Pos). The Pos are further mapped in terms of Course Learning Objectives (CLOs).

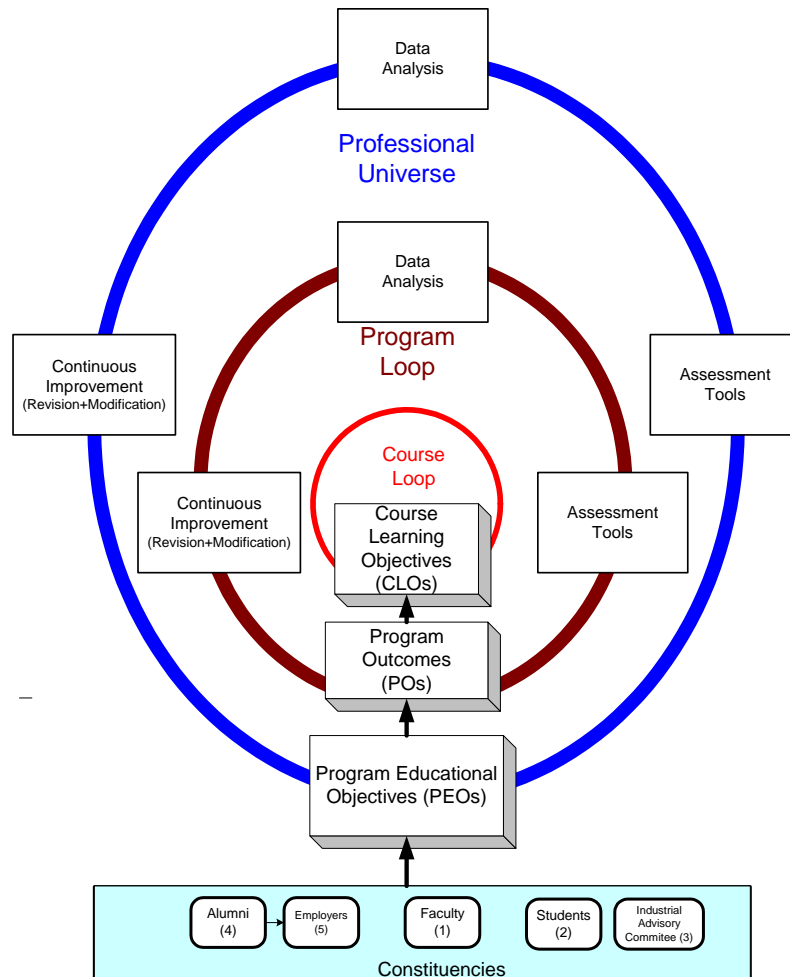


Figure 1. ECET Program Assessment Methodology

II. ABET's Criterion 1: Program Educational Objectives (PEOs)

Applicable to both Associate & Baccalaureate Electrical Engineering Technology Programs

1. The graduates of the Associate Degree Program will be engaged in analysis, synthesis and troubleshooting of electrical, electronics and computer systems.

In addition, graduates of the Baccalaureate Degree Program will be engaged in problem solving and applied design of systems.

2. The graduates of the Associate Degree Program will utilize state-of-the-art knowledge and techniques in maintenance, service, sales and marketing of electrical and electronics systems.

In addition, graduates of the Baccalaureate Degree Program will utilize their knowledge in manufacturing and application of these systems.

3. The graduates of the program will be working as effective team members with commanding oral and written communication skills. Throughout their career they would be assuming technical and managerial leadership roles.

The above PEOs describe the career and professional accomplishments that the program is preparing graduates to achieve during the first few years following graduation.

These PEOs are consistent with the Purdue University Calumet's strategic plan, The School of Technology's strategic plan and The Department of Electrical and Computer Engineering Technology Strategic Plan and Statement of Mission, Goals and Philosophy of Education.

II.a PEO Assessment Process

The PEOs were formulated based on inputs received from our various constituencies namely 1) Faculty 2) Students 3) Industrial Advisory Committee 4) Alumni and 5) Employers. These PEOs are assessed by the PO assessment tools as described under TAC/ABET Criteria 3: Assessment and Evaluation. The analysis of data from the above constituencies would result in warranted corrective action, thereby closing the loop. (Refer to Figure 2.)

