Implementing ABET 2000: An Example Work in Progress

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Abstract

The Electrical Engineering Department at Texas Tech University comes up for ABET accreditation in the fall of 1999. Over the past year, we have been working to put ABET 2000 Engineering Criteria in place. This paper describes the process, approach and current status of the program. The common problems of objectives and assessment are addressed. The objectives and assessment process that we have settled on are presented.

Introduction

The Accreditation Board for Engineering and Technology (ABET) is recognized in the United States as the sole agency responsible for accreditation of educational programs leading to degrees in engineering. To be considered for accreditation, engineering programs must prepare graduates for the practice of engineering at a professional level.

The major changes in ABET 2000 from previous ABET requirements is contained in the Basic Level Accreditation Criteria[1], specifically the first 3 criterion, which are given below

Criterion 1. Students

The quality and performance of the students and graduates is an important consideration in the evaluation of an engineering program. The institution must evaluate, advise, and monitor students to determine its success in meeting program objectives.

Criterion 2. Program Educational Objectives

Each engineering program for which an institution seeks accreditation or reaccreditation must have in place

(a) detailed published educational objectives that are consistent with the mission of the institution and these criteria
(b) a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated
(c) a curriculum and process that ensures the achievement of these objectives
(d) a system of ongoing evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program.

Criterion 3. Program Outcomes and Assessment

Engineering programs must demonstrate that their graduates have

(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.

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. The assessment process must demonstrate that the outcomes important to the mission of the institution and the objectives of the program, including those listed above, are being measured. Evidence that may be used includes, but is not limited to the following: student portfolios, including design projects; nationally-normed subject content examinations; alumni surveys that document professional accomplishments and career development activities; employer surveys; and placement data of graduates.

Of considerable concern is the assessment process. This is a measurement of the "outcomes" of the program to assure the objectives of the program are being met. Of equal concern, however, is the application of the assessment to the "further development and improvement of the program." The idea is to practice continued quality improvement in the educational program.

The Process

The College of Engineering at Texas Tech University comes up for ABET accreditation in the fall of 1999. The College has decided to go under the ABET 2000 guidelines. In the fall of 1998, the Electrical Engineering Department at Texas Tech began preparing for the ABET visit.

The Department already had a mission statement stating basic objectives. There was a departmental Undergraduate Curriculum Committee that performed an overseer role on the program with a number of subcommittees to oversee specific areas of the curriculum. All of the faculty were involved in at least one subcommittee. All classes had a basic student evaluation form at the end of each semester. The Department Chairman had an exit interview with all graduating seniors for program evaluation. In addition, the University did periodic surveys of ex-students that provide information on the applicability of the program. Although all of this was helpful in assuring the quality of the program in the past, it is not at the level required by ABET 2000.

To address the ABET 2000 issue, a subset of the Curriculum Committee was established to begin the task of preparing for ABET 2000. The subcommittee began by re-evaluating the mission statement and the program objectives.

One problem that has come up many times, with us, is the wording of "objectives" and "outcomes". Measurable objectives are usually written in terms of the outcome to be achieved by the objective. Thus, the objectives and the outcomes have a one-to-one correspondence. For ABET 2000, it would seem that Criterion 3 could be written to effectively satisfy Criterion 2. While objectives of providing the outcomes in Criterion 3 are certainly worthwhile, they are the same for all engineering programs and do not indicate the reasons for taking specific subject matter courses. One of the major differences between the same engineering programs at different universities is in the curriculum. The curriculum is also of great concern to the faculty, students and potential employers. It would seem that the reason for specific courses should be apparent from a statement of the mission and the program objectives. With this in mind and working with the faculty, the Industrial Advisory Board and with the IEEE Student Branch, a new mission statement and program objectives were developed.

