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Department Assessment and the Design Course: A Model for Continuous Improvement*

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The development and implementation of an assessment plan requires input and active participation by faculty and staff at all levels. This paper examines how an assessment infrastructure can be established to provide leadership to an entire university, how continuous improvement can be achieved through the identification of student outcomes and measurement techniques and the role the capstone design experience can play in assessment.

INTRODUCTION

IT IS THE ROLE of the institution to provide the leadership and guidance for the establishment of an effective assessment program. Although a number of models have been developed, nearly all have the same major elements: outcomes, measures and continuous improvement. An effective model is one adapted from Nichols [1] and is shown graphically in Fig. 1. This model has been developed within the framework of several guidelines [2]. First it flows from the mission of the university. It provides feedback to the institution using outcomes and multiple measures. Finally, there is a mechanism for continuous improvement. Each of the items will be discussed separately with emphasis on department assessment and the role of the capstone course.

MISSION, OUTCOMES, MEASURES AND CONTINUOUS IMPROVEMENT

The mission of the university and the department must be complimentary. The department goals and outcomes will follow from the mission and are statements that can be measured. Initially, a department could develop its outcomes from the eleven attributes from ABET criteria 2000. An outcome could be 'Our graduates will have the ability to use modern engineering tools necessary for engineering practice'. The department must now identify how these will be measured.

Measurement methods (and the associated criteria) need to be developed to assure that outcomes have been met. Each outcome should be accompanied by multiple measures. Measures could be selected from a list that includes surveys, industrial advisory committees, portfolios, capstone projects, etc. Associated with the measure is the notion that there needs to be a criterion associated with the measure. Thus, the measure for the above listed outcome could be 'In a survey of graduates (one year after graduation) 90% will agree or strongly agree that their education at the university provided them with the ability to use techniques, skills, and modern engineering tools necessary for engineering practice'.

Once the measures are developed and results are obtained, the results must be applied to the criteria for evaluation. If the goal was not met, steps should be taken to improve the situation. Continuous improvement could take two forms. First, it could be the mechanism that is used to improve the educational process. In this case changes would be made to affect student learning. The second would be to improve the process by establishing new measures or criteria. Experience with the measurement techniques or the criteria may indicate that initial estimates were not realistic and changes need to be made.

DEPARTMENT ASSESSMENT AND THE TEAM DESIGN PROJECT

The Accreditation Board for Engineering and Technology has identified the competencies expected of graduates in the new criteria. Required competencies have also been identified by practicing engineers in a recent ASME publication [1]. These competencies include the ability to work in teams and to communicate verbally and in writing. Many of the top issues were not related to 'technical' competencies but deal with communication, ethics, collaboration, etc

In a team design project a number of 'outcomes'

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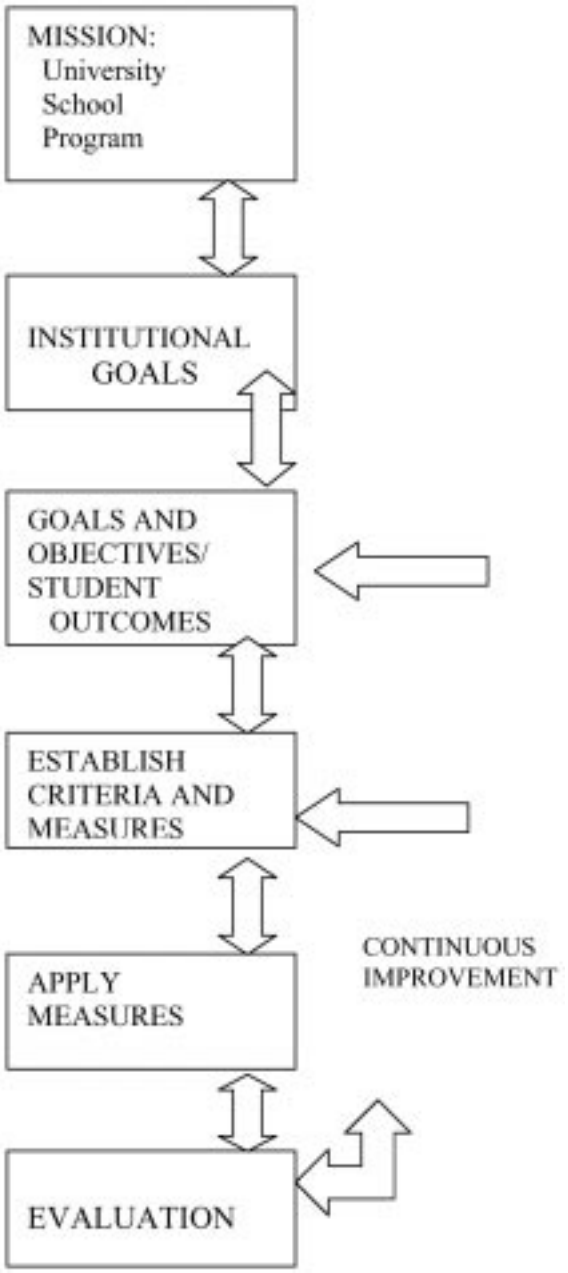