II.b Curriculum

The Department of Electrical and Computer Engineering Technology educational program, including its curriculum enables graduates to achieve the department's Program Educational Objectives.

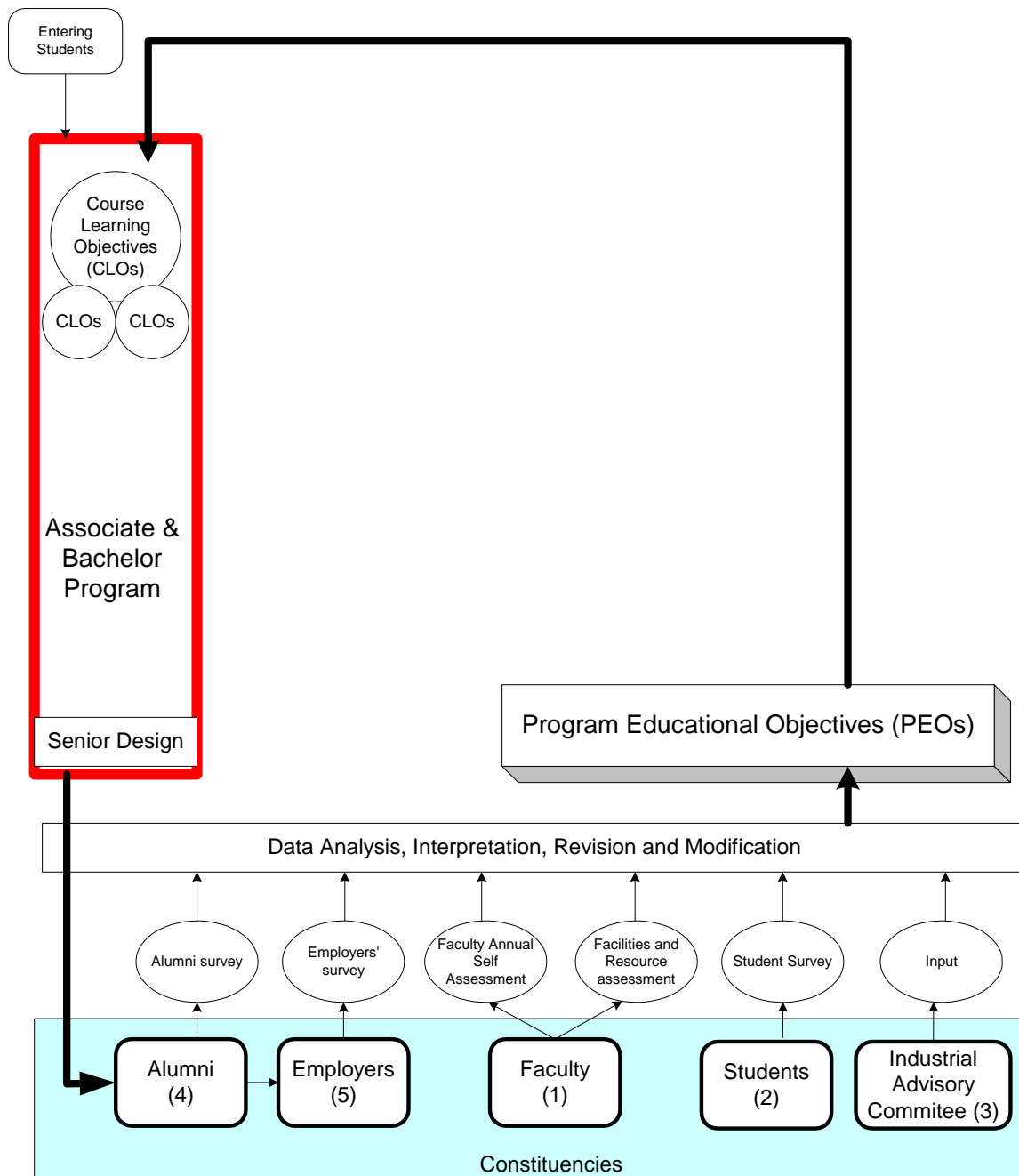


Figure 2. Program Educational Objective Assessment Process

III. ABET's Criterion 2: Program Outcomes (PO)

In order to prepare the next generation of Electrical Engineering Technologists, the department faculty, using input from various constituencies has adopted the TAC/ABET's Criterion 2: Program Outcomes as the Program Outcomes of the ECET department.

