Case Study of ABET Assessment Plan and Results

Abu S.M. Masud (abu.masud@wichita.edu)
Don E. Malzahn (don.malzahn@wichita.edu)
Industrial and Manufacturing Engineering
Wichita State University, Wichita, KS 67260-0035

ABSTRACT

The Department of Industrial and Manufacturing Engineering at Wichita State University has put in place a plan for assessment with respect to criteria 2 and 3 of EAC/ABET. This paper will explain our assessment plan, data collection tools used, and share some results and experience.

INTRODUCTION

The Department of Industrial and Manufacturing Engineering is one of four degree-granting departments in the College of Engineering at Wichita State University. Its Bachelor of Science degree programs in industrial engineering and in manufacturing engineering are accredited by EAC/ABET. While the program educational objectives of the two programs differ, the program outcomes are identical. Also, the assessment process and data collection tools used are identical. In the rest of this paper, we will summarize the assessment process, explain data collection tools, and highlight major results.

THE ASSESSMENT PROCESS TIMELINE

A schedule for assessing both program educational objective and program outcomes evolved over time. The current schedule has been developed to ensure the participation of the relevant stakeholders:

- Department administration through the chair
- Department faculty through the Curriculum and Assessment Committee (CAC)
  - This is chaired by the undergraduate coordinator and includes two other faculty members and the department chair.
- Employers through the Industrial Advisory Committee (IAC)
  - This is a 15 member committee consisting of representatives from local industry. The vast majority of undergraduates are employed locally.
  - The IAC meets twice a year.
- Students through the IMfgE Student Council (ISC)
  - This council consists of the presidents of the student professional chapters (IIE, ASQ, APICS, and SME). If the president is a graduate student, then an undergraduate is selected as a representative.
  - The ISC meets on an as needed basis and is called by the department chair.
  - The ISC also has the responsibility for approving student fee expenditures.

Revisions to the initial schedule were made to ensure that assessment data was available for the appropriate group, assessments were appropriately sequenced, and that workload was distributed throughout the year.

The current assessment schedule is:

- Each Fall,
  - October
    - **Department chair** prepares a report summarizing Alumni Survey (of previous fall/spring), the Senior Exit Survey (of previous fall/spring), and the Industrial Advisory Council (IAC) meeting actions (of previous spring).
    - A copy of the report is sent to the IAC for its review and input.
  - November
    - **Curriculum and Assessment Committee (CAC)**
      - ◊ Reviews chair's report.
      - ◊ Reviews prerequisite exam reports from instructors of current semester.
      - ◊ Prepares recommendations for revision, feedback to course coordinators, and update of curricular material.
  - December
    - **Department Faculty**
      - ◊ Reviews CAC's recommendations.
      - ◊ Discusses and approves curricular changes based on the recommendations of CAC
      - ◊ Implements changes adopted..
- Each Spring,
  - March
    - **CAC**
      - ◊ Reviews pre-requisite exam reports from instructors (of previous fall).
      - ◊ Prepares recommendations for revision, feedback to course coordinators, and update of curricular material.
  - April
    - **Department Faculty**
      - ◊ Reviews CAC recommendations.
      - ◊ Approves revision/update of program objectives and objective target levels.
      - ◊ Implements changes adopted.
    - **Department faculty** discusses and approves curricular changes based on the recommendations of CAC.
    - **IAC** meets to discuss, among other issues, program objectives (evaluation/ review), curriculum/laboratory update, and any program-related issue that may arise.
- Odd Years, College of Engineering administers the Alumni Survey, the results of which are distributed to departments.

PROGRAM EDUCATIONAL OBJECTIVES AND ASSESSMENT

Based on ABET statement [1], our working definition of the program educational objectives (PEOs) is that these are statements that describe the expected accomplishments of graduates in the first few years *after* graduation. Program objectives can be of two types: (a) what *all* graduates will do, and (b) what *some* graduates will do. Program objectives are written to be used as descriptors of the program and are such that upon reading them, prospective students and employers will have a clear idea of the program.