Fig. 1. Assessment of student Academic achievement.

could be achieved that reflect the criteria of ABET 2000. Outcomes that correlate to design are:

- the ability to apply knowledge of math, science and engineering;
- the ability to design a system, component or process to meet desired needs;
- the ability to function on multidisciplinary teams;
- the ability to solve engineering problems;
- an understanding of professional and ethical responsibility;
- an ability to communicate effectively;
- an ability to use modern engineering tools for the practice of engineering.

The above outcomes would need to be verified through the application of multiple measures. The measurement techniques that could be employed include surveys, portfolios, and industrial advisory committees. In many cases surveys could be used with graduates. However, surveys of industrial mentors provide significant input throughout the course. Such questions as 'Have the oral and written presentations been of the type and quality expected of the engineers in your organization?' At the conclusion of the project, reports, calculations, minutes of team meetings can be included in a 'course portfolio' which demonstrates student competencies in the above outcomes.

Tracking and follow-up

A series of forms have been developed to facilitate the planning, tracking and follow-up with the assessment process. The basis for continuous improvement is the assessment plan:

- *Mission statement of the department:* the mission of the General Engineering Department is to educate and prepare our graduates for productive professional careers.
- *Relationship with the university's mission statement:* the mission of the department compliments that of the university. By educating and preparing our graduates for productive professional careers we prepare and encourage them to serve their professional communities, contribute

Table 1. Assessment plan; general engineering department.

Student Outcomes	Measurements
1. Our graduates will have a solid foundation in engineering fundamentals.	1. At least 90% of our bachelors level students who take the F.E. exam will pass it on their first attempt. 2. At least 90% of our students who take the GRE exam in Engineering will score at or above the 75th percentile of all those taking the test. 3. At least 90% of the employers of our bachelors level graduates, co-ops, and interns, will agree with the statement 'Engineers from this university have a solid foundation in engineering fundamentals.' 4. At the time of their graduation and 5 years after their graduation, at least 90% of our bachelors level graduates will agree with the statement 'My engineering education gave me a solid foundation in engineering fundamentals.'
2. Our graduates will obtain professional employment or will have plans to attend graduate school concurrent with, or shortly after graduation.	1. At the time of graduation, at least 85% of our bachelors level graduates will have secured a commitment for professional employment or will have firm plans to attend graduate school. 2. Within 3 months of graduation, 90% of our bachelors level graduates will have secured a commitment for professional employment or will have firm plans to attend graduate school.

Dept/Prog: General Engineering

Chair/Director You R. Chair

Date: January 25, 2001

MEASUREMENT METHODS:

1. Survey of Graduating Seniors (each semester)
2. Survey of Graduates (4–8 mos. after graduation)
3. Survey of Alumni (1, 5, and 10 years after graduation)
4. Survey of Employers
5. Portfolio

OUTCOMES	MEASUREMENT METHOD	RESPONSIBILITY	SCHEDULE FOR DATA COLLECTION
OUTCOME 1			
Our graduates will have a solid foundation in engineering fundamentals.			
Measure 1			
90% of graduates who take FE exam pass on first attempt.	Grad Survey 1 & 2	J. P. Engineer, Dept. Assessment Coordinator	Term I '96, '97, '98, '99, etc.
Measure 2			
90% of graduates who take GRE exam score at or above 75%.	Grad Survey 1 & 2	J. P. Engineer, Dept. Assessment Coordinator	Term I '96, '97 etc.
Measure 3			
90% of employers surveyed indicate students have solid foundation in engineering fundamentals.	Employer Srvy 4	J. P. Engineer, Dept. Assessment Coordinator	Term III '97,'98, etc.
Measure 4			
90% of graduates felt prepared in engineering fundamentals.	Alumni Srvy 3	J. P. Engineer, Dept. Assessment Coordinator	Term III '97,'98, etc.
OUTCOME 2			
Our graduates will obtain professional employment or will have plans to attend graduate school concurrent with, or shortly after graduation.			
Measure 1			
90% of graduates are employed or plan to attend graduate school at graduation.	Grad Survey 1 & 2 Alumni Srvy 3	J. P. Engineer, Dept. Assessment Coordinator	Term I '96, '97 etc.
Measure 2			
90% of graduates have secured employment or definite plans to attend graduate school three months after graduation			Term I '96, '97 etc.

Fig. 2. Assessment program summary form.

to the culture of the community while enriching an influencing the lives of others.

- *Relationship with the School of Engineering's vision statement:* the mission of the department assists the School of Engineering to develop into a regional and national leader in both undergraduate and graduate engineering education. State-of-the-art curricula, faculty, facilities, etc. are necessary for preparing graduates for productive professional careers.