III.a Program Outcomes

The Electrical Engineering Technology must demonstrate that graduates have:

- a. an appropriate mastery of the knowledge, techniques, skills and modern tools of the discipline of Electrical Engineering Technology ,
- b. an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology,
- c. an ability to conduct, analyze and interpret experiments and apply experimental results to improve processes,
- d. an ability to apply creativity in the design of systems, components or processes appropriate to Electrical Engineering Technology's program objectives,
- e. an ability to function effectively on teams,
- f. an ability to identify, analyze and solve technical problems,
- g. an ability to communicate effectively,
- h. a recognition of the need for, and an ability to engage in lifelong learning,
- i. an ability to understand professional, ethical and social responsibilities,
- j. a respect for diversity and a knowledge of contemporary professional, societal and global issues
- k. a commitment to quality, timeliness, and continuous improvement.

III.b Program Outcomes Related to Criterion 2

The EET Program Outcomes (see Fig. 3) have a one to one correspondence with TAC/ABET's mandated a – k Outcomes of Criterion 2. The outcomes are distributed in an overlapping manner over the program's curriculum.

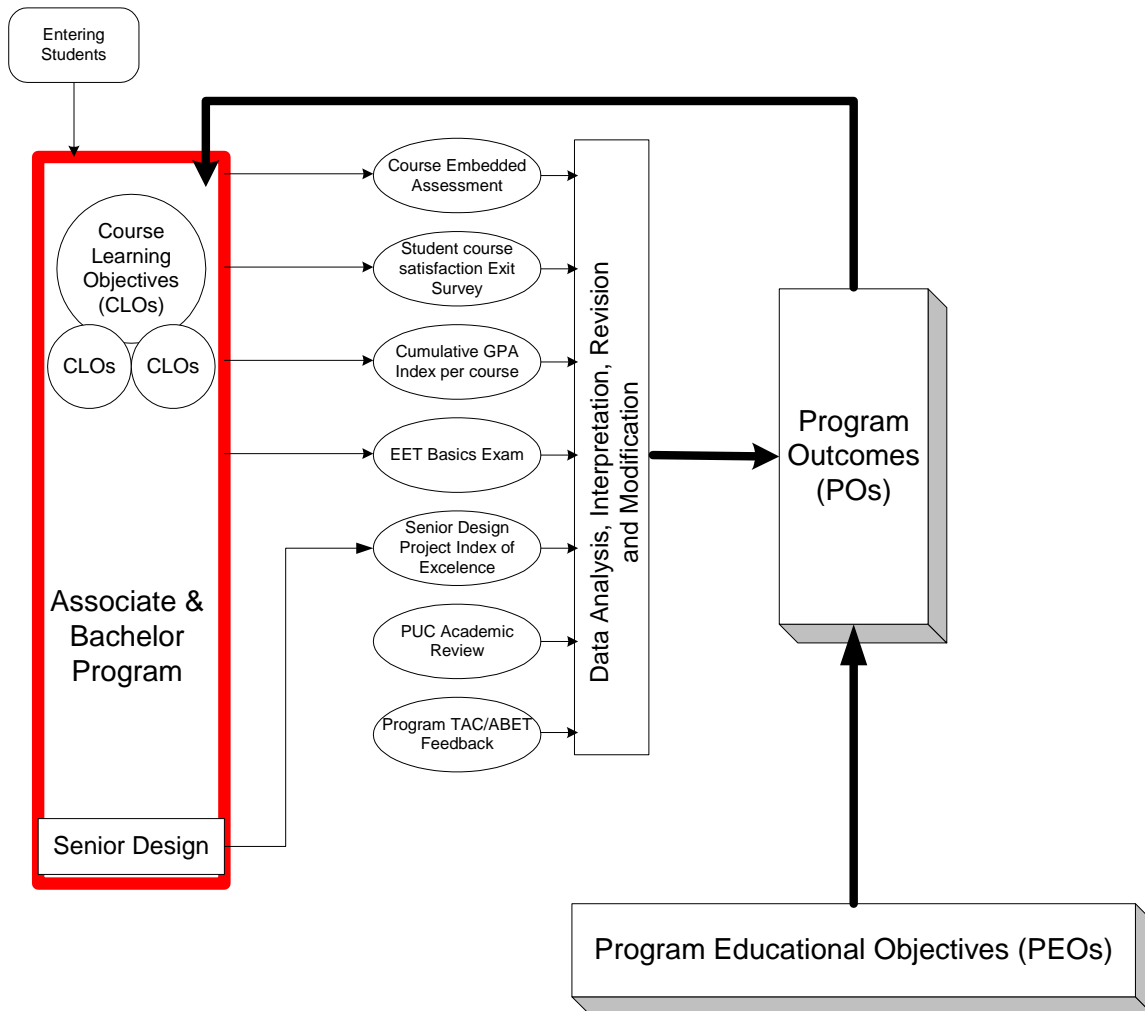


Figure 3. Program Outcomes Assessment Process

IV. ABET's Criterion 3: Assessment and Evaluation

IV.a. Continuous Improvement Plan

The Electrical Engineering Technology program of the ECET Department has an ongoing assessment and continuous improvement plan in place since 1995. The plan has gone through an evolutionary path and was refined during this time frame. The department has embraced the general philosophy of Outcome Based Education. In its

current form it is designed to encompass all aspects of Outcome Based Assessment conforming to TAC/ABET's model (Figure 1. EET Program Assessment Methodology)

The following brief expose to Outcome Based Education is presented here as a frame of reference and thankfully acknowledges the sources from the cited reference literature.

IV.b. Outcome Based Education (OBE)

Outcome Based Education is the paradigm shift resulting from the failure of Traditional Education (TE). TE narrowly focused on the content and produced students with varying degrees of achievement levels (stratification of achievers). Thus this model did not produce learners, which could perform effectively in the work place. OBE has changed the focus of learning institutions from the content to the learner. According to William Spady, a major proponent of OBE, three goals drive this approach to creating academic curricula. 1) All students can learn and succeed, but may be not on the same day or in the same way. 2) Each success by a student breeds more success. 3) Academic institutions control the conditions of success.

