CURRICULUM OUTCOME ASSESSMENT AND IMPLEMENTATION CHALLENGES

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INTRODUCTION

The Purdue Calumet engineering curriculum leads to a Bachelor of Science in engineering degree and is particularly aimed at students who work in industry. The students specialize in Electrical Engineering, Computer Engineering, or Mechanical Engineering. For the first time, in fall 2003, the engineering department had an accreditation based on ABET (Accreditation Board for Engineering and technology) Engineering Criteria 2000. ABET 2000 requires: "a system of ongoing evaluation that demonstrates achievement of program objectives and uses the results to improve the effectiveness of the program," and "each program must have an assessment process with documented results." Evidence must be given that the results are applied to the further development and improvement of the program. In this paper, the assessment plan, modification made based on the visit and challenges of the continuous implementation of the assessment process is outlined.

As mentioned, the goal of ABET is to promote continuous quality improvement in engineering education through faculty guidance and initiative. The new system for accreditation, ABET 2000, differs from predecessor in Criteria 2 and 3 (ABET, 2006). Work presented in this paper also concentrates on Criteria 2 (program objectives) and 3 (program outcomes and continuous program improvement).

During the past few years, the engineering department worked on implementing an assessment and enhancement process for the Bachelor of Science programs based on ABET 2000 criteria. Figure 1 shows the developed assessment process for continuous improvement. The objective of the process is to provide a systematic pursuit of excellence and satisfaction of the needs of constituencies. Throughout the paper different components of the process shown in figure 1 and its implementation, will be explained.

PROGRAM EDUCATIONAL OBJECTIVES

ABET criteria 2 requires each engineering program for which an institution seeks accreditation must have a detailed educational objectives that are consistent with the mission of the institution and supported by the curriculum. Well-stated program educational objectives identifies the needs of constituencies based on document able, quantifiable input and will indicate specific program focus (ABET, 2006; Carter, et al., 2001). Each engineering program must have a system of

ongoing evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program.

Educational objectives (Houshangi, 2003) are developed by the faculty with the feedback from engineering department industrial advisory committee. As shown in figure 1, the program objective should be consistent with the department mission. The objectives describe the expected accomplishments of the graduates during the first few years after graduation.

PROGRAM OUTCOMES AND ASSESSMENT

After stating the program objectives as required in criterion 2, the program outcomes need to be stated. A well stated program outcome should encompass ABET "a-k", should be supported by curriculum, and should be linked to program educational objectives. The outcomes describe what students are expected to know and able to do by the time of graduation.

Assessment process must demonstrate the outcomes and the objectives of the program are being measured. Usually program outcomes provide general information about the program and thus are not measurable. In order to measure outcomes performance criteria are developed for each outcome. Performance criteria indicate what concrete actions the students should be able to perform in order to demonstrate the outcome.

Example of performance criteria for an outcome is shown in table 1. Performance criteria for all outcomes can be found in (Houshangi, 2003). The performance criteria facilitate the curriculum delivery strategies, and assessment procedures (Besterfield-Sacre, et al., 2000). The performance criteria should be measurable and achievable with the provided resources of the program. Next, a strategy and an assessment method for each performance criteria need to be stated. Strategy will indicate what specifically is done to provide the students with the opportunity to achieve the performance criteria. Assessment is a process that identifies, collects, and prepares data that can be used to evaluate achievement. All the above information is documented in outcome notebook (table 4).

It is suggested to use more than one assessment method for each outcome with the mixture of direct and indirect methods. Example of direct method is like written test items clearly linked to course learning objectives or observing a student communication skill during project oral presentation. Indirect assessment method may include use of surveys. There are number of assessment methods and list of different assessment techniques can be found in (Felder, et al., 2003).

Table 2 indicates the primary courses supporting the outcomes. Initially, all the courses in the curriculum contributing to outcomes were included. To streamline the process, it was decided to include one, two, or maximum three courses and these are courses that will extensively be assessed and included in the outcome notebook. Of course it is still important to indicate all the courses throughout the curriculum that contribute to a specific outcome. Table 3 shows the program outcome flowchart for outcome b for the computer program. The various numbers inside the parentheses indicate the level of contribution that the course provides to the outcome. Program outcome flowchart indicates where in the curriculum the students are given the opportunity to learn, apply, and demonstrate the outcome.

In order to document the assessment and enhancement process, outcome notebooks are kept. The contents of outcome notebooks are shown in table 4. ABET 2000 criterion 3 focuses on outcome based assessment and not courses. ABET evaluators will concentrate on insuring that the listed program outcomes are achieved and there is an enhancement process in place. Outcome notebook will provide the needed documentation for each outcome.

