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The Development of a Cooperative Education Project as an Assessment Tool for an Engineering Technology Program

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Abstract

Cooperative education has been an integral part of the educational program at Maine Maritime Academy (MMA) since the founding of the college in 1941. Employers, graduates, and potential students describe MMA's "hands-on" focus, reflected in these cooperative education experiences, to be one of the main advantages of an MMA education. The MMA Engineering Department has modified and enhanced several facets of its technology programs to incorporate outcomes assessment in order to comply with the Accreditation Board for Engineering and Technology (ABET) Technology Criteria 2000. These criteria require that accredited programs demonstrate that graduates possess specified skills (outcomes) at graduation. This paper describes how the existing Power Engineering Technology program requirements for cooperative education, and the accompanying projects, have been modified to allow for assessment of several outcomes of the ABET Technology Criteria. The modifications include components to evaluate student communications, teamwork, and analytical capabilities.

Introduction

Maine Maritime Academy (MMA) has taught Engineering in various forms for over 60 years. This education has always included a core of technical and professional material, including cooperative work experiences. The work experiences were traditionally performed on board the MMA training ship or on commercial vessels. The Power Engineering Technology (PET) program was developed in the late 1980s as an expansion of the marine-focused programs at the college. Since this program was not related to the maritime industry, the school decided to incorporate a two-course, co-operative (Co-op) education experience in operating power generation facilities. These courses would follow the sophomore and junior years of the program. The experience gained during these work periods would be used to provide enough experience for the program's graduates to be eligible for the State of Maine Third Class Stationary Engineer License.

Since 1999, the PET program at MMA has been accredited by the Technology Accreditation Commission (TAC) of Accreditation Board for Engineering and Technology (ABET). The program was re-accredited in 2002. The accreditation process has changed dramatically, and

since 2003, the Technology Criteria 2000 (TC2K) uses the method of outcomes assessment to measure a program's compliance with national standards. The ABET criteria for technology programs list specific outcomes for all Engineering Technology programs, and these outcomes must be demonstrated to visiting teams during the periodic accreditation process. This paper describes actions taken at MMA to partially demonstrate compliance with the TAC of ABET outcomes using the Co-op work experience and project.

MMA PET Co-op program

MMA has a very strong reputation with employers of its graduates of producing "hands-on" engineers and engineering technologists. An MMA graduate is expected to make an immediate contribution to their employer and to bring a considerable amount of practical experience to the job. This was originally due to the United States Coast Guard (USCG) requirements for maritime program graduates. USCG regulations require that, to be eligible for the Third Assistant Engineer Merchant Marine Officer license, MMA graduates must have 180 days of work experience on an operating ship. This resulting "hands-on" knowledge has become an integral part of an MMA education. As stated in the MMA catalog, "An integral part of all Maine Maritime majors is the practical knowledge that students gain by actual work experience. A major component of all MMA programs is learning by doing."[1] Therefore, when the PET program was created, a similar component of work experience was incorporated into the program.

To further parallel the marine programs, MMA established a relationship with the Maine State Board of Boiler Inspectors to allow PET graduates to be eligible to sit for the Third Class Stationary Engineer's License. This license is a requirement for any graduate who wants to work in a steam facility in Maine. The agreement with the State Board requires that PET graduates obtain at least 1050 hours of acceptable experience in an operating steam plant prior to graduation. Therefore, the PET Co-op courses were established with minimum time requirements to allow students to qualify for this license.

Additionally, the TAC of ABET criteria have specific requirements for Co-op courses that will be used for a technology program. The criteria state, "Cooperative education credit used to satisfy prescribed elements of these criteria must include an appropriate academic component evaluated by the program faculty."[2] Therefore, an extensive written project, graded by an MMA Engineering Department faculty member (the Faculty Coordinator) was included as part of the PET Co-op courses.

The following PET Co-op course descriptions for the revised courses is taken from the MMA Undergraduate Catalog:

> Co-200: COOPERATIVE INDUSTRIAL FIELD EXPERIENCE I - A full-time work experience for Power Engineering Technology students, normally with wage compensation, in shoreside industrial and utility power plants. The work experience must be related in both theoretical and practical engineering, to the student's field of study in basic power engineering operations and maintenance. A minimum of ten full weeks, or the equivalent at the discretion of the instructor, of employment is required to be eligible

for credit in this course. Note: The combined satisfactory employment hours of Co-200 and Co-300, however, must total 1050 hours or more in a steam facility for the student to be eligible for the State of Maine Third Class Engineer (Stationary Plant) license. The course grade will be based on an extensive written project documenting this work experience. When registering for this course, you must be in good academic standing. Students in a probation or warning status are not eligible to participate in this course. Prerequisites: Eg-101, Et-101**,** Eg-261, Et-201, Et-211, Et-371, Eg-234, Et-452, and Eg-243. Cr. 2.