Each of our two programs, industrial engineering (IE) and manufacturing engineering (MfgE), have three PEOs, of which the last two are identical. Following are the PEOs:

> The objectives of the IE/MfgE Programs are to prepare their graduates to do the following:
>
> - Be employed in jobs related to design, implementation, and improvement of systems in manufacturing and service sectors (for IE) or be employed in jobs related to design, planning and control, implementation, and improvement of manufacturing processes and systems (for MfgE).
> - Pursue graduate studies.
> - Enjoy professional success because of the program's emphasis on solving real-world problems in industries and organizations in the Wichita metropolitan area.

The current process for determining and evaluating program objectives is shown in Figure 1. This evaluation process (steps 2 through 4) is formally repeated on a schedule as described in the previous section:

- The Industrial Advisory Council (IAC) meets each fall and spring. At each meeting, ABET assessment/evaluation reports are presented. At the spring meeting, IAC formally approves any change in the Program Educational Objectives or reaffirms to continue with the current PEOs.
- Each alternate year, Alumni Survey forms are mailed by the college to the graduates of the most recent two years. In the year of the ABET visit, these forms are sent to graduates of the recent five years.
- Every three years, prior to the spring meeting of the IAC, a short self-study is prepared and sent to all IAC members. This report is then discussed at the spring meeting.
- Every three years, the Employer Survey form is mailed to selected supervisors in local companies who supervise IE/MfgE graduates.
- As and when needed, the department chair convenes a meeting of the IMfgE Student Council (ISC) to discuss and get student input.

The primary assessment tools for PEOs are the Alumni Survey, Employer Survey, and IAC meetings. The Alumni and Employer surveys are quantitative while the IAC assessment is qualitative. Table 1 shows how these tools are used in assessment.

The direct method for evaluating whether the objectives of the program are being achieved is to obtain the employment history of program alumni to find out the extent to

which the program prepared them to be successful in their chosen careers. This information has been obtained indirectly, through the Alumni Survey, carried out by the