The course contributes to each outcome through its learning objectives. A course assessment report (table 5) is delivered by the faculty with the course grades at the end of each term. The outcome assessment table shown in table 5 was added to the report based on the feedback received from the ABET accreditation team during the fall 2003 visit. Reference to outcome assessment table, the 70% student level of achievement is used as a metric to indicate that the course successfully addressed the outcome. The outcome assessment table will indicate to the faculty, the student level of achievement for each outcome. For poorly met outcomes, actions are suggested from the faculty to improve the student level of achievement. This report is used as part of the documentation of the process for continuous improvement of the course. Copies of this report are made available to the course PIC (Professor-in-Charge), the Chair of the Engineering assessment committee, and the Department Head.

After the successful accreditation visit, the challenge of continuous assessment and enhancement existed. To facilitate the implementation, a detailed assessment activities schedule was prepared as indicated below:

- Department Assessment Evaluation Meeting
  The Department head and the assessment coordinator will schedule a departmental meeting in April of each year to discuss the result of the program assessment.

? Outcome Notebooks
Outcome Notebooks are due Feb.15 of each year by the faculty in charge of the outcome. The secretary will document each outcome notebook.

? Course Assessment Reports with Outcome Assessment Table
Due by faculty with the course grades at the end of each term. The secretary will put reminders for the faculty and document each term reports.

? Sophomore, Junior and Graduating Senior Surveys
The secretary will administer the surveys on week 13th of each term and the results will be documented.

? Focus Groups (Advisory Committee)
The secretary should document the minutes of October advisory board meeting of each year.

? Employer and Alumni Surveys
Surveys are conducted by the University in Feb.–March, 2006 with a two years cycle. Again, the secretary will document the results.

From beginning our goal was to design an assessment and enhancement process which is effective, simple, and implement able. Steps taken include limiting the number of performance criteria for each outcome, selecting primary courses addressing each outcome, making each faculty responsible for an outcome. To facilitate the implementation of the assessment plan, it was decided to include in the faculty yearly evaluation form a question concerning the completion of the course assessment reports and the outcome notebooks by the faculty. Treating assessment as a component of teaching excellence in faculty annual review helps to maintain the continuous assessment and enhancement process in place.

REFERENCES

[1] ABET Engineering Accreditation Criteria for evaluations during the 2006-2007 accreditation cycle http://www.abet.org/forms.html (pdf), accessed January 25, 2006.

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[3] Carter,M.,R.Brent, and S. Rajala (2001),"EC 2000 Criterion 2: A procedure for creating, assessing, and documenting program educational objectives", *Proceedings of 2001 ASEE Annual Conference*, American Society for Engineering Education.

[4] Felder, R., and R. Brent (2003)," Designing and Teaching Courses to Satisfy the ABET Engineering Criteria", *Journal of Engineering Education*, Vol.92, No. 1, pp. 7-18.

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Figure 1 BS Engineering Program Assessment & Enhancement Process

