AC 2012-3905: SUCCESSFUL ABET ACCREDITATION OF A TWO-YEAR ELECTRONICS TECHNOLOGY PROGRAM: LESSONS LEARNED

Dr. Anca L. Sala, Baker College, Flint

Anca L. Sala is professor and Dean of engineering and computer technology at Baker College of Flint. In addition to her administrative role, she continues to be involved with development of new engineering curriculum, improving teaching and assessment of student learning, assessment of program outcomes and objectives, and ABET accreditation. She is an active member of ASEE, ASME, and OSA, serving in various capacities.

Mr. James Riddell, Baker College, Flint

James A. Riddell is the former Dean of engineering and technology at Baker College of Flint, Mich. He currently works at Jazan Economic City Polytechnic in Saudi Arabia. He is a member of ASEE, ASME, SME (Past Chair), and SAE (Past Chair).

Successful ABET Accreditation of a Two-Year Electronics Technology Program: Lessons Learned

Abstract: While ABET accreditation is a must for four-year engineering programs as well as engineering technology programs, it can add value and act as a program differentiator for two-year engineering technology programs especially in the case of programs offered by less traditional institutions. Our school is a non-profit independent institution offering a combination of Bachelor and Associate level programs in engineering and engineering technology. Our Associate of Applied Science in Electronics Technology program is the only two-year Electronics Technology (ET) program currently to have been granted ABET-TAC accreditation in our state. This paper discusses the benefits and the experience gained from going through the process of ABET accreditation with the ET program. The program is delivered in an on-ground only mode for all core classes and the academic year is three 10-week quarters. This process started formally in early 2009 and was based on the 2008-09 Criteria for Accrediting Technology Programs issued by the Technology Accreditation Commission of ABET. Under those criteria no differentiation was made between the required Program Outcomes of two-year and four-year technology programs. A capstone design experience was required, which our program implemented in academic year 2009-10. The program was successful in obtaining ABET accreditation during a cycle where the bar for two-year programs was set at a fairly high level. Even though the capstone design course has become optional under current Criteria for Accrediting Technology Programs (2011-12), we believe it adds a valuable experience for graduating students in the program. Another important learning from the ABET accreditation process is that all curriculum related matters should be under the jurisdiction of the accredited program's faculty. Our school is part of a multi-campus institution where strong value is placed on standardization of the curriculum and the teaching and learning processes across all campuses. Our campus however is the only campus with ABET-accredited programs, thus giving our faculty more actual if not also formal responsibility in all curriculum related matters. The paper will address topics such as Program Educational Objectives, Program Outcomes and their assessment, curriculum, supporting resources, Industrial Advisory Board and others, and share our experiences.

Institution and Accreditation Background

Baker College is a non-profit independent higher education institution that started 100 years ago as a single-campus college. Since that time the College has evolved into a multi-campus institution that is the largest independent college in the state of Michigan, offering degrees from associate level up to graduate level. Baker College is accredited by the Higher Learning Commission of the North Central Association of Colleges and Schools. The mission of Baker College is "to provide quality higher education and training which enable graduates to be successful throughout challenging and rewarding careers". The student population is diverse with non-traditional adult students making up a majority of students. The academic calendar is based

on four 10-week quarters: fall, winter, spring and summer. Traditionally, core courses in engineering and technology areas are held only in the fall, winter, and spring quarters, with general education courses being offered also in the summer quarter.