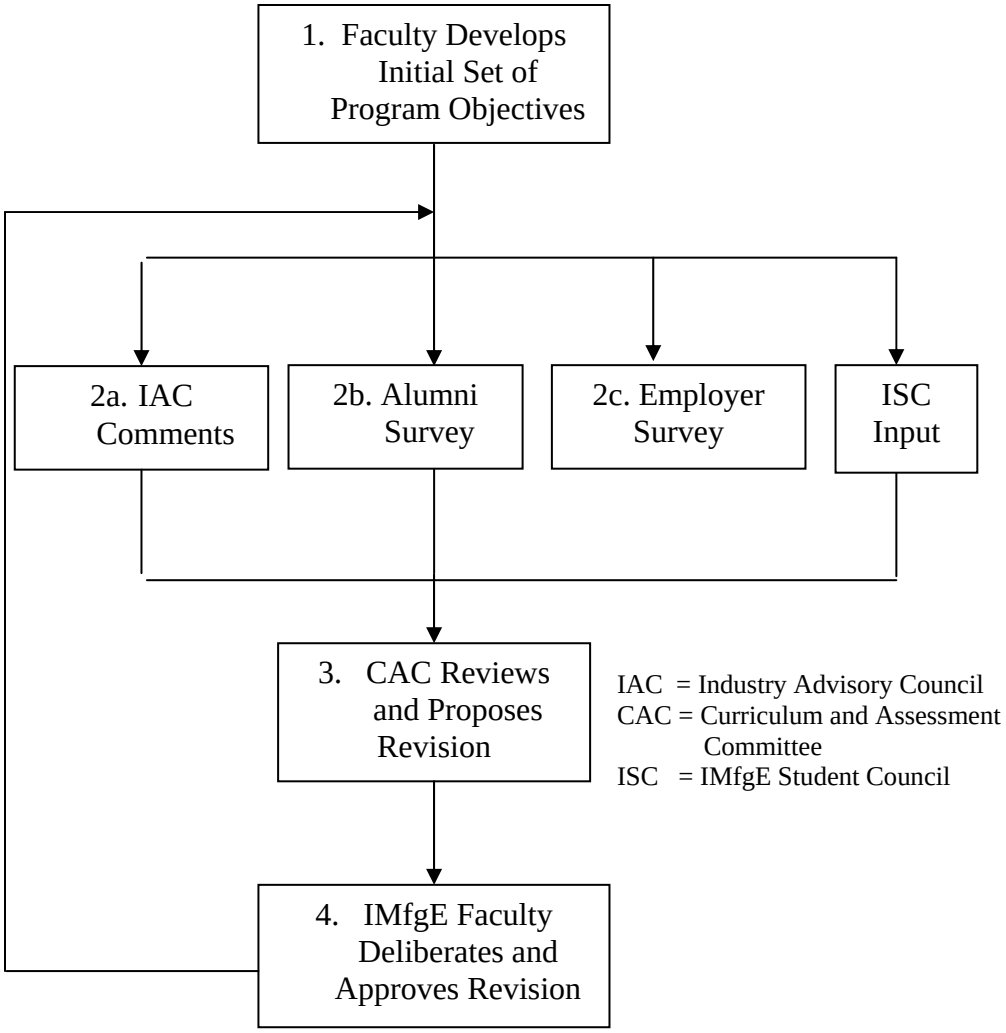

Figure 1. Program Objectives Development and Evaluation Process.

Table 1. Mapping Tools Used in Assessing Achievements in Program Objectives

Objective → **Tool ↓**	**Graduates will be Employed in Specified Job Areas**	**Graduates will Enter Graduate Programs**	**Graduates will be Successful**
Alumni Survey	✓	✓	✓
Employer Survey	✓	✓	✓
IAC Meetings	✓		✓

college every other year, and the Employer Survey, on a continuing basis. Since the response rate of the alumni has been rather low for IMfgE graduates, the department has decided to employ an online survey service using the same form as the mailed survey.

This has yielded a reasonable number of responses (26 usable responses). The Employer Survey is a new instrument, employed since the last ABET visit in 2001 and designed to measure accomplishments in meeting program objectives. We have had 14 responses evaluating 33 graduates of the IE and MfgE programs.

Alumni Survey

The Alumni Survey has both quantitative and qualitative assessments of Program Educational Objectives.

- Objective 1: Program graduates will be employed in specified job areas.
  - This is measured by the percentage of recent alums employed in companies that traditionally have job categories in the specified areas (e.g., companies involved in manufacturing and consulting in manufacturing). In addition, the form was changed in spring 2007 to ask alums to assess their preparation for performing these tasks.
- Objective 2: Program graduates will pursue graduate studies.
  - This is measured by looking at the percentage of alums that have completed or are in graduate programs. In addition, the form was changed in spring 2007 to ask alums to assess their preparation for graduate study.
- Objective 3: Program graduates will be successful.
  - This is measured by the percentage of alums that are currently employed and/or are in graduate programs. In addition, the form was changed in spring 2007 to ask alums to assess the impact of their working on real-world problems to their professional success.

Employer Survey

The Employer Survey has both quantitative and qualitative assessments of the Program Educational Objectives.

- Objective 1: Program graduates will be employed in specified job areas.
  - This is measured by percentage of WSU graduates, supervised directly by the supervisor, that are predominantly employed in jobs related to their preparation.
- Objective 2: Program graduates will pursue graduate studies.
  - This is measured by l the percentage of WSU graduates, supervised directly by the supervisor, that have pursued or are pursuing graduate studies (degree bound or just taking courses). Another measure of a related item (that of continuing education) is the percentages of WSU graduates, directly supervised by the supervisor, who have participated in professional development activities (such as attending workshops, seminars, short courses, conferences, etc.).
- Objective 3: Program graduates will be successful.
  - This is measured by the percentage of WSU graduates, directly supervised by the supervisor, who are considered to be above average compared to all engineering graduates supervised by the supervisor.

IAC Meetings

The Industrial Advisory Committee provides qualitative assessment of Program Educational Objectives through their discussions of summary data presented to them.

- Objective 1: Program graduates will be employed in specified job areas.
    - This is reflected in comments made by IAC members based on graduates employed in their own organizations.
- Objective 2: Program graduates will pursue graduate studies.
    - Again, this is reflected in IAC member comments regarding graduate studies pursued by their engineers who are IMfgE graduates.
- Objective 3: Program graduates will be successful.
    - This is reflected in IAC member comments.