IV.b.a. Curriculum Design for OBE

OBE is a methodology of curriculum design and teaching that focuses on what students can actually do after they are taught. OBE focuses on these key questions as to:

- a) What should the students learn?
- b) What is the motivation for the students to learn it?
- c) How can the academic institution and its resources help students learn it?
- d) How will it be determined what the students have learned (assessment)?

Thus, the OBE's instructional planning process is a reverse of that associated with traditional educational planning. The desired outcome is determined first and the curriculum, instructional materials and assessments are designed around to support and facilitate the intended outcome (Spady 1988; 1993)^{3,4}. All curriculum and teaching decisions are made based on how best to facilitate the desired final outcome.

IV.b.b. Essentials for OBE's successful

Towers (1996)⁶ noted the following four points to the OBE system that are essential for its success:

- a) Identification of learning material.
- b) The student's achievement is based on demonstrable measurables.
- c) Multiple instructional and assessment strategies need to be utilized to meet the needs of each and every student.
- d) Adequate time and needed assistance is to be provided so that each student can reach the maximum potential.

IV.b.c. Benefits of OBE

The benefits of OBE are as follows:

OBE is able to measure—what the students are capable to perform – this goes much deeper at a cognitive level than traditional education system which determines whether or not students know some facts (content) or some predetermined mechanical process of doing a task. OBE on the other hand not only provides the students with facts (content) it takes the approach of problem solving, which calls for all the necessary permutations and combinations which the situation demands. Hence the student is intellectually engaged in solving problems which are quite varied and situational. OBE is not only interested in content but more so in context which lends the relevancy to the content itself. Classroom practices have to allow the students to demonstrate what they have learned in many different ways. Ideally, students should have an understanding of the content, context and must have internalized the subject matter at a cognitive level and have gained mastery over it. (Spady, 1995)⁷.