Engineering and Technology degree programs are offered primarily at the original Flint Campus. The engineering program offerings include Bachelor of Science (BS) programs in Mechanical Engineering, Industrial Engineering, and more recently in Electrical Engineering, and Civil Engineering. The Associate of Applied Science (AAS) programs include Mechanical Technology, Electronics Technology, Computer Aided Design Technology, and Architectural and Construction Technology. Up to the present time two of the above programs obtained ABET accreditation: the BS in Mechanical Engineering (accredited by the Engineering Accreditation Commission), and the AAS in Electronics Technology (accredited by the Technology Accreditation Commission). The two programs went through an ABET accreditation General Visit together in fall of 2009. While this was the first accreditation visit for the AAS Electronics Technology program, it was a re-accreditation visit for the BS Mechanical Engineering. Even though the accreditation process was led by two different ABET Commissions, the previous accreditation experience accumulated by the BS Mechanical Engineering program was very valuable in guiding the AAS Electronics Technology program along the path towards initial accreditation, making the program the only two-year Electronics Technology program to have been granted ABET-TAC accreditation in the state of Michigan.

The value of going through the extensive ABET accreditation process for two-year engineering technology programs is recognized, and several papers presented at the ASEE Annual Conference in recent years have discussed its various aspects[1-3]. This paper presents challenges and lessons learned at our institution from the successful accreditation of our two-year program.

Program Educational Objectives and Program Outcomes

Prior to the ABET accreditation process the AAS in Electronics Technology program has operated mainly under the College's Mission and Purposes which provided a general framework for the program goals and objectives. Specific program goals focusing on training the graduates to act as competent electronics technicians in their careers were implied, but not articulated in written form, nor published and disseminated to all program constituencies. The accreditation process brought the program goals and their wide dissemination into focus, resulting in the program adopting its Program Educational Objectives (PEO) based on input from all program constituencies.

The Educational Objectives of the program are to prepare graduates who:
1. Function as an electronic technician capable of working with the designing, installation, manufacturing, operation, and maintenance of electronics systems.
2. Demonstrate critical thinking skills by applying the basic principles of electronics technology to solve technical problems.

3. Demonstrate competence in written and oral communication.
4. Work effectively as an individual and as a member of a team while recognizing the importance and value of diversity.
5. Demonstrate awareness of ethical, social, and professional responsibilities in a multicultural workplace.
6. Continue their professional training and adapt to changes in the workplace through additional formal and informal education.

The PEO's were adopted by program faculty with input from the program Industrial Advisory Board, as well as current students and program alumni. The PEO's were designed after the successful accreditation of the Mechanical Engineering program. Conscious effort was made to develop PEO's that were consistent with the mission of the college and educational objectives as defined by "system" which governs all campuses. The PEO's were planned to be comprehensive, complete and, most importantly, measurable. The PEO's are reviewed regularly in program meetings and Industrial Advisory Board meetings, attended by representatives of all the program constituencies. Of special importance is having a well-established process through which the PEO's are assessed to demonstrate they are achieved by the program graduates. This process is described in the next section.

Supporting the achievement of the PEO's by program graduates in the three to five year after graduation are the Program Outcomes, which express what students should be able to accomplish at the time of graduation from the program. In our case we decided that our Program Outcomes will be the same as the a. - k. Program Outcomes provided by ABET in the "ABET TAC Criteria for Accrediting Engineering Technology Programs" from the 2008-09 cycle[4]. Two additional Program Outcomes, specific to Electronics Programs, were adopted as Program Outcomes l. and m. The Program Outcomes are listed as follows:

Graduates will demonstrate:
a. appropriate mastery of knowledge, techniques, skills, and modern tools of the electronic technology field.
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 program objectives.
e. an ability to function effectively in teams.
f. an ability to identify, analyze, and solve technical problems.
g. an ability to communicate technical information effectively to technical and non-technical individuals.

h. recognition of the need for and an ability to engage in lifelong learning.
i. knowledge of professional, ethical, and social responsibilities. j. a respect for diversity and knowledge of contemporary professional, societal, and global issues pertaining to the electronic technology field.
k. a commitment to quality, timeliness, and continuous improvement.
l. the application of circuit analysis and design, computer programming, associated software, analog and digital electronics, and microcomputers to the building, testing, operating, and maintenance of electrical/electronic(s) systems.
m. the application of physics to electrical/electronic(s) circuits in a rigorous mathematical environment at or above the level of algebra and trigonometry.