The following is a brief summary of some of the major changes to the PEO assessment process that resulted from the analysis of results by the CAC and IAC.

- Alumni Survey: Data indicated that all PEOs were being achieved at a relatively high level; no change in the PEOs was indicated. The survey forms were modified (spring 2007) to better measure the PEOs and made available online by faculty decision.
- Employer Survey: Analysis of the survey data indicated that PEOs wereachieved; no change in PEOs indicated. The Employer Survey tool was added based on the suggestion of the IAC.
- Industry Advisory Council Meetings: The IAC did not recommend any change. The council reaffirmed in April 2004 and April 2006 meetings that the current PEOs were appropriate; no change was indicated. In the April 2007 meeting, the IAC approved some changes in the wording of the PEOs. Some curricular changes (such as using CATIA in IME 222) and several new courses were introduced based on recommendation of the IAC.

PROGRAM OUTCOMES AND ASSESSMENT

To ensure the achievement of program objectives, certain outcomes are observed as attributes of program graduates. The desired outcomes were initially developed by the faculty with follow-up input from the IAC and ISC. These outcomes have since been replaced by a new set that essentially replicates Outcomes (a) through (k) of Criterion 3 of ABET. This change brings the program's outcomes in a direct one-to-one relationship with those of ABET and makes it easier to measure the accomplishments of the two without duplicating efforts. In developing program outcomes, the following explanation of the term has been used based on ABET statement [1]: Outcomes are statements that describe what students are expected to know and be able to do *by the time of graduation*. The program outcomes must embrace the (a) through (k) requirements of Criterion 3.

After the level of achievement of the outcomes has been assessed, any deficiencies are remedied by revision of the curriculum or course contents, development/reorganization of laboratory or other facilities, and reallocation of financial resources. The tools used for assessment and their efficacy in assessing the outcomes are discussed in the next section.

The main instrument by which the program can ensure the achievement of desired outcomes is the curriculum. Appropriate faculty, facilities, and financial resources are the accessories required to ensure effective impartation of knowledge, skills, and experience as intended in the curriculum. Inclusion of industry-based projects and plant tours in courses and industry-based capstone projects in the curriculum are the means by which the 'Metropolitan Advantage' of WSU is used to provide students with a better appreciation for real-world engineering.

Following is the list of the current B.S.I.E./B.S.Mfg.E. program outcomes selected as attributes that its graduates will attain at the time of graduation. These are the same Outcomes (a) through (k) of Criterion 3.

1. Ability to apply knowledge of mathematics, science, and engineering.
2. Ability to design and conduct experiments, as well as to analyze and interpret data.
3. Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. Ability to function on multidisciplinary teams.
5. Ability to identify, formulate, and solve engineering problems.
6. Understanding of professional and ethical responsibility.
7. Ability to communicate effectively.
8. Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
9. Recognition of the need for, and an ability to engage in, life-long learning.
10. Knowledge of contemporary issues.
11. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Figure 2 shows a flow diagram of the process for input, evaluation, and revision of program outcomes.

The following assessment tools are used for the evaluation of outcomes achievement:

1. Prerequisite exams (each semester)
2. Course portfolio (each semester)
3. Senior Exit Surveys of graduating seniors (each semester)
4. Senior project evaluation by faculty/sponsors/IAC (each semester) [2]
5. Co-op evaluation by employer and student (each semester)
6. Mock program evaluation by IAC (every three years)

Each of these tools will be discussed below. Table 2 shows the mapping of assessment tools and to specific measured outcomes.

Prerequisite Exams

- For each course offered in a semester, the instructor prepares a short quiz based on relevant prerequisite course topics. Typically this is closed book with minimal review.