Dept/Prog: General Engineering Department

Chair/Director: You R. Chair.

Date: May 16, 1999

MEASUREMENT METHODS:

1. Survey of Graduating Seniors
2. Survey or Recent Graduates
3. Five Year Anniversary Survey
4. Survey of Employers
5. Portfolio

OUTCOMES	RESULTS
OUTCOME 1	
Our graduates will have a solid foundation in engineering fundamentals	• 95% (19 out of 20) passed on their first attempt, as determined from the report from the
Measure 1 90% of graduates who take FE exam pass on first attempt. (1 & 2)	• Not assessed at this time, will be determined from future surveys.
Measure 2 90% of graduates who take GRE exam score at or above 75%. (1 & 2)	• 24 employers (of 120 sent) responded to the survey in 1999. 100% indicated that graduates have a solid foundation in engineering fundamentals.
Measure 3 90% of employers surveyed indicate students have solid foundation in engineering fundamentals. (4)	• 95% of the 20 graduating (December 1999) senior respondents agreed that they were prepared in engineering fundamentals.
Measure 4 90% of graduates felt prepared in engineering fundamentals. (1 & 3)	• 95% of the 100 five year anniversary respondents agreed that they were prepared in engineering fundamentals.
OUTCOME 2	
Our graduates will obtain professional employment or will have plans to attend graduate school shortly after graduation.	• 75% of the 20 graduating (December 1998) senior respondents indicate they already have jobs or plan to attend graduate school.
Measure 1 85% of graduates are employed or plan to attend graduate school at graduation. (1, 2 & 3)	• 80% of the 100 five year anniversary respondents stated they had jobs or were going to

Fig. 3. Assessment activity form.

Student outcomes and measurements for the department (bachelors level)

The basic format for the planning document is shown in Table 1. The plan contains the mission, the goals, the outcomes and the measures. It is the basis to which all activities are referenced.

The summary form, shown in Fig. 2, summarizes the outcomes and measures, identifies the person responsible for implementing the outcome, the measurement methods that will be used and the frequency of making the measurement.

In Fig. 3, the activities are reported. It is here that the results are compared to the criteria. If the criteria have not been met then a description of the actions being taken is provided. This is the activity that essentially closes the loop on continuous improvement.

The design course, as identified above, can be used to achieve many of the outcomes. These include oral and written reporting, team participation, etc. Measurement methods include surveys of project sponsors (Fig. 4), evaluation forms for oral presentations and a grading format for the final written report. These address and reflect many of the ABET Criteria.

ABET CRITERIA

Frequently, many of the outcomes in the plan can be directly attributed to the ABET Criteria. In order to relate activities in the design course to the criteria some of the criteria were listed in Fig. 4. In order to complete the criteria (a through k) the following should be added:

Company: _____

Project: _____

Name: (Optional) _____

1. What was your role in this project?

2. Do you think the results of this project will be of benefit to your organization? Could you quantify the benefit? (e.g. significant, moderate, etc.)

3. Were the goals and deliverables achieved?

4. At what level did the results reflect the original goals and projected deliverables;

   Exceeded goals? Attained goals? Nearly met goals? Failed to meet goals?

5. Do you think the students and teams benefited from the interaction with your organization? If so in what way(s)?

****

Please respond to the following statements with one of the following responses:

A. Strongly Agree B. Agree C. Disagree D. Strongly Disagree E. No Opinion

1. The students on this UD team were academically prepared to work on this project. _____

2. There was good communication during the course of this project. _____

3. The oral presentations were informative. _____

4. The oral presentations were professional. _____

5. The oral presentations were at a level similar to those expected from your engineers. _____

6. The students on this team were able to apply their knowledge of math, science and engineering in the solution of problems and develop designs. _____

7. This project demonstrated that the students/team were able to design systems, components and/or processes. _____

8. The students demonstrated the ability to identify, formulate and solve engineering problems. _____

9. During the course of the project, the students demonstrated the ability to use techniques, skills and modern engineering tools. _____

If you were to run this project again what would you do differently?

Please include additional comments on the reverse side. Thank you!

Fig. 4. Industrial partner response form

- ability to design and conduct experiments—analyze and interpret data;
- understand the impact of engineering solutions in society;
- lifelong learning—recognize the need and engage in;
- a knowledge of contemporary issues.

Nearly all of the above can be incorporated into team and/or capstone design courses. Items 1 and 9 become a bit of a stretch but nearly all others can be applied directly.

REFERENCES

1. James O. Nichols, *The Departmental Guide to Implementation to Student Outcomes Assessment and Institutional Effectiveness*, Agathon Press, New York, 1991.
2. Philip E. Doepker, Continuous improvement: closing the loop on the engineering assessment process, *Best Assessment Processes in Engineering Education II*, Rose Hulman Institute of Technology, October 1998.

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