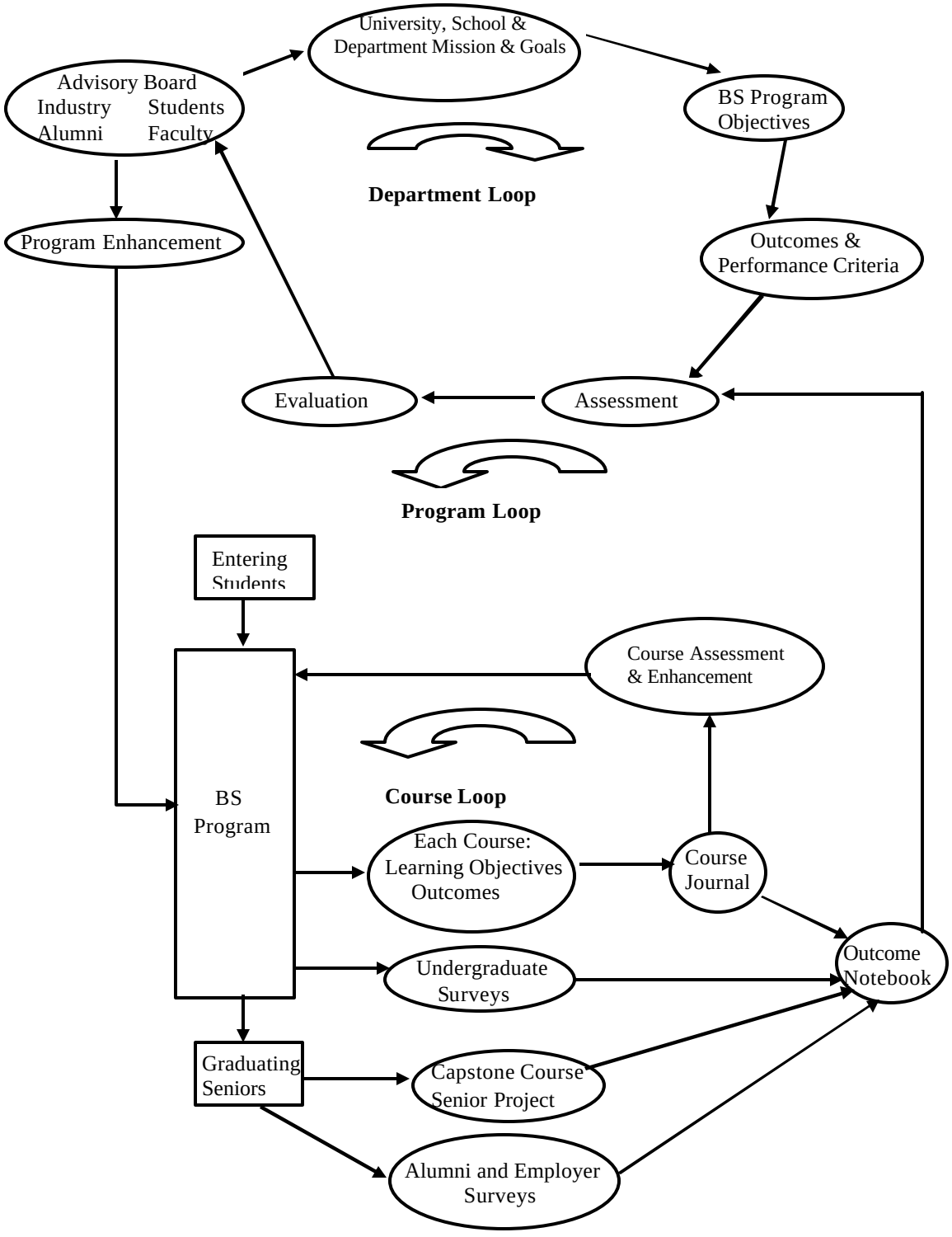

Table 1 Example of Program Outcomes and Performance Criteria

Outcome a-k: Same as ABET

Outcome l: Graduate will have the ability to apply their engineering knowledge and experience to solve industrial problems, and to enhance industrial profitability. Specifically, students will be able to

1. Work in cross-discipline teams.
2. Plan and execute projects, and prepare the necessary oral and written reports.
3. Identify engineering solutions within time and budget constraints.

Table 2 Primary Courses Supporting Outcomes

Outcome	BSCE	BSEE	BSME
a. Math & Science Engr.	**ECE** 301, 311	**ECE** 301, 311	**ME** 271, 312
b. Experiments/Data	**ECE** 370, 464	**ECE** 218, 275, 335	**ME** 345, 417
c. Design	**ECE** 370 **ENGR** 440, 460	**ECE** 370 **ENGR** 440, 460	**ME** 466 **ENGR** 440, 460
d. Multidisciplinary Teams	**ENGR** 190, 440, 460	**ENGR** 190, 440, 460	**ENGR** 190, 440, 460
e. Engr. Problem Solving	**ECE** 201, 301	**ECE** 201, 301	**ME** 275, 320, 461
f. Professional & Ethics	**ENGR** 440 **PHIL** 324	**ENGR** 440 **PHIL** 324	**ENGR** 440 **PHIL** 324
g. Effective Communication	**ENGR** 460	**ENGR** 460	**ENGR** 460 **MSE** 344
h. Global & Societal	**ENGR** 440, 460	**ENGR** 440,460	**ENGR** 440, 460
i. Life-Long Learning	**ENGR** 195A, 440, 460	**ENGR** 195A, 440, 460	**ENGR** 195A, 440, 460
j. Contemporary Issues	**ENGR** 190, 440, 460	**ENGR** 190, 440, 460	**ME** 461 **ENGR** 440, 460
k. Modern Tools	**ECE**, 160, 370, 380	**ECE** 160, 370, 380	**ME** 461, 486 **ENGR** 380
l.. Solving Industrial Problems	**ENGR** 440, 460	**ENGR** 440, 460	**ENGR** 440, 460

Table 3 Example of Program Outcome Flowchart

Level of Contribution of Courses to Outcome b.