OBE goes beyond ‘structured tasks’ (e.g. memorization) by demanding that a student demonstrate his/her skills through more challenging tasks like designing and project building. They should engage in analysis and synthesis and apply it to problem solving. Many times they should utilize other partner’s resources in the equation of problem solving. The students learn the value of cooperation in place of mindless competition that is detrimental to team spirit and resources development, which are critical to complex problem situation and solution. Thus, OBE involves students in a complete course of learning—from developing their skills in designing to completing a whole process (Spady, 1994, 1995)^{7,8,9}. OBE also identifies higher levels of thinking (e.g. creativity, ability to analyze and synthesize information, ability to plan and organize tasks). Such skills are emphasized especially when students are assigned to organize and work as a community or in teams to propose solutions to problems and market their solutions.

IV.b.d. The Four Basic Principles of OBE

a) Clarity of focus about outcomes¹

- Always have the significant, culminating exit outcomes as the focus.
- Let the students know what they are aiming for.

¹ There could be two types of outcomes: major ones such as the exit outcome of the course and minor ones that are developed by the instructor for achieving the instructional goals.

b) Designing backwards

- Design curriculum backward by using the major outcomes as the focus and linking all planning, teaching and assessment decisions directly to these outcomes.

c) Consistent, high expectations of success

- Set the expectation that OBE is for ALL learners.
- Expect students to succeed by providing them encouragement to engage deeply with the issues they are learning and to achieve the high challenging standard set (Spady, 1994b)⁸.

d) Expanded opportunity (Inclusive)

- Develop curriculum to give scope to every learner to learn in his/her own pace.

- Cater for individual needs and differences, for example, expansion of available time and resources so that all students succeed in reaching the exit outcomes.

IV.b.e. Using Outcomes to Guide Instructional Planning

Instructional planning under OBE system takes four major steps:

a) Deciding on the outcomes

Outcomes and standards should be described in terms of three dimensions:

- CONTENT—simple to complex
- CONTEXT—simple to complex
- COMPETENCE—low to high

They should be arrived at through the input from the different constituencies, which the institution deals with.

b) Demonstrating outcomes

Demonstration of the outcome is set forth by arriving at ‘benchmarks’ for each level of the program. Each of these benchmark is a skill-set that must be demonstrated by the student. Unlike the outcomes, the list of benchmarks is different in every level of the program of interest. Benchmarks should address and define specifically the goals of the curriculum and determine ways to assess whether students have reached these goals at that level of study.

c) Deciding on contents and teaching strategies

Students and instructor should jointly develop the content and teaching strategies. Students should actively participate and decide in the process of learning. Classroom should provide experiences that students are going to encounter in the workplace. Empowering the student and engaging them in learning process is the goal and path to life-long learning.

d) Assessments in OBE

The entire curriculum in OBE is driven by assessments that focus on well-defined learning outcomes and not primarily by factors such as what is taught, how long the student takes to achieve the outcomes or which path the student takes to achieve their target. The learning outcomes are set out on a gradation of increasing complexity that students are expected to master these outcomes sequentially. (Willis & Kissane 1995)¹¹ suggested two techniques for assessing students’ learning outcomes:

- ‘Standard-referenced assessment’ (similar to criterion-referenced assessment but with a clearer description of expected performance), and
- Student portfolios documenting their progress.

Given that assessments in OBE focus on the students’ learning outcomes (i.e. how much and how well the students have learnt), this could imply that students with different abilities will follow different paths to reach their goals and may finish at different times. This brings forth some questions on when and how often to carry out the assessments in a semester or how many attempts should a particular student be allowed to show her/his abilities.

In addition, as OBE requires ongoing feedback between the student and the lecturer, continuous assessments could help the lecturers determine the following:

- How to achieve the learning outcomes?
- What is the progress of particular students in the class?
- When to assess the students on how much they have learnt?