Table 2. Mapping of Program Outcomes and Assessment Tools

Assessment Tool	Program Outcome										
	1. Math/Sc/Engr Knowledge	2. Design/Experiment	3. System Design	4. Teaming	5. Problem Solving	6. Professionalism/Ethics	7. Communication	8. Global/Societal Context	9. Life-Long Learning	10. Contemporary Issues	11. Engineering Practice
Prerequisite Exams	√										
Course Portfolios	√	√	√	√	√	√	√	√		√	√
Senior Exit Survey	√		√		√	√	√				
Senior Project Evaluation by Faculty, Industry Sponsors, and IAC			√	√	√	√	√	√		√	
Co-op Evaluation by Employer and Student	√	√	√	√	√	√	√	√	√	√	√
Mock Program Evaluation by IAC	√	√	√	√	√	√	√	√	√	√	√

- This quiz is offered during the first two weeks of the semester, and its grade may have some impact on the final course grade (e.g., equivalent to homework). Student performance on the quiz is analyzed by topic area to assist in evaluating student preparation for the program courses and guide the instructor in presenting review material. The instructor's evaluation of student preparation for the course is forwarded to the CAC.
- Feedback Mechanism: The CAC assesses exam results for trends and, when needed, suggests corrective actions to appropriate course instructors. This encourages faculty to emphasize material used in following courses and provides student a review of material before it is used in the course.

Course Portfolios

- Each course that is available for undergraduate credit (numbered 100 to 699) maintains a portfolio that includes the course outline used by the instructor, a video/digital record of communications skill development activities (written reports, oral presentations, poster/PowerPoint material), and samples of.

