

DEVELOPING AN ASSESSMENT PLAN TO MEET ABET EC2000

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ABSTRACT

In 1995 the Department of Chemical Engineering at Michigan Technological University began developing an assessment plan prior to accreditation by the North Central Association (NCA) in January 1997. This assessment plan was modified and adapted to the requirements of ABET EC2000 in preparation for an ABET visit in September 1998. The assessment plans were developed by four-person committees with on-going input from the other chemical engineering faculty. The NCA assessment plan was developed by the department's Curriculum Committee. The ABET assessment plan was developed by an ad hoc ABET/Assessment Committee. Two of the faculty on this committee had worked on the NCA assessment plan developed by the Curriculum Committee.

The department's assessment plan consists of four major goals that can be related to the ABET EC2000 outcomes (a) through (k) and to the AIChE Program Criteria: (1) Students should master chemical engineering fundamentals necessary to function as a professional in an appropriate-level engineering position [ABET Outcomes (a), (c), and (e); all the AIChE Program Criteria]; (2) Students should master, or have the ability to acquire, the following skills necessary to tackle new problems and/or technologies: critical thinking, resourcefulness, problem-solving and research skills [ABET Outcomes (b), (c), (e), (i), and (k)]; (3) Students should be able to communicate effectively their technical/professional material in written, oral, visual, and graphical forms [ABET Outcomes (d) and (g)]; and (4) Students should be aware of the impacts on and responsibilities to society of chemical engineering [ABET Outcomes (f), (h), and (j); AIChE Program Criteria: "...including safety and environmental aspects..."].

Assessment tools were developed to measure the success in attaining the above goals: (1) department designed skills test to be given in a senior-level course, (2) plant design reports and AIChE senior design project, (3) exit survey and interview of graduating seniors, (4) survey of alumni two and five years out, (5) portfolio of written material in capstone and communication courses, (6) portfolio of oral presentations in capstone and communication courses, (7) participation in the "PAWS" Safety Program, and (8) performance on the Fundamentals of Engineering Exam.

Parts of the assessment plan have already been implemented. The first cycle of implementation of the entire assessment plan will be completed in the summer of 1999.

INTRODUCTION

Outcomes assessment has become a required part of the accreditation of higher education. The North Central Association (NCA), the accreditation agency which accredits Michigan Technological University (MTU), requires an outcomes assessment program. The Engineering Criteria 2000 (EC2000) now used by the Accreditation Board for Engineering and Technology (ABET) requires an outcomes assessment in the accreditation of engineering programs.

The MTU Department of Chemical Engineering has been working on the development and implementation of an assessment plan since 1995. The process began in preparation for accreditation by NCA in January 1997 and continued with preparation for accreditation under EC2000 by ABET in September 1998.

The NCA accreditation only required the establishment of broad learning goals and assessment tools that would be used to measure the achievement of these goals. ABET EC2000 set specific goals, (a) through (k), that apply to all engineering programs and other criteria that apply to individual programs. In the case of chemical engineering, the criteria were established by the American Institute of Chemical Engineers (AIChE).

NCA ASSESSMENT PLAN

In 1995 MTU established a University Assessment Council to help each unit of the university develop assessment plans for the NCA accreditation visit in January 1997. Assessment was new to most of the people on the University Assessment Council. Two of the authors served on this council. At the same time that MTU's assessment activities were beginning, the Department of Chemical Engineering was in the process of developing a departmental charter. The charter placed responsibility for assessment in the department's Curriculum Committee, which consisted of four faculty members.

The Curriculum Committee asked all chemical engineering faculty for input on the educational goals of the chemical engineering program. The suggestions from the faculty were incorporated into four broad goals. The goals were modified through discussion with the faculty and were approved by the faculty near the end of academic year 1995-1996. The final version of these goals is:

1. Students should master chemical engineering fundamentals necessary to function as a professional in an appropriate-level engineering position.
2. Students should master, or have the ability to acquire, the following skills necessary to tackle new problems and/or technologies: critical thinking, resourcefulness, problem-solving and research skills.
3. Students should be able to communicate effectively their technical/professional material in written, oral, visual, and graphical forms.
4. Students should be aware of the impacts on and responsibilities to society of chemical engineering.

At the same time that the goals were being established, the Curriculum Committee began to determine what assessment tools would be used to measure the achievement of these goals.

Much useful information was provided by the University Assessment Council. At the beginning it was hoped that there were some commercially available “magical” tools that could be used. It became apparent very quickly that no such tools existed. The Curriculum Committee eventually came up with several assessment tools that would be used for measuring the attainment of each of the four goals. Some of these tools were abandoned because they were impractical or would be too difficult to implement under the time constraints. The final version of the assessment tools will be presented later.

The chemical engineering assessment plan for the NCA accreditation received a very favorable review by the MTU University Assessment Council in the fall of 1996. Michigan Tech received a ten-year accreditation by NCA.