It must be noted that at the time of the initial accreditation of the AAS ET program no differentiation was made between the a. - k. Program Outcomes of two-year and four-year engineering technology programs. At the present time the Technology Accreditation Commission has adopted different sets of Program Outcomes (now called Student Outcomes) for two-year and four-year programs, resulting in only nine Outcomes for two-year programs (a. - i.) vs. 11 Outcomes for four-year programs (a. - k.)[5].

The Program Outcomes are assessed regularly using Direct Assessment methods. Results of the direct assessments are discussed in program meetings taking place in each of the fall, winter and spring quarters, and in Industrial Advisory Board meetings held two times per year. The Industrial Advisory Board meetings are run by each campus independently and are attended by professionals working in the industry in the local area, faculty representatives, administrators, and student and alumni representatives. Program meetings are attended by faculty and administrators from all campuses offering the Electronics Technology program, as well as "system" persons, representing the administration of the entire multi-campus institution. In general, our institution places strong value on the standardization of the curriculum, and of the teaching and learning processes across all campuses. By contrast, in the ABET accreditation process accreditation is given to individual programs and such, faculty from each program must have final authority over the program curriculum. During their visit the ABET team stressed this and noted that curriculum related decisions should not come from above but be driven by program faculty based on assessment and program constituencies feedback.

While PEO's are supported by the Program Outcomes, these in turn are achieved through the courses in the program curriculum, each having well-defined Student Learning Outcomes. A mapping was created between the Program Outcomes and the courses in the program to assure that each Program Outcome is well supported by the curriculum, as well as assessed. The mapping shows the level at which each PO is covered in the course: Introduced, Reinforced, Emphasized, or Assessed. The mapping thus shows the courses where Direct Assessment is performed and the corresponding Program Outcomes. Typically each Program Outcome is

assessed through direct assessments administered in several courses. Figure 1 illustrates the relationship between the various outcomes.

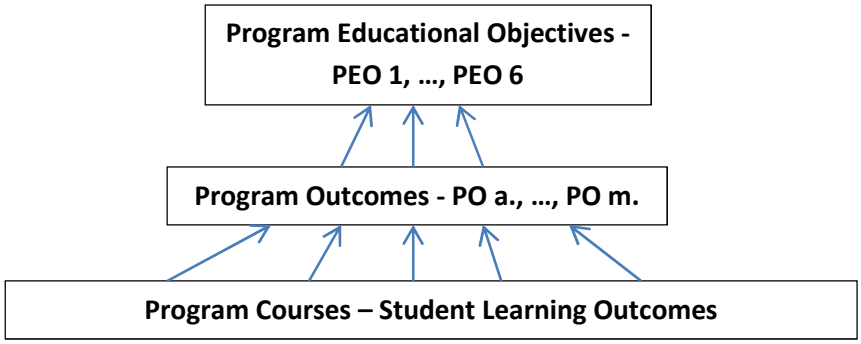

Fig.1 Relationship between Student Learning Outcomes, Program Outcomes, and Program Educational Objectives

One important curriculum change implemented by the program just before the ABET visit in 2009 was to introduce a Capstone Project course at the end of the program requiring students to complete and present a hands-on project utilizing the knowledge and skills acquired throughout their studies. The Capstone Project was essential for assessing many of the Program Outcomes that were not directly assessed previously through any other mechanism. However, the benefits of having a Capstone Project course in the program are much larger than those related to Program Outcomes assessment. The course was very well received by students, who were energized by the opportunity to show what they learned and what they can do through a hands-on project. They were also interested in presenting their work to a wider audience during the project presentation session and in answering questions. This was the first opportunity students had to do a higher level presentation in their two-year program of study, and they learned a lot from it. Based on our experience of teaching the Capstone Project course in the past three years, we recommend including this class in two-year engineering technology programs even though it is optional from the point of view of ABET accreditation.