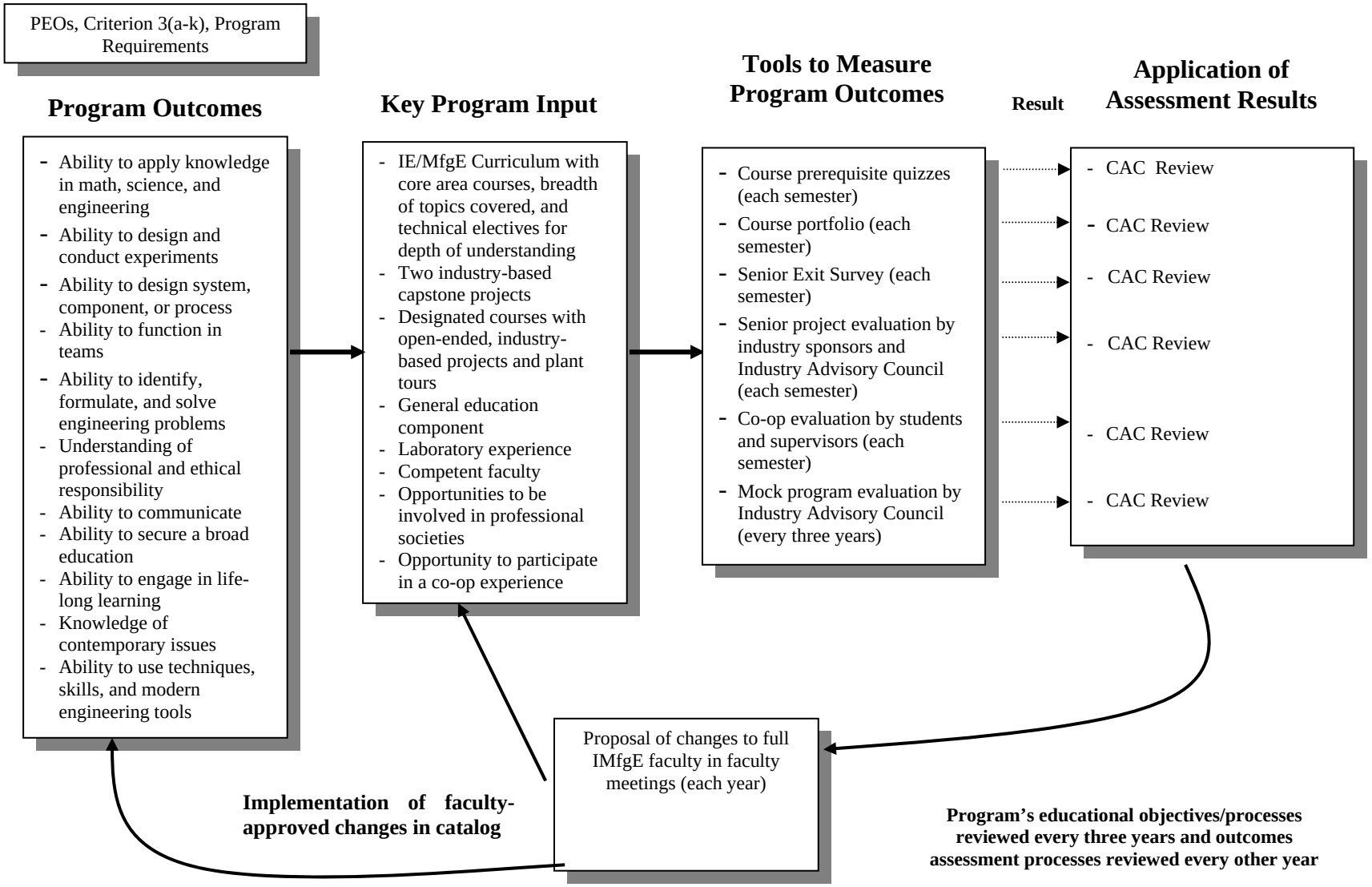

Figure 2. Process for Input, Evaluation, and Revision of Program Outcomes

tests/homework assignments.

- Each instructor also communicates to the CAC student achievement in courses identified to measure performance in specific Program Outcomes (3a) through (3k). Specific courses are assigned individual Program Outcomes for detailed assessment. These are accumulated on an annul basis for outcome assessment.
- Portfolio material is organized using a standard format for all courses.
- Feedback Mechanism: Course instructors self-evaluate their portfolio and suggest course changes to the CAC. The CAC reviews these suggestions as well as students' performance in Criterion 3 and, when needed, proposes corrective actions to faculty for approval. The integrated assessment of Program Oucomes is assessed by the CAC on an annual basis.

Senior Exit Survey

- Each semester, all graduating seniors complete the Senior Exit Survey form. This is both a quanitative and qualitative measure.
- Results are summarized by the department chair and reported to the CAC.
- Feedback Mechanism: The CAC assesses results and, when needed, proposes corrective actions to faculty for approval.

Senior Project Evaluation

- Each semester, project sponsors, faculty, students, and the instructor evaluate all capstone design projects.
  - Presentations are evaluated by faculty and sponsors using a standard seven factor rubric.
  - Written reports are evaluated by the instructor using a standard rubric.
  - Teamwork is evaluated by peers.
- At the end of each semester, the instructor summarizes evaluation results and forwards them to the CAC.
- Each of the rubrics used is mapped to Program Outcomes.
- Feedback Mechanism: The CAC assesses results and, when needed, proposes corrective actions to faculty for approval.

Co-op Evaluation

- Each semester, for students enrolled in the cooperative education program, the supervisor and the student fill out a survey form with questions linked to Outcomes (a) through (k) requirements. Again, this provide both quantitative and qualitative measures.
- A summary report is prepared by the co-op office when requested.
- Feedback Mechanism: The CAC assesses results and, when needed, proposes corrective actions to faculty for approval.

Mock Evaluation by IAC

- Every third year, IAC members evaluate a self-study report prepared by the department.
- The department chair summarizes the results.
- Feedback Mechanism: The CAC assesses results and, when needed, proposes corrective actions to faculty for approval.

Each fall, the CAC assesses results from various tools and prepares recommendations for revision/improvement. The faculty then discusses and makes a final decision concerning changes to be made. Each course coordinator, through the instructors, implements curricular changes. The chair and CAC ensure the implementation of all approved changes. Please note that the faculty has decided to use 70 percent or better as the target achievement rate. Achievements significantly below this or consistent low levels warrant corrective actions. Also keep in mind the stochastic nature of the data, which implies that occasional ups and downs are expected.

What follows is a summary of some of actions taken to improve outcome achievement, the assessment process, as well as the curriculum of instruction.

