

# Preparing for Program Accreditation Review Under ABET Engineering Criteria 2000: Choosing Outcome Indicators

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## ABSTRACT

This paper examines a variety of outcome indicators that might be used by an engineering program in meeting the assessment requirements of ABET Engineering Criteria 2000. Several categories of indicator are identified and key characteristics of these means of assessment are discussed. Also noted are some of the engineering applications of outcome indicators documented on the World Wide Web. Finally, the results of a recent telephone/fax survey on the use of outcome indicators in engineering program assessment are summarized.

## I. INTRODUCTION

In Criterion 3, the Accreditation Board for Engineering and Technology (ABET) Engineering Criteria 2000 state that each accredited engineering "program must have an assessment program with documented results...The assessment process must demonstrate that outcomes important to the mission of the institution and the objectives of the program...are being measured."<sup>1</sup> Outcome indicators are the measuring instruments used in assessment, and the means by which achievement of outcomes is confirmed.

In general, assessment begins when a program faculty establishes intended program outcomes and then identifies the outcome indicators that will be used to measure these outcomes. Outcome indicators can be broadly classified as qualitative and quantitative. These indicators can be further subdivided, based on the aspect of learning that they focus on, such as attitude, behavioral change, and performance. Outcome indicators may also be partitioned into those that are locally developed, such as senior exit interviews, and

standardized cognitive examinations such as the GRE.<sup>2</sup>

The appropriate choice of outcome indicators for a particular engineering program is clearly dependent on the types of outcomes being assessed. This choice is also dependent on the financial and time resources available for program assessment. Since assessment resources are almost always limited, faculty members charged with the task of developing program assessment processes have strong motivation to adopt outcome indicators that have been successfully used by colleagues in similar programs. This paper examines several different types of outcome indicators, discusses their relative advantages and limitations, and describes some of the uses of these indicators documented in postings on the World Wide Web. This paper also reports on findings from a Fall 1997 telephone/fax survey conducted by the authors on the subject of types of outcome indicators currently used in engineering program assessment.

## II. ENGINEERING PROGRAM OUTCOME INDICATORS

Seven different types of outcome indicator are described in this section. Each of these types of indicator is defined and categorized, its advantages and limitations discussed, and its engineering assessment applications described in the material that follows.

### A. Alumni Surveys

Alumni surveys are most typically self-administered questionnaires mailed to recent graduates of a particular program. They are particularly helpful in assessing alumni responses to program objectives and in helping to collect data about graduates' employment status, confidence in their work, satisfaction with their careers, and commitment to lifelong learning.<sup>3</sup> The alumni survey can be used to document graduates' evaluations of the content of their educational programs, and how these evaluations have changed through time. The questions on this instrument may be either quantitative or qualitative depending on the type of response sought from survey participants. Unfortunately, a survey distributed by mail provides no easy controls for misunderstood questions or untruthful responses. Hence, a simple, short questionnaire is usually the best alumni survey instrument. An alumni survey is not well suited for exploration of complex issues. Alumni surveys are usually developed locally and distributed by individual programs or a campus Office of Assessment [or some similar university-level organizational unit]. Key advantages for using an alumni survey as an outcome indicator are that a mail survey is relatively inexpensive to prepare and administer, and analysis of survey responses can be completed quickly. The alumni survey is also a mechanism that program faculty can use to maintain contact with alumni.<sup>4</sup> It must be remembered, however, that mail-distributed surveys suffer

from low response rates, and that self-administered questionnaires are likely to require several iterations of pre-test refinement before the intent of the questions on the instrument are clear to potential respondents.

### *B. Capstone Design Courses*

The capstone design course is a major design experience, taken in the senior year of a baccalaureate engineering degree program. This course serves to integrate previous course work and it requires students to perform at a professional level, demonstrating technical expertise and communication skills. The capstone design course provides a unique milestone where the combined skills and conceptual attributes of the undergraduate engineering experience can be measured.<sup>5</sup> Numerous facets of the intellectual development of program graduates can be assessed by measuring technical and communication competencies.<sup>6</sup> Here also, an assessment of student confidence in their ability to solve design problems with realistic constraints can be made. Typical quantitative tools for performance assessment include project grades assigned by the course instructor, peer evaluations of team member participation and report quality, and faculty-colleague check sheet evaluations of project reports. Qualitative assessment of capstone design work can be made through reviews of student portfolios and course folders of project work. The structure of capstone design courses is almost always locally determined by the faculty of the educational program. Similarly, the assessment instruments used to measure student technical performance, and communication and teaming skills are usually locally developed.