Level of Contribution of Course to Outcome: Slight: 1, Moderate: 2, Substantial: 3

Sem						
	MA 163 (5)	**ENGR 140 (2)**	**COM 114 (3)**	**CHM 115 (4)**	**ENGR 190 (2)**	**16**
1				Level 2	Level 2	
2	**MA 164 (5)**	**ENGR 160 (2)**	**ENGL 104 (3)**	**PHYS 152 (4)**	**HUM/SS ELEC (3)**	**17**
				Level 2		
3	**MA 261 (4)**	**ENGR 233 (3)**	**ECE 201 (3)**	**ECE 207 (1)**	**PHYS 261 (4)**	**HUM/SS ELEC (3) 18**
		Level 2		Level 2		
4	**MA 264 (3)**	**ECE 370 (3)**	**ECE 202 (3)**	**ECE 218 (1)**	**MA 265 (3)**	**CS 275 (3) 16**
		Level 3		Level 3	Level 2	
5	**CS 309 (3)**	**ECE 330 (3)**	**ECE 275 (4)**	**ECE 311 (3)**	**COM/ENGL 307 (3)**	**16**
		Level 2	Level 3			
6	**ECE 301 (3)**	**ECE 371 (3)**	**COMP ELEC (3)**	**ECE 302 (3)**	**HUM/SS ELEC (3)**	**15**
		Level 2	ECE 459 Level 3			
7	**ENGR 440 (2)**	**ECE 464 (4)**	**COMP ELEC (3)**	**COMP ELEC (3)**	**PHIL 324 (3)**	**15**
	Level 1	Level 2	ECE 375 Level 3	ENGR 380 Level 2		
8	**ENGR 460 (3)**	**ECE 468 (3)**	**COMP ELEC (3)**	**TECH ELEC (3)**	**HUM/SS ELEC (3)**	**15**
	Level 1		ECE 448/476 Level 2			
						128

Table 4 Example Outcome Notebook Table of Contents

Tab 1: Outcome Assessment
- Performance Criteria for the Outcome
- Strategy
- Assessment methods
- Assessment & Enhancement Calendar Cycles

Tab 2: Courses Supporting Outcome
- Program Assessment Matrix
- Support Course Descriptions
- Course Goals & Student Learning Objectives

Tab 3: Assessment Results
- Support Course Assessment Reports
- Survey Assessment Results
  - Sophomore Students
  - Junior Students
  - Graduating Seniors
  - Focus Group
  - Alumni
  - Employer

Tab 4: Assessment Summary
- Overall Assessment Results
- Recommendations
- Actions

Table 5 Course Assessment Report

Course: _____ Submitted by: _____

Term: _____ Course PIC: _____

Please review the course assessment guidelines attached and answer the following questions. This report should be submitted to the Department of Electrical and Computer Engineering office at the same time grade reports are submitted. Attach additional pages as needed.

1. *Were all of the approved course outcomes addressed by the lectures, assignments, or other activities associated with the course? If not, why not, and what actions do you recommend to remedy this problem in future offerings of this course?*

2. Are the course outcomes appropriate? If not, explain. What should be done?

3. Are the students adequately prepared for this course and are the course prerequisites and corequisites appropriate? If not, explain.

4. Do you have any suggestions for improving this course? If so, explain.

Outcome Assessment Table

Course Number: ECE 382/ME 485 Course Name: Introduction to Control System

Evaluator: Nasser Houshangi Semester Assessed: Spring 2003

Outcome	Expected Level of Contribution (1, 2 or 3)	Performance Criteria	Course Learning Objective	Assessment Tool BE VERY SPECIFIC (eg. Problem 1 & 3 of Test 1, Quiz 2, or Experiment 5)	Student Level of Achievement (average)
a	2	Formulate analytical models using the laws of physics	Model systems in frequency domain	Problem 1 of test #1	75%
a	2	Formulate analytical models using the laws of physics	Model systems in time domain	Problem 2 of test #1	70%
a	2	Use appropriate mathematical tools to solve equations	Analyze first/second order systems	Problem 3 & 4 of test #1	97%
				Total Performance Level for Outcome a	81%
b	1	Conduct an experiment and compare experimental with predicted or expected results.	Perform five practical experiments	Completed the laboratory assignments	100%
				Total Performance Level for Outcome b	100%
c	2	Design components that meet specifications and constraints	Design control systems via root locus	Problem 4 of test #3	65%
c	2	Design components that meet specifications and constraints	Design of PID controllers	Problem 3 of test #3	56%
				Total Performance Level for Outcome c	61%
e	2	Create sketches, figures, flow-charts, and free body diagrams	Sketch root locus	Problem 2 of test #3	76%
e	2	Show understanding of the applicable theories and principles by demonstrating the use of relevant formulae and relationships	Use or Routh table to analyze stability	Problem 2 of test #2	80%
				Total Performance Level for Outcome e	78%
k	2	Use computer programs in analysis, simulation, and design of systems and components.	Use of Matlab, and Simulink	Eight Matlab and Simulink assignments	85%
				Total Performance Level for Outcome e	85%