Undergraduate Program Educational Objectives

The mission of Texas Tech University and Texas Tech University Health Sciences Center is to provide the highest standard of excellence in higher education, while pursuing continuous quality improvement, stimulating the greatest degree of meaningful research and supporting faculty and staff in satisfying those whom we serve. The department supports the mission of the University through its undergraduate programs by providing students with appropriate curricula, and educational experiences. The curricula remain current through continuing assessment by employers, alumni, faculty and students. The current electrical engineering curriculum includes circuits and systems, electronics, electromagnetics, communications, digital systems, microcontrollers, programming, control systems, a number of electrical engineering specialty areas and a number of technical and nontechnical support courses. Students obtain a broad education necessary to understand the impact of electrical engineering solutions in a global, societal, and environmental context. To accomplish the mission, the electrical engineering faculty, with advice from students, alumni and employers, endorse the following objectives:

Students will obtain an ability to analyze and solve electrical engineering problems by applying fundamental knowledge of mathematics, science, and engineering. Modern engineering techniques, skills, and tools will be used, particularly recognizing the role that computers play in engineering.

Students will obtain an ability to identify, formulate, and solve practical electrical engineering problems. This includes the planning, specification, design, implementation, and operation of systems, components, and/or processes that meet performance, cost, time, safety, and quality requirements.

A. Students will obtain an ability to design and conduct scientific and engineering experiments, and to analyze and interpret the resulting data.
B. Students will obtain an ability to function and communicate effectively, both individually and within multidisciplinary teams.
C. Students will experience professional and ethical responsibility through interaction with other students, faculty and practicing professionals.
D. Students will recognize the need for, and ability to engage in, perpetual learning by working on projects for which they have no prior experience. They will develop their ability to learn by working both individually and within multidisciplinary teams.
E. The department will offer a wide range of technical specialties, consistent with the breadth of electrical engineering, including recent developments in the field.
F. The department will promote cultural diversity within the ranks of the profession by encouraging minority and women students and faculty.

These objectives are closely tied to ABET Criterion 3 and objectives used by other Universities that have already gone through the ABET 2000 evaluation process.

The program objectives were then broken down into individual course objectives. The course objectives are written in terms of capabilities that can be measured. The relationship between the individual course objectives and the overall program objectives is also indicated. The basic structure of a sample lecture course is shown below.

EE 2304 – Fundamentals of Electrical Engineering

1998 Catalog Data: EE 2304: Fundamentals of Electrical Engineering (3:3:0). Corequisite: MATH 2350. Principles of electrical circuits and systems. DC and sinusoidal steady-state analysis. Introduction to transformers and motors.

Objectives: Upon completion of this course students should be able to analyze passive and active electric circuits and solve electric circuits in the time and frequency domain.

Topics:
Circuit concepts – 2 hours
DC circuit analysis – 10 hours
Amplifiers and op-amps – 2 hours
Capacitance, inductance and impedance – 3 hours
Differential equations and electric circuits – 2 hours
Transient response – 2 hours
Steady state response – 2 hours
AC circuit analysis – 9 hours
AC power – 3 hours
Transformers and three phase – 3 hours
Tests and reviews – 4 hours

Professional Component: This course prepares students with the basic skills of circuit analysis. This course includes engineering topics.

Relationship of course to program objectives: This course addresses program objective A.

One of the unique features of the Electrical Engineering Department at Texas Tech is the laboratory structure.[2-6] There are five 3-hour credit project laboratory courses not directly associated with any course. These courses have significantly different types of objectives.

EE 3332 – Project Laboratory II

1998 Catalog Data: EE 3332: Project Laboratory II (3:1:6). Prerequisite: EE 2331, Phase III standing in electrical engineering. Corequisite: EE 3312 and 3323. A laboratory course to accompany third year basic courses in electrical engineering.

Objectives: The objectives of this course, listed below, are in relationship to design, analysis and synthesis of electronic circuits, communication systems and digital signal processing. At the completion

of this course students should be able to:

Identify, formulate, and solve practical electrical engineering problems. This includes the planning, specification, design, implementation, and operation of systems, components, and/or processes that meet performance, cost, time, safety, and quality requirements.
Design and conduct scientific and engineering experiments, and to analyze and interpret the resulting data.
Function and communicate effectively, both individually and within multidisciplinary teams.
Interact with other students, faculty and practicing professionals on professional and ethical responsibility issues.
Recognize the need for, and ability to engage in, perpetual learning by working on projects, both individually and within multidisciplinary teams, for which they have no prior experience and developing ways to learn.