Senior Project Evaluation

- Revise the evaluation instrument to collect more appropriate data for outcomes assessment. This has been implemented.
- Standardized detailed rubrics were developed for all Senior Design artifacts that facilitated mapping to Program Outcomes.
- Use qualitative comments/suggestions from industry representatives. Since almost no industry representative stays through all senior project presentations, it is impossible to obtain consistent quantitative evaluations of all presentations from them. As a result, CAC uses only the qualitative comments/suggestions offered by them and tracks the quantitative evaluations. The quantitative evaluations by faculty will be used in the assessment of outcomes. This has been implemented.

Prerequisite Exams

- Have course coordinators (in cooperation with course instructors) develop sets of prerequisite topics relevant to each course and prepare exam templates. This has been implemented.

Curriculum

- Develop learning objectives for all required courses. This was implemented spring 2005.
- Restructure the course IME 556 Information Systems based on the Alumni

Survey results for fall 2005, by reducing emphasis on theory and increasing emphasis on application. This has been implemented.

- Change IME 222 Engineering Graphics to use CATIA, based on industry feedback. This was implemented spring 2006.
- Address the CAC-identified weakness in multiple alternatives identification in senior design by having instructors place emphasis on this. This has been implemented, assessment has shown improvement, and this is a continuing activity.
- In order to increase technical elective hours, delete the natural science elective. In the IE Program, students have 12 hours of technical electives (six of which must be from the department). However, students can take a science course as a technical elective.
- Introduce two new courses: IME 576 Composite Manufacturing and IME 780C Aircraft Manufacturing Assembly. This has been implemented.

Assessment

- Align courses, learning objectives, and course assessment to Outcomes (a) through (k). This was implemented spring 2006.
- Identify specific courses for the assessment of specific outcomes. This was implemented spring 2006.
- Develop a new reporting format for prerequisite exam results. This was implemented fall 2005.
- Develop a common format for course content description for core courses. This has been implemented.

Laboratory

- Develop a new senior design studio (in 203A EB) to facilitate the work of the senior design teams. This was implemented spring 2006.
- Upgrade the Open Computing Laboratory (in 204 EB). This was implemented spring 2006.
- Upgrade the Cessna Manufacturing Processes Laboratory. This was implemented spring 2006.

In addition, faculty approved the following changes initiated by the CoE ABET Taskforce:

Alumni Survey

To collect more relevant information for program objectives/outcomes assessment, the Alumni Survey form has been revised.

General Education

To introduce students more formally to ethics and professionalism, a new general education course, Philosophy 385 Ethics and Professional Responsibilities for Engineering, has been developed. This course is now required for all engineering students (starting with those entering the college in Fall 2001) and is used to partially meet the current general educational requirement. With the addition of Philosophy 385 as a required general education course, CAC decided to remove Economics 202Q Principles of Microeconomics as a required general education course for the B.S.I.E. The reason for this change is that with too many required courses, students lose the flexibility of course/schedule choice. Since Philosophy 385 cannot be transferred from another institution, transfer students will face the loss of flexibility more acutely.

Computerized Prerequisite Check

To ensure that students meet course prerequisites/corequisites, a computerized prerequisite check during preregistration and regular registration is being developed with the help of the Office of the Registrar and University Computing and Telecommunications. This system is still not completely developed.

Registration of Graduating Seniors with Career Services

To collect quantitative data concerning the employment of graduating seniors, an initiative to register all graduating seniors with university's Office of Career Services has been started. The college will fund a reduced registration fee negotiated with the Career Services Office. Two benefits are expected: new employers will be attracted to the on-campus recruitment and improve the capability to collect data on job offers received by program graduates. This has been implemented.

CONCLUDING REMARKS

In this paper we have summarized the assessment process and described the measurement tools for both the program educational objectives and program outcomes used in the Department of Industrial and Manufacturing Engineering at Wichita State University. In addition, we have summarized the results and corrective actions taken. As envisioned by ABET, our assessment process has been evolving over time based on our better understanding of the need and use of the results. Assessment results have impacted curriculum, assessment tools used, laboratory/course development, and the process itself.

REFERENCES

1. "Criteria for Accrediting Engineering Programs," Engineering Accreditation Commission, ABET, March 18, 2007.
2. Whitman, L., and D. Malzahn, "Industry/University partnership in a capstone course," American Society of Engineering Education Midwest Section Conference, Kansas City, MO, September 14-15, 2006.