Assessment and Evaluation of Program Educational Objectives and Program Outcomes

Assessment of the Program Educational Objectives and Program Outcomes is a cornerstone of the ABET accreditation process. Our institution has recognized the need for direct assessment in all programs of study offered and has put in place procedures for data collection starting about ten years ago. This across-the-board effort of the entire institution has provided engineering and technology programs a basis for developing reliable assessment processes to comply with ABET requirements. It is the policy of the institution that each faculty member teaching a course with Direct Assessment must include the assessment in the evaluation of student learning, and record the results in a college-wide database at the end of the quarter. The recommendation is that students' scores from the Direct Assessments are included in the course grade so that students

treat direct assessments seriously.The database with assessment results is accessible to each faculty member, full-time or part-time, teaching in any of the Baker College campuses.

The direct assessment tools are administered each time a course is taught, generally one time every year. This allows programs to gather a sufficient amount of data to allow for meaningful interpretation and capturing of year-to-year trends in student learning. In addition to the processes put in place by the institution, each of the ABET accredited programs has named an ABET Coordinator who is responsible for all steps in the assessment process, from data collection to analysis and interpretation.

The Program Outcomes are assessed through direct assessment tools administered in multiple courses in the program. A variety of tools is used including multiple-choice tests, Lab Report assignments, research paper assignments, and hands-on projects. The latter are scored using faculty developed rubrics.

As mentioned previously the Capstone Project course is very important assessment-wise, as we use it to assess a large number of Program Outcomes. Three assessment instruments were developed for the Capstone Project: an essay assignment, the project assignment, and a presentation assignment. The essay assignment requires students to "complete an essay discussing professional, ethical, and social responsibilities, including global and diversity issues, as related to the field of Electronic Technology." This instrument is used to assess Program Outcomes i. and j. For the second assignment, the project, students must research and choose a topic, then build, test and debug the device using available schematics. Students are not required to design the circuit. This second instrument is used to assess Program Outcomes a. - g. and k. The project is scored using a rubric developed by faculty, included in the Appendix. Finally the presentation assignment asks students to "prepare a 5-7 minute presentation on educational opportunities and needs beyond the Electronic Technology Associate degree". This instrument is used to assess Program Outcome h.

With each direct assessment a numerical threshold was adopted by faculty to distinguish between achieving/not achieving a specific Program Outcome. Specifically we require at least 70% of students averaged across all questions to answer questions correctly in a test, or to achieve in the top two out of five levels when assessment is based on rubrics. This threshold has been exceeded in the majority of direct assessments ran so far.

The Program Educational Objectives are assessed using two faculty developed surveys: an employer survey, and an alumni survey. The surveys ask questions directly related to how well the PEO's are achieved by our graduates, and also supporting questions about graduates' accomplishments such as promotions, participation in professional societies, continuing their education with a higher degree or with short courses, workshops, and seminars. The surveys are administered every two years, due to the small number of program graduates, and the small rate

of return from employers. We are currently in the second cycle of data collection from these surveys.

Data collected using all assessment instruments is gathered and processed by the ABET Coordinator and brought to each program meeting and Industrial Advisory Board meeting for discussion. Program meetings take place each quarter so that the assessment results from the previous quarter are regularly discussed in the meetings. Actions to correct any issues evidenced by the assessment results and to improve the program are proposed, discussed and decided on in these meetings. The ABET Coordinator is also responsible for following on the status of implementation of corrective actions to make sure they get to be applied. The loop is completely closed once the effect of the corrective actions is assessed and evaluated. The same assessment results are also discussed with the Industrial Advisory Board in meetings taking place twice yearly. The raw data is presented to the board together with the averaged scores for intepretation. The Industrial Advisory Board learned a lot about the ABET accreditation process during the 2009 visit and is now understanding of assessment data evaluation and interpretation. Their input on assessment is an essential piece in our process.