### *C. Employer Surveys*

The employer survey is a survey administered to employers of program graduates to gain feedback from the employer's perspective concerning the performance of students after graduation. The employer survey could include qualitative and quantitative assessments depending upon the types of questions program faculty choose to ask the employers. The employer survey focuses on the attitude and performance aspects of learning. Employer survey responses can give a good indication of how well students are prepared for the workforce.<sup>7</sup> Survey responses can also help predict the likelihood that surveyed employers will hire additional program graduates. Employer responses will help the faculty to assess how well parts of the curriculum relate to surveyed industries. Moreover, employers can help to identify strengths and weaknesses in the academic unit, providing constituent inputs for the continuous improvement process required by ABET Criteria 2000. The employer survey is almost always a locally developed indicator, prepared by program faculty, perhaps with input from the campus Office of Assessment. These surveys can be administered via mail or over the phone. Possible participants in the employer survey can be obtained through the campus Career Development Office, with the program's largest employers of graduates being especially appropriate participants.

### *D. Exit Interviews*

An exit interview is a survey administered to graduating seniors in an academic program to gain feedback from the students concerning the different aspects of the academic unit and its educational program. This indicator can focus on the attitude, behavioral change, and performance aspects of learning. The exit

interview can be used to focus on the curriculum, examining both course content and subject material delivery. This indicator can also be used to assess the intellectual development, the ability to communicate, and the interpersonal, leadership, and organizational abilities of graduating students.<sup>8</sup> The occupational competency of graduates can be assessed as well. The exit interview is almost always a locally developed indicator, prepared by the director or members of the faculty of an academic program, and it typically provides a qualitative assessment. The exit interview can either be completed in person or through the mail.

### *E. Fundamentals of Engineering (FE) Examination*

The FE exam is prepared by the National Council of Examiners for Engineering and Surveying. This exam is an eight-hour test, with a morning session common to all engineering disciplines, and an afternoon session administered in six discipline areas: chemical, civil, electrical, industrial, mechanical and general engineering. The FE is a standardized cognitive exam that focuses on the performance aspect of learning, and it provides quantitative assessments. This exam can be used to assess basic engineering science knowledge acquired in an undergraduate engineering curriculum.<sup>9</sup> The FE provides a single measure of student performance. The exam can also be used to obtain longitudinal data about the pass rates of students in an engineering discipline, and to compare the performance of students in one engineering program with those in similar disciplines at other universities.<sup>10</sup> Perhaps of equal value, test scores can be used to identify opportunities to improve coverage in those subject areas where students have not done well on the exam. Problems have been reported when engineering programs have made taking the FE exam a requirement for graduation. In these cases, some students appear to take their performance on the exam with a very blasé attitude. The dilemma that a program faculty faces when considering the use of the FE exam as an outcome indicator is finding ways to have a relatively large percentage [or all] program students take the exam, yet motivating students to perform as well as they can on the test.

### *F. Nationally Standardized Tests*

Exams like the GRE and GMAT, and other nationally-administered tests are frequently used at the beginning of an educational program (placement, diagnostic, or entrance examination), after completion of the general education component of a degree program (rising junior test), and at the conclusion of a course of study (degree exam). These standardized tests are quantitative means of cognitive assessment. Nationally standardized tests can be used by an educational program to compare the performance of program students with state and national norms, and with the performance of students from other universities. Standardized tests are generally considered to have several advantages over locally developed means of assessment, in that they are relatively easier to administer, they are less open to charges of subjectivity and bias by the public, and the testing services that create the exams work to provide examination results reporting that is statistically valid and reliable.<sup>11</sup>

### *G. Industrial Advisory Boards*

The membership of an industrial advisory board for an academic unit typically includes representatives of industrial, commer-

cial, professional, and government organizations. Employers of the unit's graduates are frequently some of the advisory board's most active members. An advisory board can promote, support, and advise the faculty of an academic unit in their effort to educate students.<sup>12</sup> Inputs gathered from this type of board can be used as an outcome indicator to provide qualitative assessment of educational programs. These assessment inputs are usually focused on the attitude and performance aspects of learning. The board can review program direction and help the faculty to be aware of current and future needs of industry. An industrial advisory boards is a key source of inputs to the faculty as they conduct long-range planning for the unit. An advisory board can also be instrumental in providing jobs for program students, equipment for the academic unit, and cash donations to cover special unit needs and to support program students.