Co-300: COOPERATIVE INDUSTRIAL FIELD EXPERIENCE II - The second in a series of full-time work experiences for Power Engineering Technology students, normally with wage compensation, in shoreside industrial and utility power plants. A continuation of Co-200 with emphasis on advanced power engineering operations, maintenance, organization, and management. A minimum of ten full weeks, or the equivalent at the discretion of the instructor, of employment is required to be eligible for credit in this course. Note: The combined satisfactory employment hours of Co-200 and Co-300, however, must total 1050 hours or more in a steam facility for the student to be eligible for the State of Maine Third Class Engineer (Stationary Plant) license. The course grade will be based on an extensive written project documenting this work experience. When registering for this course, you must be in good academic standing. Students in a probation or warning status are not eligible to participate in this course. Prerequisites: Co-200, Eg-321, Et-212, Eg-372, Eg-382, and Eg-431, Et-378. Cr. 2. [1]

Prior to the start of the work experience, the students will participate in several orientation sessions, over approximately six months, to prepare them for this course. Each Co-op requires the student to complete a written project documenting their experience. The project includes descriptions of the facility, the company operating the plant, and plant maintenance and operating practices. The students are required to prepare weekly logs describing their experience and to contact the faculty coordinator for the course multiple times during the Co-op.

PET students have been completing the Co-op courses for over ten years. They have worked in power facilities throughout North America and have, by and large, been successful in obtaining the experience required to excel in the power industry.

The impact of outcomes assessment

With the implementation of the TAC TC2K criteria in 2003, MMA realized that the PET program would require several changes to demonstrate the outcomes required by ABET. TAC of ABET requires that "An engineering technology program must demonstrate that graduates have:

a. an appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines,
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 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, and
k. a commitment to quality, timeliness, and continuous improvement."[2]

The challenge was to ensure that all of these outcomes could be adequately demonstrated to a visiting team and that appropriate program and course goals could be developed that would allow for continuous program improvement. The Engineering Department established program objectives and outcomes to meet the needs of the power industry, our graduates, the school's mission, and the TAC of ABET Criteria. This resulted in the following PET program objectives and outcomes (Note that the numbers in { } refer to the MMA PET Objectives, while letters in ( ) refer to the ABET requirements listed in Criterion 1 of the TC2K criteria.):

POWER ENGINEERING TECHNOLOGY PROGRAM OBJECTIVES

1. Versatile engineering technologists with competencies in existing and emerging power production technologies, analytical thinking, problem solving, teamwork, communications, and with the ability, and hands-on experience, to apply these skills to solve existing and emerging problems. (a-g)

2. Engineering technologists who recognize the need for, and who have the ability to, remain current in their chosen field. This will include understanding professional ethics, knowledge of contemporary issues, and the pursuit of lifelong learning. (h-k)

PET PROGRAM OUTCOMES

Power Engineering Technology graduates will have these characteristics:

1) The ability to identify, formulate, and solve technical problems through the application of basic knowledge of mathematics, science, and engineering principles including computational methods, computers, and modern technical tools. {1} (a-d, f, g)
2) A thorough understanding of the current technologies used in the power industry. This will include "hands-on" expertise developed during laboratory and cooperative education experience. {1} (a, b, d)
3) The ability to design and conduct experiments and to analyze and interpret data. {1} (c)

4) The ability to support the design of a system, component, or process to meet desired needs. {1} (a, d)
5) The ability to function effectively on teams and within a diverse environment. {1} (e, j)
6) The ability to communicate effectively through oral, written, visual, and graphical methods. {1} (g)
7) Recognition of the need for self-improvement through continuing education and the ability to engage in lifelong learning. {2} (h, k)
8) Understanding of professionalism, ethics, contemporary issues, and the impact of engineering and/or technical solutions within a global perspective. {2} (i-k)

The TAC of ABET TC2K criteria require that "Each program must utilize multiple assessment measures in a process that provides documented results to demonstrate that the program objectives and outcomes are being met." Additionally, the criteria state, "Each program must demonstrate that the results of the assessment of program objectives and outcomes are being used to improve and further develop the program in accordance with a documented process."[2] PET program faculty then prepared an assessment plan, which described where and how each of these outcomes would be assessed within the PET curriculum.

Program assessment using the Co-op projects

The Co-op projects were revised in 2004 to reflect the outcomes assessment focus of the PET program. In the overall assessment of the program, the assessment of outcome numbers 2, 5, and 6 were included in the first Co-op course. Assessment of outcomes numbers 1 and 8 were added to the second Co-op project. While these outcomes were also to be evaluated in other areas of the program using various assessment techniques as required by the TC2K criteria, specific actions and results were included in the PET Co-op projects for assessment purposes. Note that Outcomes 3,4, and 7 are not assessed using the Co-op projects. Rubrics for the evaluation of these results are currently under development.