ABET EC2000 ASSESSMENT PLAN

After the NCA accreditation was completed, the department had to begin preparing for the ABET accreditation visit in September 1998. The responsibility for developing the ABET EC2000 assessment plan for the Department of Chemical Engineering was assigned to an *ad hoc* ABET/Assessment Committee, which consisted of four faculty members. Two of the faculty had served on the University Assessment Council and on the department’s Curriculum Committee during the development of the NCA assessment plan. This made it much easier to adapt the NCA plan to the ABET requirements.

There is a major difference between the type of assessment required by NCA and that required by ABET EC2000. NCA allows each unit to establish its own goals. As mentioned earlier, ABET EC2000 (ABET, 1997) sets down specific goals, (a) through (k), for all engineering programs and the AIChE sets criteria for chemical engineering programs (AIChE, 1996), numbered (A-1) through (A-9) by the committee:

- (a) “an ability to apply knowledge of mathematics, science, and engineering
 - (b) an ability to design and conduct experiments, as well as to analyze and interpret data
 - (c) an ability to design a system, component, or process to meet desired needs
 - (d) an ability to function on multi-disciplinary teams
 - (e) an ability to identify, formulate, and solve engineering problems
 - (f) an understanding of professional and ethical responsibility
 - (g) an ability to communicate effectively
 - (h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
 - (i) a recognition of the need for, and an ability to engage in, life-long learning
 - (j) a knowledge of contemporary issues
 - (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice”
- (A-1) “a thorough grounding in chemistry and a working knowledge in the following areas: advanced chemistry such as organic, inorganic, physical, materials chemistry, or biochemistry, selected as appropriate to the goals of the program”

- “working knowledge, including safety and environmental aspects, of:
- (A-2) material and energy balances applied to chemical processes
 - (A-3) thermodynamics of physical and chemical equilibria
 - (A-4) heat, mass, and momentum transfer
 - (A-5) chemical reaction engineering
 - (A-6) continuous and stage-wise separation operations
 - (A-7) process dynamics and control
 - (A-8) process design
 - (A-9) modern experimental and computing techniques.”

The first step was to relate the four broad goals developed for the NCA to the ABET goals, (a) through (k), and AIChE criteria (A-1) through (A-9):

- Goal #1 Students should master chemical engineering fundamentals necessary to function as a professional in an appropriate-level engineering position.
ABET goals addressed: a, c, e
Program criteria addressed: A-1 through A-9 (all)
- Goal #2 Students should master, or have the ability to acquire, the following skills necessary to tackle new problems and/or technologies: critical thinking, resourcefulness, problem-solving and research skills.
ABET goals addressed: b, c, e, i, k
Program criteria addressed: none
- Goal #3 Students should be able to communicate effectively their technical/professional material in written, oral, visual, and graphical forms.
ABET goals addressed: d, g
Program criteria addressed: none
- Goal #4 Students should be aware of the impacts on and responsibilities to society of chemical engineering.
ABET goals addressed: f, h, j
Program criteria addressed: “...including safety and environmental aspects...”

The committee also had the faculty identify the extent to which these goals were being addressed in their courses. This could provide instant feedback on the achievement of the goals in individual courses.

Throughout the development of the assessment plans, assessment tools and the desired achievement level were being established for measuring the achievement of these goals. Several faculty meetings and a faculty retreat were devoted to this task. Eight assessment tools were finally established:

- Tool #1 Department-designed skills test to be given to the seniors in the Spring Quarter. The grade will be included in the course grade in the Unit Operations Laboratory. The test will measure fundamental knowledge, design skills, and problem solving skills.
ABET goals addressed: a, c, e
Program criteria addressed: A-2 through A-8
Desired Achievement Level: 95% pass rate (>80 out of 100 score)
- Tool #2 Plant design reports and AIChE senior design project. Faculty not involved in teaching plant design will review these for fundamental knowledge, innovation, research, and problem-solving skills
ABET goals addressed: a, c, e, k
Program criteria addressed: A-1 through A-6, A-8, A-9
Desired Achievement Level: 95% pass rate (>70 out of 100 score)
- Tool #3 Exit survey and exit interview of graduating seniors. The department chair will administer these in the Spring Quarter to ascertain fundamental knowledge, critical-thinking skills, and overall educational experience
ABET goals addressed: a, c, e, g, k
Program criteria addressed: A-1 through A-9
Desired Achievement Level: 3.0 on a scale of 1 to 4 on rated questions
- Tool #4 Survey of alumni two and five years out. These will be conducted by the College of Engineering and by the department. The Assessment Committee will evaluate the results for fundamental knowledge, communication skills, professional ethics, contemporary/global issues, and environmental/safety issues.
ABET goals addressed: a-k
Program criteria addressed: A-1 through A-9
Desired Achievement Level: 3.0 on a scale of 1 to 4 on rated questions
- Tool #5 Portfolio of written materials in capstone and communication courses. Faculty and an industrial group will evaluate for communication and teamwork skills.
ABET goals addressed: g
Program criteria addressed: none
Desired Achievement Level: 85% pass rate (>80 out of 100 score)
- Tool #6 Portfolio of oral presentations in capstone and communication courses. Faculty and an industrial group will evaluate for communication and teamwork skills.
ABET goals addressed: g
Program criteria addressed: none
Desired Achievement Level: 95% pass rate (>80 out of 100 score)