IV.b.e. Outcome Based Education in Conclusion

According to Chandrama Acharya¹², OBE promises high level of learning for ALL students as it facilitates the achievement of the outcomes, characterized by its appropriateness to each learner's development level and active and experienced-based learning. Moreover, knowing that this system is going to be used would also give students the freedom to study the content of the course in a way that helps them learn it. OBE must involve administrators, educators, parents, teachers and students (all constituencies) for successful implementation.

V. ABET's Outcome Based Assessment Model

Outcome Based Assessment is the culminating part of Outcome Based Education (OBE). ABET's model is as follows:

1. Each program has major defining constituencies.
2. The constituencies define the Program Education Objectives (long term and broad outcomes).
3. ABET assessment is based on Outcome Based Education's methodology, and defines a through k components for the Program's Outcomes as the General Criteria.
4. IEEE as the lead society for the Electrical Engineering Technology Program defines the program specific outcomes as the Program Criteria.
5. Each program designs a curriculum that incorporates the General Criteria and Program Criteria as the Program's Outcome, defined in terms of the Program Learning Objectives.
6. Each program accomplishes Outcome Based Assessment as an integral part of the Outcome Based Education. This process utilizes multiple tools to assess and evaluate, which in turn translates into Continuous Improvement of Outcome Based Education.

VI. The Electrical Engineering Technology (EET) Program's Continuous Improvement Plan

VI. a. The Department of Electrical and Computer Engineering Technology Teaching Philosophy.

The ECET department's Teaching Philosophy is the reflection and commitment to student centered, Outcome Based Process Education. The Electrical & Computer Engineering Technology Department draws its teaching philosophy from the secular scientific tradition of free inquiry leading to the unhampered growth of knowledge.

The Electrical & Computer Engineering Technology Faculty addresses the holistic needs of the society at large. This need looms higher in our department's approach to education. No longer can our educators afford to be parochial in their approach to education. That is, the faculty is sensitive to the needs of diverse student body, consisting of part-time and full-time students. Along with all of Purdue University Calumet, the Department of Electrical & Computer Engineering Technology supports the commitment to diversify among its faculty and students.

We as a department demonstrate high standards and take particular pride in our teaching pedagogy and continually assess with keen sensitivity the learning process that is in place.

Our faculty is proactive rather than reactive in meeting the challenges of our time. We make sure that our classroom instruction meets the needs of our students and attracts student interest. As a department we are aware of the fact that no longer can we engage in a mode of teaching which may result in half of our class performing below the average.

Thus our faculty is engaged in going beyond the formal classroom instructions; we are empowering the students so that they are actively engaged in the process of learning. We, as role models, are involved in creating a culture of high standards and giving a new meaning to learning, that of life long learning.

VI. b. Significant Constituencies of the Program

The following constituencies of the Electrical Engineering Technology Program dynamically define and shape the program's content, context and currency:

1. Faculty
2. Student
3. Industrial Advisory Committee
4. Alumni
5. Employers
6. ABET – as the professional accreditation body
7. IEEE – as the lead professional society

The above constituencies play a direct role as depicted in Figure 1, in defining the EET Program's Educational Objectives. The constituencies play a defining role in the EET Program's Outcome Based Education and its Outcomes. The EET Program Outcomes are distributed throughout the EET curriculum and are documented under Criterion 2, Table I-a, I-b, Table II, and Appendix IV.

The EET Program's PEO and PO assessment process is elaborated in Figure 4.