### III. TELEPHONE/FAX SURVEY ON USE OF OUTCOME INDICATORS

In order to determine how outcome indicators are currently being used in engineering program assessment, a survey was developed and sent to representatives of engineering programs at universities across the United States. Participants were selected from the roster of individuals who attended the *Best Assessment Processes in Engineering Education: A Working Symposium* conference at Rose-Hulman Institute of Technology in April 1997. Thirty-two candidate participants were randomly selected from the attendance roster. Each of these individuals was contacted by telephone and/or email to see if he or she would be willing to participate in the survey. Out of the original pool of 32 individuals, 24 people said that they would be willing to complete the survey. Survey questionnaires were faxed to these individuals. Sixteen survey instruments were sent back completed; and two of the survey instruments were returned only partially complete.

The survey listed outcome indicators, asked participants if their academic units used the indicators, and if so, to what extent and how useful are these indicators. Respondents rated the usage of indicators and the usefulness of these indicators to assessment on a scale of zero to two. Respondents were also asked to list other outcome indicators they had found useful, as well as those they no longer use (table 1). If a respondent indicated that he or she "use regularly" a particular outcome indicator, then the respondent was asked to assess the indicators' usefulness (table 2).

There was a range of responses to the survey in terms both of use and usefulness of alternative outcome indicators. Respondents used alumni surveys, capstone design courses, student surveys, and

	Somewhat Useful	Very Useful
Alumni Surveys	5	9
Capstone Design Courses	2	10
Employer Surveys	3	3
Student Survey (including exit interviews)	2	9
FE	6	4
GRE/GMAT	1	0
Other Standardized Tests	1	1

*Table 2. Assessments of the usefulness of outcome indicators*

the FE regularly. The FE was judged very useful to some, but not useful at all to others. Alumni surveys, the capstone design course, and student surveys were rated as very useful. The GRE/GMAT and other standardized tests were regarded as not useful.

Respondents indicated several other types of outcome indicators that they are using. Among these are employment surveys recording the number of job offers and the average salary of jobs taken. Several universities also use graduation rates, graduate program feedback, and a matrix of course objectives versus course assignments and exams as outcome indicators. Other indicators in use include department/committee meetings, analysis of transcripts, and input from external consultants. Some indicators that respondents have used in the past but no longer use are standardized tests that are administered in-house, and university-wide surveys of graduating seniors.

### IV. CONCLUSION

ABET Engineering Criteria 2000 require that each accredited engineering program confirm that the outcomes important to its mission are being measured. That measurement cannot be accomplished without appropriate use of outcome indicators. This paper has described several frequently used outcome indicators, and reported on their use in engineering program assessment. The report clearly demonstrates that much must be learned about how best to select and use outcome indicators. Hopefully, at some point in the near future, best-in-class indicators will be identified for each type of outcome assessment.

### REFERENCES

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2. Nichols, James O., *The Departmental Guide and Record Book for Student Outcomes Assessment and Institutional Effectiveness*, Agathon Press, New York, 1995, pp. 17-52.
3. Purdue University World Wide Web site, <http://fairway.ecn.purdue.edu/v1/asee/fie95/2c1/2c11/2c11.htm>.
4. Council of Graduate Schools World Wide Web site, <http://www.cgsnet.org/vcr/10-YRLTR.HTM>.
5. Ref. 4.
6. Virginia Polytechnic Institute and State University World Wide Web site, <http://fbox.vt.edu.10021/admin/assess/instruments.html>.

	Do Not Use	Use Rarely	Use Regularly
Alumni Surveys	0	1	14
Capstone Design Courses	0	3	12
Employer Surveys	3	4	6
Student Survey (including exit interviews)	0	3	11
FE	5	0	10
GRE/GMAT	8	5	1
Other Standardized Tests	9	4	2

*Table 1. Use of alternative outcome indicators*

7. Schmitt, Neil M., "Meeting Educational and Outcome Assessment Requirements of Criteria 2000," *Proceedings, 1996 Frontiers in Education Conference, IEEE/ASEE, 1996*, pp. 579-583.
8. Ref. 6.
9. Ref. 4.
10. University of Colorado at Boulder World Wide Web site, <http://www.colorado.edu/outcomes/ovview/table1.htm>.
11. Ref. 2, pp. 33-37.
12. California Polytechnic State University World Wide Web site, <http://www.ee.calpoly.edu/dept/iac>.