Tool #7 Student participation in the “PAWS” Safety Program in the Unit Operations Laboratory (Pintar, 1998 and Pintar, King, and Crawl, 1998). A faculty committee will evaluate the level of participation to assess professional responsibility and safety awareness.

ABET goals addressed: f

Program criteria addressed: “...including safety and environmental aspects...”

Desired Achievement Level: Continued improvement; > 70% of PAWS forms to be generated by students not in the Safety

Committee

Tool #8 Fundamentals of Engineering Exam. A faculty member who is a Professional Engineer will assess the performance for fundamental knowledge, design skills, and problem solving skills.

ABET goals addressed: a, c, e

Program criteria addressed: A-2 through A-8

Desired Achievement Level: 90% pass rate

Most of these tools have already been implemented. The department skills test will be given for the first time in the spring of 1999. The exit survey and exit interview will be implemented by the department chair in the spring of 1999.

USE OF ASSESSMENT IN CURRICULUM REVIEW

One aspect of assessment is the use of the results to make curriculum changes. Several changes have been made already. Evaluation of the plant design reports and the AIChE design project led to several changes in the plant design course. In particular, the AIChE project must be done individually rather than in groups. Weaknesses in communication skills and in thermodynamics were also identified. As a result, the junior communication courses and thermodynamics course were made prerequisites for plant design and for the unit operations laboratory. There also appears to be a need for more fluid dynamics in the curriculum.

Michigan Tech is switching from quarters to semesters in the fall of 2000. The assessment results are being used to plan the semester curriculum. For example, there very likely will be more thermodynamics and fluid dynamics in the new curriculum. The current chemical process safety course will probably be broadened to also include environmental concerns in order to meet the AIChE Program Criteria.

REVIEW OF THE ASSESSMENT PLAN

Assessment involves two feedback loops. The first feedback loop is associated with the use of assessment results to make curriculum changes as just described. The second is the review of the assessment plan itself. During the development of the assessment plan, the committee received input from the faculty throughout the process and held annual faculty meetings to review the plan. As mentioned earlier, a faculty retreat was used to finalize the assessment tools to be used. Now, annual faculty retreats will be held to review the assessment program and the assessment results.

INPUT FROM CONSTITUENTS

Because of time constraints, the current assessment plan was developed primarily by the faculty. However, input was obtained from the department's Industrial Advisory Board at each of its annual meetings. The department is now getting more input from all of its constituents. The Industrial Advisory Board and the department's Industrial Safety Advisory Board provide input on the assessment program, on the assessment results, and on curriculum changes. A Student Advisory Board has been formed to provide student feedback on the assessment plan and on the curriculum. Finally, the department's alumni provide feedback by participating in the alumni survey. A monthly department electronic newsletter provides a mechanism for additional alumni input into the assessment program and into the curriculum review. Input from these key constituent groups is already being used to plan the semester curriculum. As the new curriculum evolves, input from these constituents will be even more important.

CONCLUSIONS AND RECOMMENDATIONS

Development of an assessment plan to meet ABET EC2000 is a very time consuming process. It is very important to get as many faculty members involved as soon as possible so that all of the faculty will buy into implementation of the assessment plan.

Input from constituents other than the faculty is very important in developing and in reviewing the assessment plan and the curriculum. Industry, students, and alumni should be consulted throughout the process.

ABET EC2000 and the assessment results are being used in the development of the new semester curriculum being developed at Michigan Tech. It is expected that the assessment plan will evolve as the conversion to semesters proceeds and as more experience with implementation of the assessment plan is acquired.

The amount of faculty time required to implement the assessment tools is yet to be determined. Hopefully, the reward will be a more effective curriculum that is ever changing to meet the ABET EC2000 goals and to meet the needs of the constituents, particularly the students.

REFERENCES

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BIOGRAPHICAL INFORMATION

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Lecturer, Engineering Communication, Chemical Engineering Department, Michigan Technological University; MS (Rhetoric and Technical Communication), Michigan Technological University, 1988. Teaches technical writing and oral presentation courses to ChE undergraduates. Member of the MTU Assessment Council since 1995; member of ChE Curriculum Committee (1995-97, 1998-99); chair of ChE Ad Hoc ABET/Assessment Committee (1997-98). Working on PhD dissertation examining technical communication needs and practices in engineering communities, particularly in chemical engineering.

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