- Assessment of Outcome #1 – "The ability to identify, formulate, and solve technical problems through the application of basic knowledge of mathematics, science, and engineering principles including computational methods, computers, and modern technical tools." The second Co-op project requires that the students complete a technical analysis of some aspect of the plant's management or operation. This project must involve quantitative and computational analysis and thorough documentation of the methods used and the results. The student must formally propose the topic of their analysis and have it approved by the Faculty Coordinator. The resulting analysis is included in the Co-op project and is graded by the Faculty Coordinator. This part of the project is graded based on the student's technical ability to apply the appropriate methods to the solution of the problem. The graded analysis will be retained as one part of the student work portfolio to be evaluated by future accreditation teams.

- Assessment of Outcome #2 – "A thorough understanding of the current technologies used in the power industry. This will include "hands-on" expertise developed during

laboratory and cooperative education experience." Both Co-op projects require that the students investigate and document the performance characteristics of the major equipment used at their facility. Additionally, each student must completely investigate up to three main systems at the plant and prepare a formal description of how the equipment in the system works, how it interfaces with other systems, and how it supports overall plant operation. This description will be developed by "walking down" the system, investigating plant drawings and technical manuals, and observing (and in some cases, performing) system operation. The Faculty Coordinator will evaluate the written report to ensure the student correctly understands the operation and organization of the plant. The graded report will be retained as one part of the student work portfolio to be evaluated by future accreditation teams. Additionally, in some cases, the Faculty Coordinator will perform a site visit during the Co-op. As part of these visits, the student will perform a facility tour, which will include significant discussions of the plant, its equipment, and the student's experience. The faculty member visit is documented in a formal report.

- Assessment of Outcome #5 – "The ability to function effectively on teams and within a diverse environment." Due to the limited staffing at a modern power facility, the personnel must work as a team on a regular basis. The requirement for teamwork and good teamwork practices are included in the pre-Co-op preparation sessions. The pre-Co-op preparation sessions also include a discussion of diversity in the workplace. Co-op students are typically fully integrated into the plant workforce and spend a considerable amount of their work time as a part of a team. Assessments of the student's ability to function as a member of a team and appreciation for diversity are included in both the student and employer evaluations completed at the end of the Co-op period. The Faculty Coordinator and PET Program Coordinator review these evaluations and exceptional and problematic comments will be investigated. The student evaluations will be retained as one part of the student work portfolio to be evaluated by future accreditation teams.

- Assessment of Outcome #6 – "The ability to communicate effectively through oral, written, visual, and graphical methods." Both Co-op projects require that the students prepare significant written and graphical documentation of their experience. In the past, the students worked on their projects during their Co-op and then handed in a finished product for grading. The project has now been revised to require that the students submit, electronically, sections of the project during the time at their worksite. These project sections are then "graded" and the Faculty Coordinator provides written feedback, again electronically. The students then will factor this feedback into their final project. When grading the project, the Faculty Coordinator will not only grade the project for effective communication skills, but will also evaluate the student's ability to effectively use feedback on their work. The graded reports will be retained as one part of the student work portfolio to be evaluated by future accreditation teams.

- Assessment of Outcome #8 – "Understanding of professionalism, ethics, contemporary issues, and the impact of engineering and/or technical solutions within a global perspective." The requirement for professionalism and good ethical practices in any workplace are included as topics in the pre-Co-op preparation sessions. The second Co-op project also includes a specific section on the facility's compliance with environmental regulations. This includes a requirement that the student review the plant's emissions permits. Assessment of a student's understanding of professionalism and ethics are included in both the student and employer evaluations completed at the end of the Co-op period. The Faculty Coordinator and PET Program Coordinator review these evaluations and will investigate exceptional and problematic comments. When grading the project, the Faculty Coordinator will not only grade the project for the effectiveness of the technical description of the environmental systems, but will also evaluate the student's understanding of the plant's impact on the environment. The graded reports and student evaluations will be retained as one part of the student work portfolio to be evaluated by future accreditation teams.

At the end of each Co-op session, the Faculty Coordinator will prepare a "lessons learned" report for the PET Program Coordinator that will be factored into the overall assessment of the program. This report will document the findings of the assessments conducted during the Co-op courses.

Conclusion

A revised PET Co-op project has been implemented to support outcomes assessment in accordance with the ABET TC2K criteria. The project will be used to evaluate several PET program outcomes, including communications skills, analytical ability, and student teamwork performance. The project will be used for the first time in the summer of 2005 and initial assessment will take place in the fall. The result of these assessments will be factored into the PET program's continuous improvement program.

Bibliographic Information:

1. "Undergraduate Catalog." Castine, ME. Maine Maritime Academy, 2004
2. "Criteria For Accrediting Engineering Programs" (Pamphlet). Baltimore, MD: Accreditation Board for Engineering and Technology, 2004.

Biographical Information

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