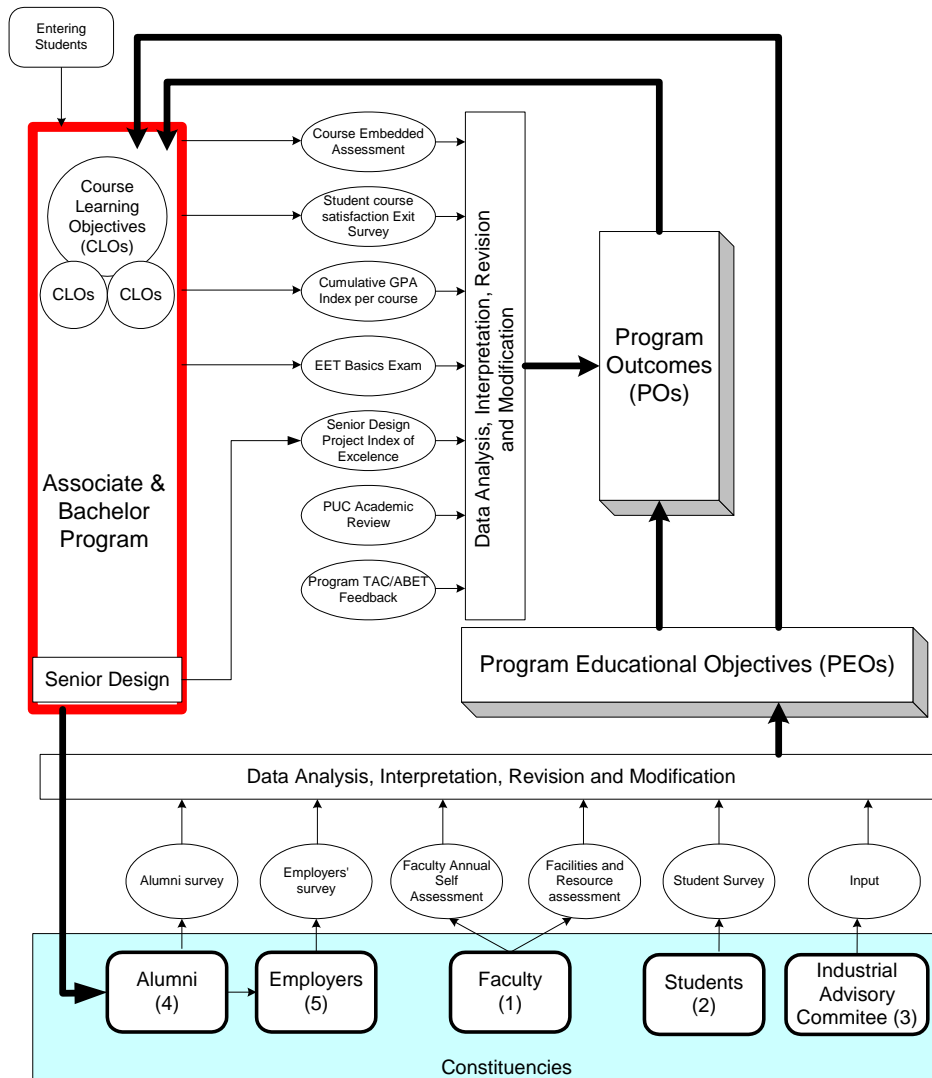


Figure 4. EET Program Assessment and Evaluation

The EET Program has put forth the following process to establish and review the Program's Education Objectives (long term objectives) and Program's Outcomes (at the time of graduation) by utilizing the following tools.

VI. c. Assessment Tools for Program Education Objectives (PEO)

1. Alumni Survey
2. Employers' Survey
3. Input from Industrial Advisory Committee
4. Program Educational Objectives Students' Survey
5. Faculty Annual Self-Assessment (faculty retreat)
6. Facilities and Resources Assessment (faculty retreat)

VI. d. Assessment Tools for Program Outcomes (PO)

1. Course Embedded Assessment
2. Student Course Satisfaction Exit Survey
3. Cumulative GPA Index for Each Course
4. Electrical Engineering Technology -- Basics Exam
5. Senior Design Projects -- Index of Excellence
6. a. Program TAC/ABET Accreditation
b. Academic Review - Purdue University Calumet

VII. Conclusion

The paper has provided to the reader the philosophical framework of Outcome Based Education and thus has established the rational and justification for Outcome Based Assessment. Outcome Based Assessment has become commonplace and is in hot pursuit simply due to the enforcement of Accreditation agencies like ABET. The paper's contention is that: *Outcome Based Assessment is only possible and meaningful and would bear fruits of Continuous Improvement of the Learning Process only if implemented after the understanding, appreciation and implementation of Outcome Based Education.*

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