Topics:
Students, working together in teams of two or more, are required to design, construct and test, using faculty consultants, two electronic systems to meet given specifications. Each student is required to submit written and oral reports on each project. The projects assigned are in the following areas:

Design, development and test of a DSP microprocessor based system
Design, development and test of a communication system

Professional Component: This course includes engineering design.

Relationship of course to program objectives: This course addresses program objectives B, C, D, E, F, G, and H.

Once the objectives are determined, a means to determine if the objectives are being met is necessary. An evaluation form for each course has been developed with a sample shown below.

EE 2304--Fundamentals of Electrical Engineering
Faculty Course Assessment

Objective: Upon completion of this course students should be able to analyze passive and active electric circuits and solve electric circuits in the time and frequency domain.

Professional Component: This course prepares students with the basic skills of circuit analysis. This course includes engineering topics.

Relationship of course to program objectives: This course addresses program objective A.

Attach a copy of the syllabus

Semester Fall Spring Summer Year
Section Number _____

Faculty _____ TA_____

Specific Objectives:

Objectives

Identify the ways in which the students demonstrated the ability to analyze passive circuits in the time domain. Provide examples of student work and indicate the average grade or score for the class.

Identify the ways in which the students demonstrated the ability to analyze active circuits in the time domain. Provide examples of student work and indicate the average grade or score for the class.

Identify the ways in which the students demonstrated the ability to analyze passive circuits in the frequency domain. Provide examples of student work and indicate the average grade or score for the class.

Identify the ways in which the students demonstrated the ability to analyze active circuits in the frequency domain. Provide examples of student work and indicate the average grade or score for the class.

The evaluation forms are to be filed out for each class each semester by the instructor. As indicated, the forms must be accompanied by sample student work. A student evaluation is also carried out for each class. Two questions added to the standard evaluation form are:

Did the instructor present the material necessary to meet the stated objectives?

Do you feel you meet the stated objectives of the course?

All of this course material goes to the area subcommittees for verification and additional evaluation. A report on the results is forwarded to the Undergraduate Curriculum committee and the Department Chair.

The graduating senior exit interviews have been restructured and formalized to provide for additional measurements on the program. In addition, a new alumni survey form has been created and will be mailed out periodically. The Industrial Advisory Board and the IEEE Student Branch will also be asked to continue to provide input on the program objectives.

All of these inputs will go to the Undergraduate Curriculum Committee. The Committee will summarize the results to determine the effectiveness of the individual classes and the objectives. The Committee will develop a report indicating the changes needed to the delivery of the course, the course itself and/or the objectives of the course to assure continual improvement of the program. The report will be used during the next evaluation period to determine the effects of the change.

Quality Improvement

The basic Deming Plan-Do-Check-Act procedure is embedded in the ABET 2000 criteria. Our feedback mechanism involves a number of quality control techniques. Quality Function Deployment is used as a means of relating the customer's needs to teaching procedures. This is done through a "House of Quality" form which relates customer requirements to course competencies and curricula. The course competencies can then be related to instructional techniques and processes.

Senior exit interviews, alumni surveys and fundamentals of engineering type exam results are used to measure the overall program and curricula. Each of these measures yields a quantitative value that can be used in a control chart to monitor progress.

The course competencies are measured through the course evaluation forms and sample student work. Instructional techniques are related to the course competencies and are also measured by the student evaluation questionnaire. The area sub-committees within the department evaluate each section of each course to determine the effectiveness of meeting each course objective. These values can also be used in a control chart form to monitor progress.

The undergraduate curriculum committee will identify problems or areas for improvement. The committee will meet with representative faculty, students and alumni to determine cause and effect relationships and develop a plan of action. Upon approval of the constituencies, the plan will be implemented. Results of the action will then be measured during the next cycle.

Conclusion

This paper presents a snapshot of our current thinking and progress toward meeting the ABET 2000 requirements. We have made numerous changes since the beginning of this process and the final form may vary considerably from what is given here. Hopefully, this snapshot of the process we are going through and our problems and concerns will be helpful to others.

References

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