Lessons Learned and Conclusions

The Electronics Technology program was successful in obtaining first time ABET-TAC accreditation after the ABET visit in 2009. The processes put in place prior to the ABET visit and refined post visit are continuing after two years and a half since then and will continue into the future. The ABET accreditation process was very valuable, not only due to the positive outcome, but also through focusing our efforts on understanding what is being done well and what needs improvement in the program. It set the standard of carefully documenting every aspect of the program and it empowered faculty even though it added responsibility and took time out of their schedule.

A lesson learned is in relation to knowing your target regarding the needs of the industry which would normally employ the program graduates. Moreover, consider not only employment skills highly regarded by local employers but also global requirements as the graduates should end up with a very portable degree with options in a variety of employment fields, levels and technology. It is imperative to have an Industrial Advisory Board that is vibrant and willing to contribute to the program improvement process. This is not just due to ABET requirements of external review but rather vital for any program.

Another ‘best-practice’ developed was to provide the students with information on how particular Student Learning Outcomes support which particular Program Outcomes. This gives the student a feel for “why am I learning this stuff anyway?” and potentially a talking point during a job interview to help them explain why they took the classes they did. Students are regularly reminded about this last point.

Having more than one program being ABET accredited in a school is helpful, especially in smaller engineering and technology schools where there is a lot of interaction and support between faculty in different programs. In the same vein, our experience is now shared and is extremely valuable to one of our sister campuses who applied for initial ABET accreditation of their AAS in Electronics Technology program in January 2012.

Bibliography

1. Hill, W., "Accreditation of Engineering Technology Associate Degree Programs", Proceedings of the 2008 ASEE Annual Conference and Exposition.
2. Hill, W., "Accreditation of Engineering Technology Programs", Proceedings of the 2009 ASEE Annual Conference and Exposition.
3. Denton, N., Fuehne, J., Kraebber, H., Cooley, T., Dues, J., "The TC2K Visit is Done – Now What?", Proceedings of the 2007 ASEE Annual Conference and Exposition.
4. ABET TAC Criteria for Accrediting Engineering Technology Programs 2008-09.
5. ABET TAC Criteria for Accrediting Engineering Technology Programs 2011-12.

Appendix. Rubric to evaluate the Capstone Project

EET 271 CAPSTONE PROJECT Individual Student Rubric For Assessing the Capstone Project

Points	Rubric Criteria
5	**Demonstrates highest level of competence by achieving over 90% of the required criteria**
4	**Demonstrates high level of competence by achieving 80- 89% of the required criteria**
3	**Demonstrates minimum level of competence achieving by 70- 79% of the required criteria**
2	**Demonstrates below minimum level of competence by achieving 60-69% of the required criteria**
1	**Demonstrates no level of competence by achieving below 60%of the required criteria**

Student Name/s: _____

	WRITTEN PROJECT Final Documentation	Highest Standards (5)	High Standards (4)	Minimum Standards (3)	Below Standards (2)	Excessively Below Std. (1)
	Use of knowledge, techniques, skills and modern tools					
	Apply current knowledge and adapt to applications of mathematics, science, engineering and technology					
	Conduct, analyze, and interpret results to improve the process					
	Apply creativity					
	Function effectively as a team					
	Identify, analyze, and solve problems					
	Quality and continuous improvement					

	Communicate technical information effectively					
	Completed Project on time					
	Writing is clear and concise, and contains appropriate diagrams and charts					

ORAL PRESENTATION Project Presentation		**Highest Standards (5)**	**High Standards (4)**	**Minimum Standards (3)**	**Below Standards (2)**	**Excessively Below Std. (1)**
	Amount, relevance, and sound technology content of material presented within a 25-30 minute					
	Presentation visuals					
	Public presentation abilities					
	Ability to answer questions					
	Professionalism and Teamwork					
Total (75 points possible)						
Total:						